

**Social Influence in Second Life: Social Network and Social
Psychological Processes in the Diffusion of Belief and Behaviour on
the Web**

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Abstract

The Internet has challenged social psychological theories of influence that have focussed on interpersonal perceptions of trustworthiness, expertise and similarity, and normative attributions of social identity. As knowledge is increasingly decentralised and user-generated, new questions arise about how online participants identify which information to adopt or reject.

This thesis examines which social psychological and social network analytic features predict attitude and behaviour change using information gathered about 47,643 related avatars in the virtual community Second Life. Using data collected over three studies from online surveys and data accessed from the application's computer servers, it describes why the structure of a social system, an individual's position in a social group, and the structural content of an online relationship have been effective at predicting when influence occurs.

The first study assessed the relationship between network strength and attributions of trust, credibility, social comparison and prototypicality. Results suggested that network theories that describe influence on the basis of network strength do so because it implicates interpersonal and normative features of influence, evident in this community by the amount of offline information account holders disclose to online contacts. The second study examined the features that predicted attitudes to sexual activity in the virtual world. In the online space, perceptions of norms were the strongest predictors of personal attitudes, and network features identified how accurate and inaccurate they were. The third study followed the diffusion of the new voice service through Second Life over a nine-month period. Network features emerged as most important immediately before and after an innovation achieved critical mass, but the psychological features assured that diffusion persisted during periods of slow uptake.

The results extended the theoretical understanding of the interplay between psychological and network processes in the adoption of attitudes and behaviour online.

Statement of Originality

This thesis and the work to which it refers are the results of my own efforts. Any ideas, data, images or text resulting from the work of others (whether published or unpublished) are fully identified as such within the work and attributed to their originator in the text, bibliography or in footnotes. This thesis has not been submitted in whole or in part for any other academic degree or professional qualification. I agree that the University has the right to submit my work to the plagiarism detection service TurnitinUK for originality checks. Whether or not drafts have been so-assessed, the University reserves the right to require an electronic version of the final document (as submitted) for assessment as above.

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1. Introduction

1.1. *Overview*

The Internet is a communication medium that challenges traditional theories of social influence. Widespread, free and open content sources like weblogs and forums produce libraries of user-generated contributions that can be accessed and repurposed by consumers, challenging models of knowledge ownership and distribution via top-down sources like newspapers, radio and television. Influence theories that focus on notions of interpersonal trust (e.g., Bandura, 1977), source credibility and similarity (e.g., Hovland, Janis, & Kelly, 1953; Petty & Cacioppo, 1986) are potentially contested in the new web paradigm, where identity is fluid (Turkle, 1995) and rapid dissemination of new ideas and disinformation from anonymous sources is made possible because of the ease with which the digital content can be reproduced and shared.

Further, paradigms that emphasise social norms appear inappropriate to apply to a medium in which communication is so lean that group processes are challenged (McKenna & Bargh, 2000). Yet although early accounts constructed these environments as dehumanised, antisocial and lawless spaces (Kraut *et al.*, 1998), extensive research over the past 20 years has documented the plethora of social structures and group phenomena that have emerged from the widespread webs of interconnections between people gathered in communities of practice (Wellman, 2001; Wellman, Boase, & Chen, 2002; Wellman & Gulia, 1999; Haythornthwaite, 2007). Ethnographers, anthropologists, sociologists, economists, political scientists and psychologists have found extensive evidence for systems of self-organisation (Correll, 1995), governance (Dibbell, 1999) and, indeed, influence (Guadagno & Cialdini, 2005). These outcomes have emerged from online spaces that encourage social interaction (e.g., Book, 2004), from e-commerce sites where reviewers develop reputations (Rheingold, 1993) to chat rooms where new patterns of language are established (Boase & Wellman, 2006), to sprawling virtual worlds where economic value based on rarity and social capital allow for the construction of

culture in disembodied cyber-spaces (Barlow, 1993; Bergquist & Ljungberg, 2001; Giesler, 2006).

Social psychological research that has sought to understand the processes and implications of online influence has tended to focus on experimental situations, using short-term computer-mediated systems to assess the impact of anonymity on conformity (Spears & Lea, 1994; Guadagno & Cialdini, 2005). This research has described how the Web creates a “levelling-ground”, simultaneously devaluing offline status, but at the same time making salient offline commonalities that are wittingly or unwittingly communicated between participants. Results of these analyses have highlighted the benefits of such systems for stigmatised and low-status populations, but they also have cautioned that the deindividuation of online activity supports compliance, leading to pockets of homogenous groups of individuals seeking confirmation from others perceived as similar. Arguably, these outcomes do not take into account the meanings of the online relationships developed by participants invested in the social systems of online communities (Guadagno & Cialdini, 2005).

This research seeks to address this by assessing the effects of interpersonal and normative source attributes on the development of attitudes and behaviour, as outlined in the Elaboration Likelihood Model of Persuasion (ELM; Petty & Cacioppo, 1986), Social Comparison Theory (SCT; Festinger, 1954) and Social Identity Theory (SIT; Turner, 1982), in an online community.

The ELM aims to identify when the target of an influential message will attend to the content of a persuasive message or the attributes of the source. It proposes that when an individual is invested in the content of the message, s/he will consider the content of the message, but when s/he is not motivated to process it, s/he will be persuaded by features like perceived trustworthiness and credibility.

This has implications for online persuasion. Although relationships online have been described as starting at a disadvantage when it comes to attributions of credibility and interpersonal trust (Green, 2007), there is evidence that online participants do develop trusting relationships and that they ascribe credibility to web

content. This brings questions to bear on the relevance of these attributions for online persuasion.

Festinger (1954) proposed in SCT that influence occurs when individuals change their attitudes or behaviours to align themselves with an individual or group whom they compare themselves with: they seek to increase their self-esteem by becoming more similar. Sources of such social comparisons are likely to be perceived as sharing similar attributes already. It has been argued by Spears & Lea (1991; Spears, Lea, & Postmes, 2007) in the Social Identity Model of Deindividuation Effects (SIDE) that the anonymity of the online medium produces greater attributions of interpersonal similarity based on social cues that result from stereotyped perceptions extrapolated from the few social cues available online because of the leanness of the communication environment.

The Social Identity Deindividuation Effects Model (Spears & Lea, 1994) seeks to explain how stereotypes affect influence online. It proposes that these stereotypes activate a social identity, based on the perceptions of a group prototype that individuals conform to in order to increase self-esteem, which they do by aligning with an in-group and distinguishing themselves from an out-group. Indeed, the online environment has been criticised for producing a confirmation bias, balkanising individuals in groups of similar-minded people who confirm each other's attitudes and behaviours and ensure conformity (Williams, 2007). This is one element under scrutiny in this thesis.

The context of this research is Second Life, an online community created and maintained by the commercial organisation Linden Lab. It was opened to the public in 2001, and by the end of 2006, over 15 million accounts had been created by people from around the world. Public and media interest in Second Life during 2005-2006 focussed on the possibilities for commercial, non-profit and ideological organizations to convey their messages to its population. The analyses that are described in this research took place during this time.

Second Life belongs to a sub-category of online communities called social virtual worlds. In this space, participants were embodied by avatars, or computerised

representations of themselves, which they used to interact with other avatars and objects in the 3D computer-generated space.

Lazer (2007) argued that these environments demonstrate contexts of natural human interaction better than experimental paradigms because the participants in these social virtual worlds are invested in the relationships and the cultures that emerge there. This research proposes that because of this, it is possible to examine the processes of social influence in Second Life in order to extend an understanding of how attitudes form and behaviours are adopted. While virtual communities like Second Life have been criticised for undermining offline social interaction, it is proposed in this thesis that the interpersonal interactions that are established in Internet environments can have meanings for the participants who engage in them, and that they can support the social attributions that have been implicated in offline theories of influence.

In addition, the Internet offers an opportunity to describe pathways and processes of social change because its connections are explicit: interactions and behaviours are captured by computer servers. Social Network Analysis has been one effective strategy for articulating interpersonal connectivity, by describing the topographical map of social systems. It has been used to identify clusters and holes in the pathways of diffusion, describing the processes involved in social change using structural explanations for attitude and behaviour similarity. As Internet technologies have emerged, analysts have begun to examine the virtual social structures of influence.

They assess the patterns of connections between people and extract three types of features. First, they describe networks by their structures. Loose networks have few interconnections between individuals, while dense networks feature many interconnections between individuals. It has been argued that social change occurs more quickly through dense systems because innovations have many pathways along which to flow. In contrast, loose networks are hypothesised to demonstrate slower diffusion because the links that would facilitate the spread are absent. The Web has been described as a network of networks (Wellman, 2001) because its extensive, but

loose, topography connects dense communities. This pattern of connectivity has been cited as the reason for the rapid dissemination of ideas and information.

Second, network theorists describe individuals in the network by their positions. Central people are described as being connected with many people, while peripheral people are described as being connected with a few. Central people have been found to facilitate social change because they are able to expose more people in the network to an innovation. When they are at the centre of a dense network, it has been found that they facilitate the spread of new ideas or practices to their local cluster. In contrast, innovations that originate from peripheral members have been found to diffuse slowly, but they have been described as more innovative and responsible for bringing new ideas to communities from elsewhere in a system (Rogers & Kincaid, 1981).

Central content sources have been identified in data-driven network analyses (Freeman, 1978) of the Internet by focussing on hyperlinks between Web content, or the number of contacts an individual has connected on social network sites. The results have pinpointed influential websites, weblogs or people who are well connected around the Web who arguably facilitate the dissemination of content via their many links around the world.

Third, network analysts describe relationships between individuals by their strengths. Weaker relationships have been found to be important in maintaining diffusion across loose networks because they are responsible for bringing new information to new groups (Granovetter, 1973). In contrast, stronger relationships have been described as more persuasive, and facilitate the spread of innovations. Strong ties have been associated with pairs of people who have similar attitudes and behaviours.

In this thesis, it is argued that Social Network Analysis and social psychological theories of influence are complementary in the processes they use to describe social influence. However, psychological research rarely considers structure and position in the social network (Weenig, 1993; Weenig & Midden, 1991), and social network analysts rarely consider why, psychologically, their measurements are

effective predictors of social influence (Weenig, 1993). Psychologists argue that Social Network Analysis is focussed on the outcomes rather than the interpersonal and normative reasons behind them, and analysts argue that the experience of the individual that psychologists describe complicate the structures of relationships (Burt, 1987; Valente, 1995). The focus of this analysis is to unpack the subjective meanings of network measures for community participants, and to identify elements of network analysis that are not explained psychologically, in order to extend our understanding of social influence. It is argued that these two related disciplines are well placed to assess influence in this new, connected world, explaining the interpersonal and normative constructions of online social phenomena.

This research aims to explain why social network features have been effective in predicting influence by examining them alongside social psychological features when identifying the influence sources behind personal attitude and the adoption of a new behaviour. There were three objectives: first, to identify why network strength has been effective in predicting influence by examining its relationship with interpersonal and normative attributes that have been associated with influence in the ELM, SCT and SIDE; second, to examine why network density, network position and network strength have been effective at predicting attitudes; third, to assess why network position and network strength have been effective at predicting when an individual will adopt a new behaviour.

Data was gathered across three studies using self-report surveys and by collecting information from the Second Life community servers. A multi-method design was implemented to generate the most complete network and behaviour information, while at the same time retaining content about attitudes and perceptions from the perspectives of the participants.

The results provided evidence that analyses that implement network strength predictors are effective because they identify relationships that are psychologically meaningful for relationship partners. It was demonstrated that network density and network position are important in the accuracy of the perceptions of the norms that group members have about their local networks. Finally, the results suggested that

network variables identified the times during diffusion events when innovations transformed from socially risky phenomena into legitimate behaviours.

These results extended the research that has observed that social psychological and social network features are related, and that they complement one another. They described when and why attitudes and behaviours are adopted in an online community based on interpersonal attributions and the structures of social interaction. The research did this by measuring the behaviour and connections of 47,643 members of the Second Life community, creating an extensive and unique social network analysis of a diffusion of innovations, and the first to do so on such a scale that simultaneously took into account the experiences of the participants.

It provided evidence for the interpersonal and normative processes that occurred in online communities, demonstrating that the Internet medium offers affordances for influence research.

1.2. Overview of the Chapters

Chapter 2

Chapter 2 provides an introduction to influence theories in the social psychological and social network paradigms, investigating the processes that have been theoretically associated with influence in each. It seeks to identify the common processes and establishes the areas where structural and psychological explanations may diverge.

It continues with an analysis of the unique features of online communities that challenge the influence theories. It is argued that the deindividuated nature of identity, the meanings ascribed to depersonalised, disproximate relationships and the development of virtual social identity based on a sense of belonging rather than on physical place particularly challenge the identity approaches to influence within psychological thought.

It argues that research about online influence in both disciplines has not considered the meanings of online communities for participants, whether because

they have examined online influence with disinterested participants or have described social structure using data-driven methodologies that do not take into account the community members' experiences.

This chapter will finish with the research questions and the specific question that each empirical chapter addresses.

Chapter 3

Chapter 3 introduces the tools used to answer the research questions. It introduces the Second Life domain, describing the design features that encourage the development of personal identity, interpersonal relationships and social identity. It continues by outlining the methods used to collect data in egocentric and whole network studies, the two types of social network analysis undertaken in this research. For the former, sociometric surveys were developed to capture the meanings of relationships between people. For the latter, access to the Second Life servers was arranged with the support of the virtual community owners to capture the connections between all community members in the sample, plus the behavioural outcomes described in Study 3 from their database. It describes the criteria for interpersonal connection operationalised in this research – Second Life Friendship – and discusses what it means to be Friends in this virtual world.

The ethical implications are outlined, focussing on participant anonymity, secondary sources and informed consent.

Research in online environments requires special ethical considerations, and these are also discussed at the end of Chapter 3.

Chapter 4

Chapter 4 describes the first empirical study. Using a sociometric online survey that identifies interpersonal connections and defines network and psychological attributions of closeness, it explores why network strength has been effective in predicting influence offline, and how properties of the online relationships in Second Life may affect this. This investigation seeks to understand the psychological attributions associated with three actions in this online community,

which were identified as the network strength criteria to identify interpersonal closeness and distance.

The results suggest that the three network strength measures – the likelihood of granting an Second Life Friend the right to modify the avatar, the likelihood of establishing an virtual world “partnership” with an Second Life Friend and the likelihood of communicating in public, via instant message or outside the virtual world – with an Second Life Friend were differently related to psychological attributions of trust, credibility, social comparison and group prototypicality.

It is argued that the findings of this research help to establish a relationship between social network analysis and social psychology because definitions of network strength explained the meanings of interpersonal and normative features of influence in this virtual world.

Chapter 5

Chapter 5 describes the second empirical study. It examines why network position and network density have been found to predict attitude similarity between two Second Life Friends. It explores how psychological and network features predict attitudes about cybersex by measuring an egocentric network using self-report online surveys to gather data about network connections and psychological attitudes.

The data suggests that perceptions about others’ attitudes to sexual activity in Second Life were the best predictors of the personal attitude, and that network density and network strength measures generated more or less accurate predictions about what friends were expected to believe. It is argued that the online environment may have enhanced inaccuracy, as the medium offers little corroborating evidence for actual practices and stated beliefs, but that normative influence has a structural component that has not been defined in the literature before.

This leads to new insights into the structural effects of the looseness of Internet networks on the perceptions of norms, resonating with (Wojcieszak, 2008) findings that online pluralistic ignorance engenders confirmation biases that may

lead to peer pressures, attitude homogeneity and greater antagonism towards a perceived out-group.

Chapter 6

Finally, the last empirical chapter uses behavioural and self-reported data to describe the diffusion of an innovation, voice communication, along the pathways of adoption through a 47,643-person Second Life network. It aims to examine why structural predictors are effective at identifying when an individual is likely to adopt a new behaviour and what the catalyst is for periods of rapid and slow uptake. It identifies the importance of both structural and interpersonal and normative attributes for the success of a new technology in this community.

This research was able, with the support of Linden Lab, to follow the diffusion of this new innovation through the community as participants adopted the voice service. It uniquely had access to the computer servers underlying the technology, and was able to unpack the network and psychological factors that predicted the uptake of this new behaviour over a period of nine months from the service's launch. In doing so, it was possible to examine what the social network analytic predictors offered, in addition to the interpersonal and normative features of influence described by the Elaboration Likelihood Model of Persuasion (ELM; Petty & Cacioppo, 1986), Social Comparison Theory (Festinger, 1954) and the Social Identity Deindividuation Effects Model (Spears & Lea, 1994), to social psychological theories of influence.

Chapter 7

Finally, Chapter 7 provides a summary of the findings and the conclusions drawn regarding the unique roles social psychological and social network attributes play in social influence. It focuses on the ways network and psychological features of influence are related, and how they are complimentary to one another. Attention is paid to the online context of this research, proposing that the processes of interpersonal and normative influence in the psychological literature and the network processes described by social network analysts were similar online and offline.

The chapter presents the methodological issues this study raises and proposes best practices for studying influence phenomena in online networks. It concludes with suggestions for future research.

2. Literature Review

The Internet is a communication medium that has changed perceptions of information sharing, knowledge ownership and interpersonal interactions (Lazer, 2007). Highly inter-connected social software networks like weblogs, forums and other collaborative online entities such as virtual worlds have challenged traditional notions of information ownership, resulting in a reconsideration of online contributors' involvement in news reporting and other forms of citizen participation. In the four decades since the original ARPAnet¹ was established between four universities, the Internet has transformed from an exclusive technology with few gatekeepers into an open technology that can be used and contributed to by anyone with access to a computer terminal with an Internet connection. This brings new questions to bear about existing approaches to social influence that focus on interpersonal processes like attributions of trust and credibility and social comparisons, and normative processes like identification with a group prototype and social identity, as physically distributed networks of individuals who engage with one another in virtual communities - from different cultures and perspectives - consider which innovative attitudes and behaviours to adopt or to reject.

Social psychology has studied social influence since the discipline was established (Turner, 1991). Hogg and Vaughan (2002), Turner (1991) and others have argued that it is interchangeable with the discipline's definition. While there have been many descriptions of social influence, this thesis takes as its starting point Turner's (1991) proposal: that social influence is the process by which people affect others' thoughts, feelings and actions directly and indirectly.

This definition incorporates the processes implicated in the adoption of attitudes and behaviours based on interpersonal and normative features of influence that have been evaluated in theories like Elaboration-Likelihood Model of Persuasion

¹ ARPANET, or Advanced Research Projects Agency Network was developed by the US Department of Defence and is the predecessor of today's Internet. It is the technological protocol on which today's data and voice communication are shared across the network, allowing multiple consoles to access the same material at the same time.

(Petty & Cacioppo, 1986), which focussed on the attributes of the source of a message as the driver of persuasion, Social Comparison Theory, which identified the motivation for enhanced self-esteem as the process for influence, and identity theories like Social Identity Theory (Tajfel & Turner, 1979) and Social Identity Model of Deindividuation Effects (Spears & Lea, 1994) which described the conformity associated with belonging to a social group. Turner (1991) emphasised the context of influence, proposing that the impact of others was based on the situation in which influence occurred. However, this definition does not stipulate a physical, proximate component to influence; rather, it allows for influence that is indirect, or mediated.

The Internet's primarily text-based communication may introduce contextual differences that affect social influence processes. McKenna and Bargh (2000) have proposed four ways in which cyberspace is different from face-to-face encounters that have been assessed by social psychologists for their effects on social influence: 1) anonymity introduces implications for non-normative behaviour, depersonalisation and attention to category salience (e.g., Bailenson & Yee, 2005; Blascovich *et al.*, 2002; Guadagno & Cialdini, 2005; Guadagno, Blascovich, Bailenson, & McCall, 2007; Spears & Lea, 1994); 2) absence of physical cues reduces the importance of status, expertise and liking on the effectiveness of influential messages (Guadagno & Cialdini, 2005); 3) the mediated format places greater emphasis on the content of opinion formation (Petty & Cacioppo, 1986; Correll, 1995; Kendall, 2002); and 4) lack of physical proximity between online participants accentuates the importance of time and place of online co-presence in the development of influential interpersonal relationships (Correll, 1995; Kendall, 2002).

Indeed, the 'leanness' of computer-mediated communication (CMC) has been criticised by social theorists (Kraut *et al.*, 1998); however most of the criticism has surrounded the offline social effects of the early World Wide Web which, it has been argued, was a socially desolate environment that had a high cost to entry in terms of technological know-how and access (Kraut *et al.*, 2002). Since this early research, there has been evidence to suggest that online interaction is socially rich,

encouraging public participation, interpersonal altruism and community involvement (Kraut *et al.*, 2002; McKenna & Green, 2002; Rajani & Chandio, 2004; Utz, 2000; Wellman & Gulia, 1999).

Criticisms remain, however. Some recent research has continued to identify shortcomings of the medium, particularly focussing on the instability of online relationships in social networking services (Sigman, 2009), but these analyses have focussed on the number of friendships people are able to maintain, and the meanings of interpersonal closeness ascribed to them compared with offline relationships. These analyses have not assessed, for example, the implications of the number of connections for the speed of widespread social change, or how participants in these online communities differentiate between virtual contacts in terms of relationship closeness. Further, the majority of online influence theory has arguably sought to apply offline approaches to influence, usually within the context of short-term experimental groups.

This body of research arguably has also not taken into account the social structures of online groups that have been described by economists, political scientists, sociologists and psychologists in terms of their emergent social phenomena. For example, synchronous and asynchronous communities, from text-based bulletin boards to multi-media virtual worlds, have been observed to display systems of government (Johnson, 2003; Schuler, 1997; Shirky, 2003), social hierarchies (Correll, 1995; Jacobsson & Taylor, 2003) and online-only norms (Chester & Bretherton, 2007; Guadagno & Cialdini, 2005) that these researchers have argued reflect and inform influence processes similar to their offline counterparts.

This thesis proposes that online contexts present differences to offline contexts that challenge social influence processes, but that many of the processes described by social psychologists are more similar than the outcomes of previous research has suggested. It is argued that the online environment does have the capacity for influence based on interpersonal and normative attributions and group pressures, but that to measure these in computer-mediated communication requires

that tools and practices be adapted. For example, offline influence theories which emphasise identity, relationships and norms should take into consideration how these phenomena are experienced by online participants in the virtual contexts rather than comparing them between the online and offline spaces.

Further, online analyses should consider the structural formations of social groups, which have been observed to encourage greater connectedness. One approach that has taken this into consideration and articulates the pathways of social relationships in online and offline communities is Social Network Analysis.

Social Network Analysis (SNA) describes social influence outcomes as they diffuse across a whole social system, seeking to predict how attitudes and behaviours move through a population based on its structure, an individual's position within it and the nature of relationships that connect people. Haythornthwaite (2007) has argued that Social Network Analysis is a useful approach to describe online communities because it makes the connections explicit: by mapping relationships in cyberspace, it identifies communities that are difficult to define in the leanness of CMC, particularly without relying on geographies or physical proximities to do so. She proposes that SNA identifies communities that have meaning for participants, which is arguably the prerequisite for many social psychological theories of influence. Drawing on social network theory, this thesis argues that influence is not uniformly experienced by individuals, rather, it differentially affects them depending on interpersonal and normative features, the structures of their networks, where they are located with them and the nature of the relationships that connect them.

There have been some psychological theories that have attempted to integrate features of SNA by looking, for example, at the number of sources who hold an attitude or perform a behaviour (e.g., Festinger, Schachter, & Back, 1950; Latané, 1981). Conversely, some network analysts have extended beyond the structural focus of their field by considering the content of subjective interpersonal connections (e.g., Correll, 1995; Kirke, 1996; McCarty, 2003; Rogers & Kincaid, 1981b). These studies have emphasised a strong, supportive link between the two approaches. Particularly in the context of the challenges presented by online community, it is

argued that attitude and behaviour adoption can be best described from both perspectives. This thesis explores their relationship and describes how they compliment one another in predicting social influence.

This chapter reviews the psychological perspective of social influence, focussing on interpersonal and normative predictors of attitude and behaviour uptake (section 2.1). It identifies the specific challenges that the online environments pose to these social influence theories (section 2.2), and presents the structural processes that may be useful in addressing these concerns (section 2.3). It describes the structural descriptors used by analysts to predict influence, proposing that these are related to psychological phenomena, and that they contribute additional unique predictive power in describing social change. It concludes with a statement of the research question and the questions that will be addressed in the rest of this thesis (section 2.4).

2.1. Psychological Perspectives of Social Influence

Social psychology has offered an approach to social influence theory that describes how individuals experience social pressures that lead to adopting attitudes and behaviours.

There are many different ways social psychological theory has described the processes that lead to attitude and behaviour change, but this section focuses specifically on those that McKenna and Bargh (2000) described as most affected by the features of the Internet context: interpersonal and normative influence. Although the Web appears to be an environment in which information-based social influence would produce outcomes like attitude and behaviour change because it is a medium that trades in knowledge content (Barlow, 1993), it is proposed that the quantity of data that can be accessed online contributes to perceptions of the features of the person or group who presents it.

The aim in this section is to describe why interpersonal source attributions of trust, credibility and perceived similarity, and normative source attributions of group prototypicality, have been observed to produce offline influence outcomes.

Thereafter, these constructs are examined in online environments, seeking to establish the foundations for social influence in computer-mediated communication (CMC).

Interpersonal influence

Theories that emphasise interpersonal features of influence describe the attributions individuals make of influence sources, and suggest that influence occurs because an individual is persuaded to adopt an attitude or behaviour by someone who is considered trustworthy or credible, or because of the observed or communicated experiences of someone with whom they compare themselves. These attributions may act in concert, but the goal of the research in this area has been to understand how each of these individually contribute to attitude and behaviour change. The next section briefly addresses the each of these factors.

Trust and credibility

Social psychological research has examined attributes of the source of a message with the aim of identifying when and how a message becomes most persuasive (e.g., ELM; Petty & Cacioppo, 1986). Attributes that are believed to enhance persuasiveness of sources include trust and credibility (McGuire, Kiesler, & Siegel, 1987; Wilson & Scherell, 1993). Though other features, such as likeability and physical attractiveness have also been identified in the literature as playing a role in influence by creating what Petty & Cacioppo described in the ELM as a temporary, ‘peripheral’ shift in attitude or behaviour, trust and credibility have been considered the decisive agents in convincing a resistant population to adopt a new innovation (Renn & Levine, 1991). Trust and credibility may be complimentary concepts, but it is argued that they are distinctive.

Trust is a complex interpersonal factor that has been widely studied across multiple disciplines. The abstract concept has both specific and generalised components: an individual may be perceived as trustworthy in a particular situation, or s/he may be perceived as trustworthy across contexts. Trust is often associated with risk, uncertainty and vulnerability (e.g., Kramer, 1999), and psychologically,

Holmes and Rempel (1989) have broadly defined it as, “the confident expectation of positive outcomes from an intimate partner” (p. 188).

Theories that have described the development of trust have suggested that it is based on social and behavioural dimensions. For example, Cvetkovich (1999) found that people perceived as similar, based on cognitive inference that they are part of an in-group, will be perceived as trustworthy. Behaviourally, an individual who has previously demonstrated competence, consistency and fairness encourages attributions of trustworthiness (Poortinga & Pidgeon, 2003).

Trust in a source is one of the factors leading to opinion change. In a series of meta-analyses, Wilson and Scherell (1993) examined the quantitative effects of source effects on persuasion and found that trust demonstrated a positive effect on attitude change across 114 studies in the psychological and marketing literature. This extended the early outcomes observed by Kelman and Hovland (1953), who manipulated source attributes in a series of experiments, and found that trust produced long-term opinion change.

In contrast, credibility has been more closely linked with perceptions of source expertise based on personal or perceived experience of past performance. Renn and Levine (1991) defined credibility as, “the degree of shared and generalised confidence in a person or institution based on their perceived record” (p. 180). An individual will be perceived as credible because s/he is perceived to know the truth and is expected to tell the truth (Hovland, Janis, & Kelly, 1953).

There has been a large body of evidence in the literature that perceptions of credibility are important in generating attitude and behaviour change. For example, the risk literature has focussed on credibility attributions in its analyses of communications aimed at generating public understanding of risk (Renn & Levine, 1991), while marketing research has focused on promoting the use of brands for businesses as a way to develop reputation associated with hallmarks that project quality and credibility (e.g., Herbig & Milewicz, 1995). Across these studies, appearance, communication style, honesty and perceived similarity emerged as features that affect perceptions of credibility.

However, Kelman (1961) argued that credibility attributions were most effective in processes of opinion change when the content of a persuasive message is perceived as relevant to the context. He found that attributions of appearance and communication style mediated the effectiveness of opinion change because they focussed the locus of attention on the relationship between the target and the source (attractiveness) and the context of the communication (communication style). These, he proposed, were temporary outcomes. Rather, he argued that credible communication that was perceived as relevant resulted in internalisation more often than the other attributes. Indeed, Wilson and Scherell (1993) found that perceived expertise, an operationalisation of credibility arguably associated with a specific topic, explained the largest proportion of variance in persuasion outcomes in the studies they scrutinised.

Social Comparison

Source attribute models like those described above that emphasise attributions of trust and credibility have been criticised for disregarding the group and placing too much emphasis on conformity and compliance processes. Influence outcomes become the result of majority influence pressures, i.e. that persuasion is acted upon an individual, who accepts its demands if the source is viewed as sufficiently trustworthy or credible.

Bandura (1977) argued that influence occurred because of the communicated or observed experiences of close friends and significant others. In Social Learning Theory, he argued that an individual adopts an attitude or behaviour because s/he identified with a source rather than because s/he was perceived as trustworthy or credible. Bandura's approach was an extension of Festinger's Social Comparison Theory (SCT; 1954), which emphasised the interpersonal pressures than an individual experienced because s/he wished to be more like or unlike the source of comparison. Festinger emphasised active participation rather than passive acceptance of influence, and his theory suggested that the process that produced influence outcomes was the drive for self-esteem.

A shortcoming was that it did not contextualise the comparisons: he proposed that they were constructs of the target. Sources of comparison needed only be on the ‘same level’ for comparisons to occur. Subsequent research has identified comparisons with media sources (Richens, 1991), across organisational power hierarchies (Bartel, 2001) and across different socioeconomic statuses (Knell, 1999), and comparisons have been experimentally generated based on performance (Bandura & Jourden, 1991). In these cases, influence still occurred based on the personal representations of the other as a source of reference and because the outcome was increased self-esteem, but these studies highlighted that Festinger did not explore what it meant to identify a source of reference, or, indeed, how the influence occurred. Although the comparisons were more active than those described by the ELM, it was assumed that the attribute – whether trust, credibility, or the basis identified by the individual for comparison – acted upon the target.

Suls and Wheeler (2002) described the process as a self-evaluative function, re-asserting the role of the individual in the influence outcome. The source became a proxy for the self, allowing the individual to identify with desired selves. They suggested that this was reliant on the view that the source was similar in some way, which, as Kelman argued with regards to credibility, made a persuasive message or other influence outcome relevant to the target.

However, this view arguably remains too narrow in scope. It focuses on the target only, emphasising the effect on the self. Other theories, like Bandura’s SLT, placed the comparison in a social context, proposing that the learning that occurred in the SLT was also based on the observed or communicated response of the social environment in which the comparison was situated.

This was further refined by Perez and Mugny in Conflict-Elaboration Theory (C-ET; Perez & Mugny, 1996), which emphasised both the social and the individual dimensions of attitude integration. They described several levels of elaboration: the objective rightness or wrongness according to the individual, the perceived rightness or wrongness according to the social context, and the dimensions of the source that originated the idea. Objective rightness or wrongness was dependent to an extent on

the context of an influence overture, which meant that it may have been considered for its social relevance rather than the personal relevance described by Suls and Wheeler. Arguably, this is dependent upon whether an individual is motivated to consider the social context as the reference, or the individual as the reference.

Perez and Mugny emphasised the social and individual context in which influence occurs, a feature that was absent from Festinger's original theory. Their emphasis on this more situated aspect differentiated this theory from the interpersonal dimensions discussed in this section. Rather, its focus on social acceptability suggested that influence was constructed by social norms. The next section explores this further.

Normative influence

In the last section, it was suggested that the research on interpersonal influence emphasised a target's view of the source of an attitude or behaviour, and that this had an effect on how likely it was that a target would be persuaded by a source: if the reference was perceived to be trustworthy, credible or was similar, the outcome would be adoption of an attitude or a behaviour.

However, as argued, this approach is arguably individualistic: its emphasis on attributions of trust and credibility, or on social comparisons with an individual perceived as similar to the self do not take into consideration what Perez and Mugny aimed to integrate in C-ET: the effect of the norms of a group on the individual. This section argues that when an individual identifies with a social group and this social identity is salient, s/he will be influenced by its attitudes and behaviours.

Social Identity

A social identity has been described as the part of the self-concept that is defined by membership of social groups and social categories. It has been argued that it operates on three psychological processes: categorisation of the self, objects and others into groups; comparison of the self, others and groups to identify in- and out-group belongingness; and the use of the categorisations and comparisons to boost self-esteem Tajfel & Turner (1979).

Tajfel & Turner (1979) theorised that social identities work within the bounds of norms and roles. They observed that social identification with a group defined and limited behaviour, promoting conformity to shared behaviours, as defined in the social context. They described this in Social Identity Theory (SIT). SIT and the related Social Categorisation Theory (Turner, Hogg, Oakes, Reicher, & Wetherell, 1987) aimed to integrate group and individual processes by seeking to differentiate between personal identity and social identity, emphasising the social context in social influence, motivated by the drive for self-esteem.

SIT proposed that normative influence occurred through the categorisation of the self as part of one group, and not the other. Unlike Festinger's SCT, which was focussed on the individual's relationships with the source of comparison, Tajfel & Turner described esteem increasing with an individual's perception that his/her in-group was distinct from an out-group. The perceived norms of the groups, which Hogg (2001) defined by their prototypes, identified the boundaries of acceptable behaviours or attitudes for individuals who wished to remain group members. In this way, they proposed, norms influenced.

Prototypes

Hogg (2001) proposed that perceptions of in and out-group members are based upon the reference point for the social identity: the group prototype. This was a construct he found to be mutually determined and representative of the norms and attitudes that defined group belongingness. Rivas and Sheeran (2003) extended Hogg's thesis by identifying two aspects of prototype perception that contributed to influence: affective evaluations of prototype (e.g., liking) and comparative evaluations of the prototype (e.g., similarity). Their analysis demonstrated that evaluating the prototype as positive and similar resulted in an increase in adoption of a behaviour.

Hogg proposed that prototypes emphasised in-group similarities and accentuated out-group differences. If a negative reference group was salient, the individual sought to differentiate him/herself from that prototype; if the reference group was positive, the individual aimed to integrate aspects of the prototypical

member into his/her self, including the attitudes and behaviours that were perceived as normative. This was demonstrated in relation to risk behaviour (Gerrard *et al.*, 2002; Gibbons & Buunk, 1999) and was an explanation for group polarisation (McGarty, Turner, Hogg, David, & Wetherell, 1992). In Hogg & Hains' (1996) analysis, prototypes were the benchmarks for evaluation of group membership.

There are relationships between the interpersonal and normative features that are based on group membership. A social identity arguably has implications for source attributions: when a social identity is salient, the perception of a message or person as trustworthy or credible will be integrated with the view that the source of a persuasive message emerges or the group to which the person belongs is trustworthy or credible. In other words, the attributions would be socially determined, established by perceptions of the source as a member of the in-group, the norms of a salient group identity, and the social context.

Additionally, Hogg & Hains (1996) found that a target perceived as the group prototype and sources perceived by a target as belonging to a common social identity were viewed more positively, more socially attractive and were sources of social comparison. In other words, individuals who were viewed as representing the social group's prototype became the sources of social comparison for behaviours and attitudes that were socially-situated and made the social identity salient because they were evaluated for their in-group membership.

The normative features of influence address one of the shortcomings of the interpersonal features: the emphasis on the context. In situations of depersonalisation, when contextual cues are emphasised (Spears & Lea, 1994), Hogg (2001) found that individuals increased identification with a prototype: it became more salient and engendered more identification. Individuals became more likely to conform to norms based on their stereotyped perceptions of the social identity when cues that enhanced interpersonal attributes were absent. Hogg proposed that this reduced uncertainty by focussing the social identity for all in- and out-group members. Indeed, this is consistent with the effects described by McKenna and

Bargh (2000) with regards to the psychological research that has assessed the effects of online anonymity on influence in virtual environments.

However, the assumption that the online environment is depersonalised is arguably problematic. The literature has described situations in which social phenomena have influenced the decision making process online: social software designers have leveraged the connections between online friends to retain membership (Kim, 2000), e-commerce sites have tested the ELM when designing sites for perceived trustworthiness, credibility, expertise and similarity, and examples of group belonging have been observed in online games, where participants identify group members with virtual badges (Yee, 2006; Taylor, 2001) and in other virtual environments, where language patterns (Paolillo, 1999) and social rituals (Correll, 1995) have been documented. In addition, there have been offline implications for online information campaigns that have promoted political participation, charitable activity and ideological messaging. The next section discusses the theoretical basis for why, in an anonymous environment, such examples of interpersonal and normative influence outcomes may occur, even when the context appears not to support it.

2.2. Applying Psychological Perspectives to Online Communities

The challenges of CMC outlined by McKenna & Bargh arguably affect social psychological approaches to understanding attitude and behaviour change online. The leanness of the online context makes attributions of trustworthiness, credibility, similarity or prototypicality difficult.

However, the literature that has described the development of online trust and credibility, the bases for social comparisons and the emergence of group prototypes in virtual communities suggests that such attributions are possible. This section discusses their findings and their implications for influence research.

First, it describes the context of this research. Online communities that are specifically designed to encourage sociability, in which participants engage over months and years, have been the focus of much of the enquiry that has explored these

theses. They are introduced in the next section. The chapter then describes how researchers have theorised the features of online interpersonal influence and online normative influence. It concludes by summarising shortcomings of the psychological theories when applied to online communities, and proposes how Social Network Analysis may be used to extend psychological understanding of influence in Internet environments.

Online communities

The Internet has been described as a “network of networks” because it explicitly connects groups of people using computer networking technologies (Garton, Haythornthwaite, & Wellman, 1997). A variety of interactions occur online, from functional transactions between a computer user and an e-commerce storefront to relationships that develop between participants in social environments that seek to encourage their members to form communities around topics of interest.

Even within the latter category, there are sub-strata that vary on the degree of sociability that is expected, based on the design of the application. One virtual environment that was explicitly created to encourage user populations to form interpersonal relationships was the social virtual world (Book, 2004b). The interpersonal and normative features of these environments have been described by



Figure 1. A Second Life Environment

researchers, from their early text-based iterations to contemporary, media-rich 3D environments. An example of a social virtual world is Second Life.

Second Life

Second Life was a free² online community for people who were 18 years

² There is an option to become a paid account holder, which allows the customer preferences and options that are not available to free account holders. For example, paid customers have the option to own virtual land, which they can build on or rent to others.

of age and older³. It was the descendent of text-based online systems called MOOs and MUDs (e.g., Dibbell, 1999) in which participants gathered to hang out and to co-create a perpetuating virtual hallucination (Gibson, 1984), or conceptual third place of an active yet parallel world (Ducheneaut & Moore, 2004; Oldenberg, 1989). In them, people with common goals engaged in social interactions and shared information and knowledge (Chiu, Hsu, & Wang, 2006).

Second Life was arguably distinct from goal-oriented environments like Massively Multiplayer Online Games (e.g., World of Warcraft) or social networking services (e.g., Facebook, MySpace, Bebo) because it was situated in self-contained computer-generated 3D environment that its creators provided for participants to socialise and to collaborate in (See Fig. 1). It was developed by the US commercial company Linden Lab and was launched to the public for PC users in 2003⁴.

Second Life was a technological platform that can be conceptualised as a 3D World Wide Web. Virtual ‘locations’ were built⁵ and owned by community members that, like websites on the Web, could be visited by any account holder at any time by navigating an avatar, or computerised representation of the user, to the location. The difference between Second Life and how websites are navigated and consumed was that participants were able to see the avatars of other account holders, or Residents, who were visiting the locations at the same time. This co-presence was a feature of synchronous online communities at this time; Second Life, like other similar social virtual worlds, was comprised of webs of personal relationships based on

³ Another Linden Lab product, Teen Second Life, provided the same services as Second Life but for minors between 13-17.

⁴ At April 2009, there were over 15 million accounts, most of which represented consumers based in English-speaking countries, with some strong representation from Portuguese, Japanese, German and French speakers. Community members were predominantly between 25-30 years old and 41.0% were recorded as female.

⁵ Second Life objects were created using integrated computer graphics modelling tools.

interpersonal interactions that existed within the bounds of that environment⁶ (Rheingold, 1993).

Although research has documented interpersonal and normative phenomena in asynchronous environments like bulletin boards (Correll, 1995; Kendall, 2002), forums and social networking websites (boyd & Ellison, 2007; Hine, 2000), analyses that have described chat rooms, MUDs, online games and social virtual worlds have tended to draw on similar constructs as offline psychological research to explain influence (Yee, 2006; Yee & Bailenson, 2009). Social virtual worlds were not new technologies at the time of analysis, but little attention to these processes had been paid in these online communities in particular, and psychological analyses in these environments was recommended by influence researchers because of their unique social properties (Guadagno & Cialdini, 2005).

Interpersonal influence in online communities

There has been evidence that the depersonalised virtual environment can support attributions of trust and credibility and social comparisons based on self-categorisation. In environments like Second Life, the interpersonal negotiations of trust and credibility emerged over time as part of the growth of relationships. In online communities, like offline environments, trust and credibility appeared to develop between community members based on social and behavioural attributions. Social comparisons appeared to be established based on perceived similarity.

This section describes the social and behavioural attributions of trust, credibility and social comparison in online communities, focussing on the interpersonal, normative and behavioural features that have been associated with the development of trust, credibility and perceptions of similarity.

⁶ Account holders signed up to the service via a website and downloaded the software for the application. Once activated, the software connected the user's personal computer to the network of computer servers that ran the virtual world, where they were able to explore the 3D space and interact in real-time with other account holders who were also logged in.

Online trust and credibility

Social attributions of trust refer to perceived similarities of values, cognitively inferred, observed or based on the context (Cvetkovich, 1999). Yet, Internet relationships arguably start at a disadvantage; Kraut and his colleagues (1998) found that people had more trouble establishing similarity-based trust than face-to-face encounters because the uncertainty shrouding an individual's offline identity undermined confidence in a source of online information. Their analysis of interpersonal online interactions over several months found early on that relationships in the virtual environment featured fewer attributions of trust.

It was anticipated that the reason for this was that people expected more deception: Kraut *et al*'s participants believed that other Web users would hide behind anonymity and use it as an opportunity to present a false self. The literature since that time has demonstrated that online deception is rare, that it is easier to identify than offline deception: DePaulo (1994) assessed perceptions of honesty-based face-to-face encounters and found that the ability to accurately identify deception in face-to-face situations was only slightly greater than chance, while Vazire & Gosling (2004) replicated their analysis online to find that participants were able to discern accurate perceptions of friendliness, intelligence and similarity because they were familiar with the tone and content of online interactions of the fellow community members. Indeed, more recent research has confirmed these findings, indicating that virtual identities were likely to be accurate representations of the offline self (Postmes & Baym, 2005).

Kraut and his colleagues (2002) revisited their initial analysis several years later and found evidence that contradicted their earlier findings. The outcomes of the later study demonstrated an increase in sociability, and there was evidence for the development of meaningful, trust-based online relationships. They argued that the differences between the two studies resulted from the differences in Web uptake; their first analysis took place before the Web became commonplace, and the expectations of participants and the social networks that they developed online were

sparser than the later research that took place after the Internet diffused to a much larger population.

Online trust has been the subject of a large body of research and it has been related to perceived liking and empathy (Feng, Lazar, & Preece, 2004; Levine, 2000), integrity, similarity (Green, 2007) and conceptual and virtual proximity (Levine, 2000). Research has also suggested that there is a tendency for online participants to attribute interpersonal trust more quickly than has been reported in studies of offline trust (Blanchard & Horan, 1998). Results of experimental and observational studies have suggested that attributions of trust were the outcomes of participants' perceptions of openness and honest disclosure in online environments (Ben-Ze'Ev, 2003).

Online trust research has generally applied offline trust paradigms to online contexts, hypothesising that the processes involved in trust's development and its effects on interpersonal interactions are the same. Indeed, the outcomes have suggested that it operates in similar ways in terms of helping to establish and to support relationships, and in terms of the functions they play within communities. Trust is arguably important when developing meaningful relationships in online groups: Riegelsberger, Sasse and McCarthy (2007) found that it encouraged the development of control structures and adaptable social systems that facilitated exchanges that they argued otherwise would not have taken place in the lean, anonymous CMC environment. However, it is argued that some differences remain. For example, the anonymity literature has focussed the expectations of openness and honesty by examining disclosure practices of online community members explained by the absence of offline cues or consequence (Blanchard & Horan, 1998; McKenna & Bargh, 2000a; Turkle, 1995). Rubin's (1975) research has been used to explain this: he described the openness with which strangers on trains revealed personal information about themselves to one another.

Additionally, Bargh, McKenna and Fitzsimmons (2002) described users' sensations of being a 'True' self in computer-mediated communities. Their experimental analyses suggested that participants were more willing to present

themselves online in a way that they felt represented themselves more accurately than in similar offline situations, and this sense of self-disclosure was projected onto other online participants, who they believed were presenting accurate, or ‘true’ selves in virtual environments. This also arguably has implications for online social comparisons.

Online social comparison

Conditions of anonymity in offline environments have been observed to produce positivity biases (Klar & Giladi, 1997), or projections of similarity based on the interpersonal evidence that is projected into the virtual world. The reduction in social cues generates what has been described as a ‘levelling ground’ that hides offline-apparent cues that would enhance differences, and so attributions of similarity

have been found to be enhanced based on the stereotypic evidence that was extrapolated from any available cues Lea, Spears, & deGroot (2001).



Figure 2. Default avatar categories in Second Life

in the form of group associations. It was proposed that these alleviated some of the effects observed in the anonymity literature.

First, the avatar has been described as an object of personal expression (Turkle, 1995). In Second Life, each new avatar belonged to one of a few visual categories (see Fig. 2). Community members were able to refine the look of their

avatar representatives using built-in modification tools, or they paid for personalisation options using the virtual world's currency, the Linden Dollar⁷.

Turkle (1995) and Taylor (2001) argued that the avatar is a systematic and regulated bulletin board of identity, an active yet private nucleus of self-definition. Its creation arguably represented the opportunity for a Second Life user to try out different methods of expression behind a digital mask. As Lyman, Scott, & Harre (2009) maintained, however, the use of the body through manipulations and adornments non-verbally conveys both identity and interpersonal boundaries. In other words, visual cues of identity associated with the avatar were expected to reintroduce physical cues into the mediated environment, re-emphasising their importance in social attributions. It was argued that the avatar and other objects that account holders generated in the virtual world served a similar function as the costumes Lyman and his colleagues observed in offline life.

Second, there was a system of user-created formal groups in Second Life centred on common interests. Most of these were publicly advertised, and could be found by searching for keywords like "Brits," "Educators," or "Music" on an in-world interface. These groups held events or offered special incentives to their members. There was a wide range of groups, ranging from language and lifestyle and each participant was able to choose a salient group name to be listed above his/her avatar for public view. As group membership has been described as an indication of belonging, signalling similarity cues to other virtual world participants (Jacobsson & Taylor, 2003), it was anticipated that the group affiliation also re-individuated the

⁷ A virtual world currency is typical in social virtual worlds (Book, 2004), acting as a business model for the companies who maintain them, and as a design construct that works to add value for the time and effort spent by virtual world participants in the online space. Second Life is a digital environment with an economy based on upon the distribution of goods at low-cost to the supplier, but the currency-based economy offers a degree of rarity that reduces the amount of gift-giving between Residents in the community. This is a feature that has resulted in high-profile examination of the economic systems of Second Life and similar environments (Castranova, 2002; Dibbell, 2006). It also arguably has contributed to the hierarchies that emerge in these online spaces, discussed in the last chapter.

online self, creating a pseudonymous avatar self relevant to the interpersonal interaction in the online world.

The avatar and group identifications were expected to offer salient cues that other community members would be able to use to ascribe perceptions of similarity. It was argued that these, in addition to the reported tendency of online community participants to disclose more about themselves to online contacts, and to project similarity on them based on the few social cues available in the environment would establish the foundations for social comparisons.

Attributions of online trust, credibility and social comparison were also expected to be based on behaviour. Cvetkovich (1999) found that behavioural attributions of trust and credibility were historically situated, based on interpersonal confidence developed during previous direct or indirect experiences. Behaviourally, components of online trust have been observed to include: duration and frequency of time spent online (Green, 2007), spelling and grammar of content (Vazire & Gosling, 2004), frequency of communication (Guadagno & Cialdini, 2005; Utz, 2000; Vazire & Gosling, 2004) and quality of content (Hemetsberger, 2002; McKenna & Bargh, 2000). Because participants in this virtual world retained their avatar identities over time, it was expected that attributions of trust, credibility and similarity in the Second Life community would be based on the repeated social interaction between account holders in the virtual world.

This section has addressed the evidence for the existence of features of offline interpersonal influence theories in online communities; however, as was discussed previously and alluded to here, source attributes in this context were arguably tied to the normative cues that were also expected to be discerned online. The next section describes how online social identity has been described in the literature for its implications, and online normative influence.

Normative influence in online communities

Early analysis of the social effects of the Web described CMC as unable to support a sense of collective identity. In their analysis, Kraut and his colleagues (1998) proposed that Internet users were individuals who communicated

independently at computer terminals. Since that time, other research has emerged that has attempted to explain influence based on the deindividuation of the offline identity in the anonymous online space. In this section the literature is outlined that challenges their findings, focussing on how the normative environment of social virtual worlds has promoted the development of an online social identity and group prototypes.

Online deindividuation

Anonymity has been problematic for social influence theorists. Utz (2000) argued that the reduced social cues of the Internet medium conceptually destabilised the theoretical impact of the social group on the individual. Indeed, many online theories of influence have emphasised the deindividuation of the self in favour of a group identity as the stimulus for normative social influence (e.g., Spears & Lea, 1994).

In offline contexts, the outcomes of deindividuation have been increased conformity to the group's social identity based on contextual factors and the scant social cues that are available. In his experimental analyses of deindividuation and social cues, Zimbardo (1969) found that adhering to a group identity promoted compliance to the behaviours and attitudes that emerged through feelings of social arousal in the context. He argued that the costumes his participants wore downgraded personal identity, and that they decreased self-awareness. This was replaced by a motivation to fulfil a role in the group by complying with situation-specific group norms. This was observed even if the group's norms were antithetical to the personal beliefs or to other social identities to which participants subscribed.

The Social Identity Deindividuation Effects model (SIDE; Spears & Lea, 1994) was developed as an extension of the SIT to explain influence in deindividuated states. It has frequently been applied in studies of online interaction and has been used to explain behavioural outcomes when an individual is in an anonymous state in a group context, both offline or through CMC. As was outlined in Zimbardo's analysis, an influence outcome resulted because the experience of performing the social identity strengthened and affirmed group identities in situations

of anonymity, and served to persuade individuals to adopt attitudes and behaviours prototypical of the group based on the only salient cues available.

In analyses that have supported this theory in online spaces, social categorisation has been based upon the offline cues that were unconsciously disclosed, or were experimentally made salient. This resulted in conformity outcomes (Sassenberg & Postmes, 2002; Spears, Lea, & Postmes, 2007) and enhanced attributions of source trustworthiness or credibility (e.g., Blanchard & Horan, 1998). However, these categorisations were based on offline phenomena, rather than constructs that were exclusively online phenomena, and were observed in low-investment decision-making tasks in low-investment social groups. Analyses assessing the persuasion outcomes proposed by the processes described in the ELM have also described similar conformity. It has been argued that this resulted from the low likelihood of elaboration of the arguments presented in a message, with individuals referring to source attributes to determine whether a message should be adopted or rejected. The SIDE analyses have demonstrated that online-only groups can inspire group belonging under conditions of deindividuated anonymity, but arguably they have not considered the effects of influence situated in online communities.

As argued in the Online Community section (p.34), there were features in social virtual worlds that researchers had identified that had challenged assumptions of online deindividuation. For example, participants developed social knowledge of others on the basis of the avatar-self and anticipated future online-only interaction (Guadagno & Cialdini, 2005), factors which Yee and Bailenson (2009) found to motivate an individual to process a message. The next section describes the social ecosystem of Second Life, identifying the emergent social features that supported the development of virtual social identification.

Online social identity

Online communities in Second Life and across the Internet have been described as liberated communities of practice centred on shared interests that span national and professional boundaries (Haythornthwaite, 2007). Wellman (2001)

identified the liberated community identity in his Netville studies, in which he observed how the newly-wired citizens of a physical town used the Web. The results suggested that the online community became a conceptual space in which individuals from the offline community gathered together to share time and experiences while in physically different contexts. Rheingold (1993) described this phenomenon almost a decade earlier, based on his participant observation in an early Web community.

Although Wellman's analyses of liberated communities were focussed on the online phenomena based on communities situated in the offline context, the literature that has analysed virtual social structures has observed similar outcomes across the many communication modalities, from short-term text-based asynchronous environments (e.g., Spears, Postmes, Lea, & Wolbert, 2002; Lee, 2002; Michinov, Michinov, & Toczek-Capelle, 2004) to small, long-term text-based asynchronous communities (e.g., Correll, 1995) to large, text-based long-term synchronous spaces (e.g., Rheingold, 1993; Kendall, 2002; Dibbell, 1999) to large, pervasive, synchronous multimedia goal-oriented online games and virtual worlds (e.g., Jacobsson & Taylor, 2003; Yee, 2006; Ducheneaut & Moore, 2004; Book, 2004a). Ethnographic research by Correll (1995) and others has found that elements of community which were described by offline theorists as interpersonally important (e.g., belongingness, common symbols, shared stories; Goffman, 1959) were achieved across time and space, between distributed individuals.

Wellman suggested that the conceptual community complimented the offline community to form a cohesive social identity that featured many of the attributes of offline social contexts: he observed the emergence of group norms, hierarchies and other defining factors that were based upon the interactions between community members to result in a socially-constructed consensus. Palloff and Pratt (1999) extended this by proposing that the normative boundaries that emerged in these online communities were mutually established constructs that functioned as policing structures to maintain internal codes of conduct in the absence of formal justice systems. Arguably, this implied that participants in these communities identified with a group and would comply with its rules in order to remain in-group members.

It has been proposed that online norms are more polarised versions of offline norms, and the reasons for this have been debated. Kiesler, Siegel, & McGuire (1988) observed that the opinions voiced in online groups were more extreme than the opinions participants would voice in offline contexts. This was in keeping with the effects of anonymity described by McKenna and Bargh (2000). However, the results of Wojcieszak's (2008) review of the content in Internet forums suggested that extreme views may have resulted from false norms, or the perceptions that participants had of fellow community members' attitudes. She found that members of listserv Internet groups who participated more often expressed their opinions more openly, and were considered prominent. This extended Correll's (1995) ethnographic analysis of an online community, in which she argued that the prominent members became sources of reference, and that other community members' responses to them established the normative boundaries of the group. Wojcieszak (2008) also found that this helped newcomers to the group determine if they belonged. She argued that misconceptions about the group's prototypical attitude led to more extreme personal attitudes. Indeed, there has been concern in popular media that Internet communities encourage a confirmation bias for personal views, and that the opportunities for finding groups that are similar on very specific interests online generates a cyberbalkanisation effect of extreme group-affinity and antagonism of the out-group (Williams, 2007).

Online social identity has been observed in long-term virtual communities (e.g., Baines, Fill, & Page, 2008; Hsi, 2007). It has been found to be constructed through knowledge of others, feelings of connectedness and social presence, and has been predictors of online group participation (Whitelock & Wheeler, 2006). The online social identity in Whitelock & Wheeler's research was typified by the virtual group prototype and embodied by those individuals nominated by participants as prototypical members.

Online prototypes

Some Social Identity Model of Deindividuation Effects (SIDE) research has been undertaken to assess the influence of norms developed in online groups, seeking

to understand what impact they had on individuals (e.g., Postmes, Spears, Sakhel & deGroot, 2001). Salient group identity centred on a prototype did support the conformity outcomes in these studies, however group identity was experimentally induced; that body of research did not take into consideration online groups that were meaningful for online community members. Rather, participant investment was low and the interpersonal context in which norms work was overlooked (Guadagno & Cialdini, 2005).

Online prototypes were identified in early text-based community research (Jacobson, 1999), although these analyses attended to stereotypical constructions of offline others rather than to group prototypes; however, a similar finding from that work cautioned that the cognitive models actors brought to the space resulted in inaccuracies between online and offline impressions. These analyses demonstrated that misjudged prototypes based on personal experience defined and limited behaviour, establishing inaccurate normative expectations at the group level.

This extended self-categorisation theory's emphasis on prototypes into the virtual world. In offline situations, Hogg (2001a) proposed that group members are able to assess themselves and others on how prototypical they are (Hogg, 1996, 1999; Hogg & Terry, 2000); prototypes may produce depersonalisation, resulting in a conformity effect similar to that described by SIDE in virtual environments. This was expected to occur when group identity was salient, as these prototypes would provide guidance for new situations, and people who embodied them appeared to exert influence over group members.

In this research, it was anticipated that the online prototype will draw attention to the abstract reference group within the structural one, and would emphasise connections between trends in network location and online social identity. By exploring the social virtual experience of community members and the interplay between their online social selves, the group prototype was expected to become an important part of the online influence experience.

In sum, it has been argued that the social identities that have been observed in Internet communities are theoretically and conceptually similar to offline social

identities, yet there are notable differences between the online and offline social systems. There are further questions that arise, for example, what effect would the quick interpersonal attributions of trustworthiness and credibility have on how quickly social change might occur as it spreads through online space? Further, although social psychology has offered a perspective on why individuals may adopt an attitude or behaviour, what effect might the online-only relationships have on how information spreads around the virtual world?

The next section describes Social Network Analysis, which has proposed an account of communities that applies social structural descriptives to predict where and how quickly information will spread. It has identified structural measures that identify influence that do not emphasise psychological interpersonal and normative features.

2.3. Social Network Perspectives of Social Influence

Social Network Analysis is a model that has described influence by examining the structural properties that have emerged from looking at the connections between people in a social system. It originated in social psychological paradigms and has been used to explain the interpersonal pathways along which attitudes and behaviours diffuse through populations. In addition to providing a methodological approach for observing and describing relationships (see Chapter 3), it has also theoretically sought to understand how different patterns of interconnection, relationships of different strengths, and why people in different positions in networks are more or less influential.

Social Network Analysis arguably applies a different but complementary approach to social psychological theories: rather than explain influence based on interpersonal and normative attributions, it has described the effects that the path an innovation takes to get to a target has had on his/her decision to adopt it. Further, it has been implemented to predict where an innovation will go next. Social Network Analysis has been used to identify the speed with which system-wide social change occurs and it has been useful in pinpointing the actors in a population who were crucial to its diffusion.

This section begins by outlining the phenomena explained by the interpersonal and normative social psychological theories and social network theories. It argues that they describe some similar processes, but retain unique explanations for influence. The next section describes the social network analytic concepts that are hypothesised in this research to predict the adoption of attitudes and behaviour. It considers four network descriptors: network exposure, network density, network position and network strength. The features of online social networks of Second Life are problematised throughout. Finally, this chapter concludes by proposing how Social Network Analysis and social psychological attributes may work independently and in tandem to better predict social influence outcomes.

Relationships between psychological and network perspectives

Social Network Analysis has emphasised the role of social interaction in influence when describing the complex ways populations work from a similar perspective as identity theories have done: rather than assume targets passively receive information from top-down sources (e.g., media outlets, public and private organisations or spokespeople), it has promoted a horizontal approach to understanding distribution and uptake. In other words, network theorists have described influence as a result of the dynamic communicated experiences of similar others, creating a process of mutual sense-making for the population of the social network (Valente, 1995; Valente & Davis, 1999). They have argued that this is the reason trends, cultures and practices pass between members of a community.

The difference between Social Network Analysis and social psychological theories of influence may be that the former has sought to understand the impact of the connections, developing theories of diffusion (e.g., Rogers, 1995), while the latter has examined the experience of the individual within the network. Diffusion research has carried with it psychological assumptions of social exchange (Homans, 1958) incorporating issues of social indebtedness (Hemetsberger, 2002), symbolic representations (Hollenbeck, Peters, & Zinkhan, 2006) and other complex movements which have been used to define how meaning is managed in each context

(Giesler, 2006), yet these psychological dimensions have rarely been addressed in Social Network Analysis.

There have been some psychological theorists who have attempted to integrate network principles by, for example, including the number of sources who held an attitude or performed a behaviour (e.g., Latané, 1981; Festinger *et al.*, 1950). This has been described as exposure in the network literature. Psychological research that has integrated network concepts into studies of attitude and behaviour change has shown that this approach has contributed additional predictive qualities to social influence models by helping to identify sources of persuasion at the interpersonal and the group levels. For example, Bauman and Ennet (1996) used social network techniques to measure how accurate individuals were in predicting their group norms about substance use in a way that challenged traditional peer influence models, because they were able to identify a division between perceptions and observed instances of behaviour.

Further, integration in a network, based on the number of connections an actor has, has been found to have an effect on aggressiveness (Xie, Farmer, & Cairns, 2003), friendship choice (Gibbons & Olk, 2003), attributions of identity in anonymous situations (Hayne & Rice, 1997) and altruism, interpersonal helping, cooperation and interpersonal facilitation (Settoon & Mossholder, 2002). This has been described as network position in the network literature.

Finally, by focussing on the patterns of interconnections between people in a system, analysts have been able to identify network attributes that stimulated interpersonal similarity. The research that has considered the impact of the network patterns have sought to explain influence using network density as a descriptor.

Some network analysts have extended beyond the structural emphasis of their field by considering the content of subjective interpersonal connections (e.g., Coleman, Katz, & Menzel, 1957; Rogers & Kincaid, 1981b; Kirke, 1996; McCarty, 2003). This has been described as network strength in the network literature. When examining the affective nature of ties between individuals in a social network, they have described evidence in line with Bandura's (1977) SLT to suggest that

innovation adoption occurs more quickly and is more persuasive along pathways that are described as strong, close or significant, rather than simply focussing on the source's structural distance from a target or the interconnectedness of one's friends.

In particular, emotionally strong ties have demonstrated features that are important to the flow of information. These may be the empirical sources of social comparison that analysis which only describes structural phenomena is unable to capture. In addition, research that has examined the communication patterns between connected members has demonstrated that unofficial social networks can disrupt interventions because of the structural ways in which social contagion spreads through a population (Bovasso, 1996; Scherer & Cho, 2003; Kerckhoff, Back, & Miller, 1965).

Yet the conceptual gaps between social psychology and Social Network Analysis arguably still remain. Most notably, Social Network Analysis has explained influence by focussing on explicit connections that document pathways of potential diffusion, rather than considering implicit psychological influence of, for example, interpersonal attributes like trust and credibility, social comparisons or group prototypes.

Network exposure, network position, network density and network strength have been effective predictors of influence outcomes, however, and this thesis proposes that these descriptors offer unique explanatory power to influence theories that may extend social psychological understanding of the processes. The next section discusses these features.

Structural influence

In section 2.2, it was argued that a target would choose to adopt an attitude or behaviour because someone whom they trusted, viewed as credible or compared themselves with had used it or believe it, or because the group they belonged to had adopted it. It was also argued that there were shortcomings to these formulations, particularly when applied to Internet communities. It was proposed that social virtual worlds like Second Life were communication media that were rich enough to support

social influence, but that their features were still lean; online worlds like Second Life have continued to challenge interpersonal and normative perspectives of influence.

Social Network Analysis is arguably uniquely adept at addressing many of the challenges faced by psychology in the online environment. It is able to articulate the communication pathways in multi-user environments that are typified by simultaneous exchange rather than sequential transmission across the large, loose and transient social systems (Song, 2005). Shirky (2003) and Watts (2004) argued that online spaces were different from traditional communication paradigms because information was not necessarily relayed through one-to-one chains of social connections; rather, they proposed that the opportunity for communicating ‘many-to-many’ meant that paths of social influence became complex and multiplicitous. The Internet is arguably not just an interactive medium that facilitates communication between relationship partners; it also facilitates communication between multiple entities at the same time.

While it has been suggested that the rapid diffusion of an Internet meme or the slow uptake of a political dictum is due to the normative construction of the contagion (Kennedy, 2004), Social Network Analysis has been successful in articulating the structure of the network and the key positions within it that have helped to identify how quickly it diffuses and where it spreads (Weenig & Midden, 1991). It was anticipated in this thesis that network descriptions of structure, position, exposure and strength would contribute additional explanatory power to social psychological theories of social influence on the Web.

Network density and network exposure

Analysts have proposed that the structure of a network has implications for how much potential influence the social system may have on the individual. This is based on the principle of network exposure, which anticipates that the more people who have an attitude or perform a behaviour who are directly connected with an individual, the more likely the individual will adopt that behaviour or attitude. Exposure is progressive and maximal.

This proposition is arguably problematic, as it does not account for indirect influence effects, or for differential influence based on interpersonal or normative features. However, analysts like Valente (1995) and Burt (1987) have argued that exposure is a prerequisite for the flow of ideas and behaviour.

These analysts have described populations based on their density, i.e. the proportion of observed links to the total possible links, and there is evidence to suggest that density has an effect on the speed with which innovations diffuse the homogeneity of groups. Network structures range on a scale from loose to strong, and these distinctions have been associated with the influence processes of social capital (loose networks; e.g., Burt, 1999) and homophily (dense networks; e.g., Monge *et al.*, 1998).

Loose networks

Low-density, or loose networks have been described as featuring many un-related or loosely related sub-groups (see Fig. 3). Valente (1995) maintained in Network Theory that innovations diffused slowly or stagnated in loose networks because the connections required to facilitate their spread were absent. Rogers' (1995) research supported this; he observed a slow diffusion of a birth control practice through the networks in a South Korean village and found that the innovation took longer to spread through the loose networks, and that many failed to spread through the population.

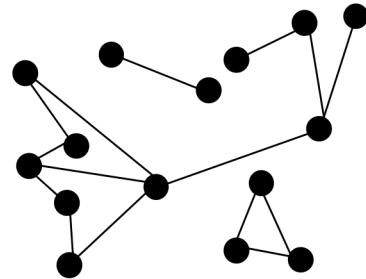


Figure 3. A structurally loose network featuring few interconnections

Wellman (2001) described the networks on the Web as loose, arguing that the Internet offered the opportunity to meet groups of individuals who shared interests, but that they were not connected in any other way. This extended Adamic's (1999) finding that participants in online environments were able to become multiple members of many partial groups, destabilising the structures and architectures of virtual communities. These CMC-spaces were populated by predominantly weakly tied individuals.

Analysts have hypothesised that loose networks do not demonstrate normative social influence because the group members are incompletely connected with one another, reducing the opportunity to reinforce a collective category. Valente (1995) argued that there was no structural bias in loose networks that was strong enough to establish social identity amongst its members.

However, although low density has been described as responsible for slow and truncated diffusions, it has also been identified as the reason for the speed with which rumour and trends diffuse online (Jo, 2002). As Rogers' South Korean analysis indicated, innovations did diffuse around the loose networks even though ties were absent. He argued that this was because of the presence of weak ties. Granovetter (1973) described these interpersonal connections as loosely tied relationships that were not reinforced by any other avenue of connection; he suggested that people connected by weak ties were likely to have infrequent interaction, but that they were important in spreading innovations through diffuse networks because they ensured that new content was delivered to new groups. Granovetter found that they also played useful roles in information seeking because they were triggered by the need to find new information, usually from outside the local network, and that they helped maintain the structure of communities by ensuring that sub-groups remained connected to one another.

However, weakly tied individuals were found to be at an interpersonal disadvantage in influence studies because although they were able to distribute information widely and to many different subgroups, the relationships between the individuals connected by the weak tie were not strong enough to have developed attributions of trust, credibility, social comparison or prototypicality. Burt (1999) theorised that attitudes and behaviours that passed between weakly tied individuals did so because they traded in an interpersonal attribute that implicated both the structure of the network and a psychological element, social capital.

Burt's (1999) theory of social capital described the advantage an individual had based upon his or her location in a network's structure. Individuals were found to rely on mediation and supposition about a weak tie's suitability as a source of

influence based on his/her social capital (Burt, 1999; Valente & Davis, 1999). Structurally, high social capital has been associated with individuals who bridge multiple subgroups: they have access to information and contacts that are different than those accessible to each network, and so they play brokerage roles between the groups. However, social capital also arguably implicates perceptions of trustworthiness and credibility. Indeed, trust and its components have featured in many of its definitions: Belliveau, O'Reilly III and Wade (1996) suggested it was based on perceptions of social similarity, while Best & Kreuger (2006) used it interchangeably with 'generalised trust'; deNooy *et al* (2005) found that social capital reduced uncertainty and risk and generated trust; and Haythornthwaite (2007) argued that its benefits for a community were very similar to those of trust and relationship building: to develop a common language, to create a network mechanism to manage behaviour and, ultimately, to create the capacity for actors to trust other network members.

Individuals high in social capital arguably play an important role in Internet environments. If, as Wellman and Adamic have argued, networks and online community members are loosely tied, the assets and information that are in one part of the Web rely on brokers connecting groups by weak ties to bring them to other parts of the Web.

However, Putnam (2000) argued that the Internet deprived the opportunity for social capital to develop because it did not offer the platform for informal exchange. He argued that the distributed, non-face-to-face environment did feature many weak ties, but that it did not offer the facility to for the development of interpersonal trust or attributions of credibility because there was no opportunity to bond.

In contrast, Williams (2007) argued that social capital was contextual; he proposed an adaptation of a social capital measurement instrument for the Web that identified examples of social capital in online communities. He observed that there were virtual links that bridged gaps by connecting new ideas and people and links that bonded by securing practical and emotional support. Raymond (2000) and Sun, Lin and Ho's (2006) findings lent support for Williams' research: their analyses of

virtual reputation suggests that it is an important interpersonal currency in CMC and that it has greater value in virtual worlds than offline.

Dense networks

At the other end of the structural scale from loose networks are dense networks. Density defines groups that have many interconnections between members, so that there are few gatekeepers with more control over information and ideas (see Fig. 4).

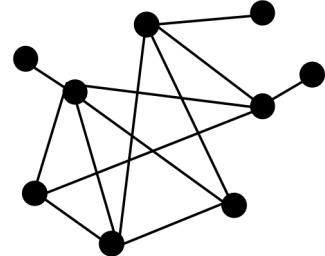


Figure 4. A dense network featuring many interconnections

Dense networks have been described as facilitating influence because the multiple connections encourage frequent contact with sources of potential influence (e.g., Valente, 1995). Indeed, Costenbader and Valente (2003) found that dense networks encouraged rapid diffusion because each person in the network had many possible pathways of direct exposure to an innovation. Evidence from the network literature that has supported this has drawn on the observed homophily, or similarity, between members of dense groups.

There has been some disagreement between network analysts and psychologists about the source of homophily. In social network theory, homophily of attitudes and behaviours has been used to explain why people create, maintain, dissolve and reconstitute networks (Monge *et al.*, 1998; Settoon & Mossholder, 2002; Adamic, Buyukkokten, & Adar, 2003). In contrast, SIT (Tajfel & Turner, 1979) has explained this process by describing how the shared experiences and regular communication between actors in dense networks has worked to rapidly form group prototypes around which a cohesive social identity was established, as there are few to no external links that could be sources of new information. It is argued that this may encourage the development of a strong social identity amongst dense network members.

Network analytic theories and social psychological theories have disagreed about whether homophily is the catalyst for the formation of cliques or other closely-tied networks, or whether it is a by-product of the interactions between group

members (c.f., Huguet, Latané, & Bourgeois, 1998). Network analysts have argued that groups formed because similar actors have sought out one another; some psychological research has provided evidence for this. For example, SCT (Festinger, 1954) proposed that a social identity developed based on the social category into which an individual placed him or herself and others. Indeed, Monge & Contractor (1998) argued that SCT is a network theory; however, the approach of and findings from studies of peer influence in psychology have demonstrated that similarity also develops as a result of normative influence processes.

Psychological research that describes the similarity between individuals as influence has tended to offer interpersonal and normative explanations that challenge network theories of exposure. For example, Graham and Braun (1999) identified interpersonal closeness as a predictor of behavioural similarity, while Giordano, Phelps, Manning & Longmore (2008) linked similarity with academic performance and Piontkowski, Rohmann & Florack (2002) problematised perceived threat in acculturation situations based on the similarity of dominant and non-dominant group attitudes.

While the disciplines have disagreed about the relationship between interpersonal similarity and the development of groups, both have recognised its effect on influence. Network homophily has occurred in both offline and mediated environments, particularly amongst closely tied groups of people. This has been observed offline in terms of demographics (Tsui, Egan, & O'Reilly III, 1992), gender (Leenders, 1996), personality (Brass, 1995) and roles (Krackhardt & Brass, 1994). It also has been retrospectively observed in analyses of product uptake (Rogers & Kincaid, 1981b; Ryan & Gross, 1943; Whyte, Jr., 1954), pockets of political opinion (Adamic & Glance, 2005) and language (Paolillo, 1999).

The disciplines have agreed that that homophily sustains group structures. Social Network Analysis has proposed that these are maintained by the threat of losing connections. In identity theories, this would arguably be translated as normative influence: rather than the loss of links motivating the individual to conform to group norms as in Social Network Analysis, individuals are expected to

conform to a social identity because they find their in-groups more favourable than their out-groups, and they seek to make their own identity and that of the group more positive and distinct from other groups.

Although Internet networks were described by Wellman (2001) as loose, Adamic (1999) demonstrated that the likelihood that friends of friends were friends was four times more likely in the online space, generating local structures that are much denser than anticipated offline. This finding supported the description of the Web as a loose system that connects densely tied groups people. Indeed, network maps of the Web have also identified online clusters of political opinion (Adamic & Glance, 2005), nationality and consumer uptake.

Such online homophily provides support for the network analytic perspective that similarity brings people together.

Network position

Individuals' positions in a network have been defined by their relative importance both overall (globally), and within the groups they are most closely connected with (locally) (Kerckhoff *et al.*, 1965; Rogers & Kincaid, 1981b; Coleman *et al.*, 1957; Granovetter, 1973). Individuals who have ties to many others in their clique, network or system have been described as central, while those who have fewer ties to others in the network have been referred to as peripheral (see Fig. 5). In studies of innovation diffusion, the structure of the receiving network and the positional attributes of the receiving actor were found to determine whether an innovation was adopted or rejected by everyone in that group. It was expected that a well-integrated group member would produce greater influence based on the number of people s/he exposed to the innovation. A poorly integrated member was anticipated to produce less exposure-based influence.

People at the centre of networks have been described as opinion leaders. Rogers (1995) proposed that these actors are considered prototypical in their communities, representing accepted norms and acting as source of social

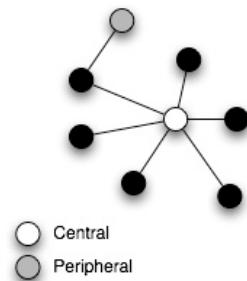


Figure 5. Central and peripheral network positions

comparison. Their positions have been leveraged by outside interests to create opinion and behaviour change (Lazarsfeld, Berelson, & Gaudet, 1948; Rogers, 1995; Valente, 1995). The assumption in these models is that the central actor, as a member of the target community, is viewed as a source of reference for other members of the network, rather than as an outsider trying to influence the majority.

The calculation of network position – by tallying the number of contacts an individual has relative to the potential number of connections – suggests that central people are ‘popular’. Popularity has been observed to be a correlate of trust (e.g., Gil & Artz, 2007) and credibility (van den Boom & deBruyn, 2005). deBruyn and van den Boom’s (2005) analysis found that popular people were more often imitated and admired than less popular people, while Benoit-Smulyan (1944) found that their friendships were readily sought by other group members. Costenbader and Valente (2003) findings supported this research, as the individuals in central positions in their study represented community members important in understanding the process of seeking consensus of opinions in the group.

Social psychologists have proposed an alternative explanation for central actor influence: they have argued that the degree to which these actors adhered to the norms of the group implicated how they affected the spread of ideas and practices. Rogers’ (1995) analyses supported this. He found that the number of connections an individual had in a network limited the degree to which s/he was able to express counter-normative attitudes or perform counter-normative behaviours. He found that the threat of losing links by championing a non-normative innovation or rejecting one too slowly ensured that this actor was a conservative adopter. His results suggested that this was a better predictor of influence than exposure. Strang & Soule (1998) extended this in their analysis, finding that central actors did not innovate unless the innovation was within the bounds of the social norms of the group. However, when they did, they were able to shift the norms of the community.

Latané and Bourgeois (2001) proposed that central actors consolidated expectations of the contacts in their groups, and helped to establish associations between the various points of view, serving to legitimise more innovative ideas that

emerged from more peripheral members with the more conservative members. Peripheral actors' positions on the outside of the social sphere suggest that they have connections with other groups who have novel information. While they arguably remain bound by the normative rules of the group (Rogers & Kincaid, 1981), they are able to introduce radical innovations into the network. By identifying as an in-group member, they can arguably help to transform an innovation into a socially acceptable phenomenon.

Kerckhoff and colleagues (1965) found that that social change that originated from peripheral positions diffused more slowly than change that originated from central people. They proposed that this was because the community needed to look inward in order to establish the appropriateness of the new phenomenon. This was supported by Bandura and Jourden (1991), who suggested that a new practice or belief that entered a community inspired a process of reinvention and legitimisation that worked to determine the eventual format it would take. Rogers described the legitimisation process as a time during which peripheral actors recruited converts, who helped to establish the innovation within their local webs of connections.

In a synchronous environment like Second Life the central and peripheral actor roles were expected to be more stable than generalised Internet interactions (Efimova & Hendrick, 2004) as the social emphasis of the virtual world was not based on outreach and interconnectivity, but instead was based on developing strong connections within communities of practice. Additionally, it was anticipated that the weakly tied networks would generate the need for a greater emphasis on social capital and reputation rather than simple connectivity (Hemetsberger, 2002).

Network strength

A shortcoming of the network descriptors described is that they identify phenomena that are based only on contacts. Identifying only connectivity in a network assumes that each actor influences his or her connections in a uniform way. Coleman *et al* (1957) and Rogers and Kincaid (1981) and other phenomenological analysts, have proposed that collecting information about the strength of the relationships between group members describes a predictor of influence.

Network strength is a property of the link between two people, rather than a property of the individuals who are linked. This arguably differentiates it from psychological attributes but it is arguably the closest to the psychological interpersonal features, as it defines a connection between two network actors rather than describing the structural features that emerge from it. Network strength has been defined in many ways, including emotional closeness (Coleman *et al.*, 1957; Rogers & Kincaid, 1981b; McCarty, 2003) amount of communication (Latané & L'Herrou, 1996; Festinger *et al.*, 1950; Rogers & Kincaid, 1981a), financial exchange (deNooy, Mrvar, & Batagelj, 2005) and physical distance (Festinger *et al.*, 1950).

Indeed, social networks that measure network closeness require attention to the criteria with which the networks are generated in order to ascertain the most accurate degree of (perceived) closeness between two people. Discriminating degrees of closeness requires the development of nuanced questions that capture the subjective sense of connectivity, as well as identifying context-specific activities that indicate stronger or weaker relationships. For example, Kirke (1996) described the subtleties required to establish the most accurate measures of friendship in a sample of Irish youths. Using interview techniques, she noted a difference between the descriptors 'friend' and 'pal', a distinction only identified because she allowed participants to define it. Other methodologists have conducted similar work using surveys, and have concluded that community-generated meanings are the best representations for the collective under observation (McCarty, 2003).

Another approach relevant to online studies is Rogers and Kincaid's (1981a) communication network closeness, which defines the variation in relationship strength based on the frequency of interaction and the various modes used to communicate. The analysts described strength by both frequency and communication across multiple modalities; online theorists have proposed similar strength indicators (Garton *et al.*, 1997; Correll, 1995), indicating that conversing in communities via computer-mediated communication using more or less private channels signals stronger relationships. The benefit for online analyses is that such communication modes are explicit, and so can be measured through self-report or observation.

It was theorised in this research that network closeness measures would be conflated with the interpersonal attributes trust, credibility, social comparison and prototypicality. Psychological relationship studies draw on similar mechanisms in particular to indicate influential features of relationships.

2.4. Conclusions and Research Question

The literature reviewed in this chapter has outlined the approaches to influence that have sought to explain the direct and indirect ways that individuals' thoughts, feelings and actions are affected by other people. Psychological theories have proposed that interpersonal and normative attributions work by persuading individuals to adopt attitudes and behaviours on the basis of perceived trust, credibility, social comparison and prototypicality, or conformity to a social identity.

Social Network Analysis has proposed that influence occurs on the basis of exposure, network strength, network density and network position. It has been argued that these features work to produce interpersonal and group homophily, that they describe the likelihood an individual will adopt a new idea or practice and the speed with which an innovation will diffuse through a social system.

Computer-mediated communication presents challenges to psychological theories. It has been proposed by some theorists that the anonymity of CMC has an impact on the development of interpersonal relationships and social identities. However, the literature that has been presented has demonstrated that online communities have interpersonal relationships, and that they demonstrate group processes. It was proposed that network analysis is a useful perspective to bring to Web communities because it can identify dense networks, relationship strength and important positions that describe influence pathways.

This review has also proposed that there are psychological features of influence and network constructs that are related to one another that may explain why each discipline has been able to predict attitude and behaviour change. In addition, it has proposed that there are differences between the two that may compliment investigators' examination of social influence. In particular, it is

anticipated that network analysis offers four constructs to social psychological measures: network exposure, that identifies who has already adopted in an individual's network; network density, that identifies where in the network an innovation may stagnate because of loose networks, and where it will thrive because of dense groups of interconnected actors; network position, which identifies the speed with which an innovation will spread based upon how embedded in a the network the source is; and network strength, which identifies which pathways an innovation will diffuse along based on the attributions ascribed to each relationship.

This review results in following research question:

What does social network analysis offer to the prediction of influence above that predicted by social psychological theories? Specifically, what is the relationship between network strength and psychological features of influence?

This question raises three specific areas of enquiry that are considered in each of the three empirical chapters:

- Why have network strength measures been effective at predicting influence? It is expected that network analysts who predict influence using this criterion implicitly measure psychological features. Further, it is anticipated that measures of strength in online environments will similarly predict psychological influence outcomes, but that their effects will vary based on the degree to which the strength measures identify online behaviours that give information about the offline account holder to another account holder, or control of the online account holder's online identity to another account holder.
- Why have the density of a network and the position of an individual within a network been effective at predicting influence? It is expected that these network features predict group member attitudes because they help to define the exposure an individual has to others' attitudes. It is anticipated that this will be particularly relevant in online environments because of online

community participants' reliance on stereotyped perceptions of in-group members.

- Why have exposure to an innovation and the position of an individual within it relative to a contact who has already adopted the innovation been effective predictors of influence? It is expected that the network's topology will explain the adoption of a behaviour over time in a way that explains the variance in uptake better than psychological theories. It is anticipated that this will be a large effect online because of the capacity of CMC to make explicit and to archive action.

In the next chapter, this thesis explores how these features were constructed and measured in Second Life, and the benefits of using this online environment for this task.

3. Method

The last chapter introduced the main concepts in this research. It argued that network analysis would explain attitude and behaviour change in ways that were unique from social psychological features associated with influence, and in ways that were complimentary to social psychological theories. It was anticipated that variance in influence would be predicted by interpersonal and normative attributes of sources of influence by targets and the positions of community members in the social networks of virtual world Second Life, the density of the networks, how much exposure an individual had to influential thoughts, feelings and actions, and the network strength of the relationship between two people in the community.

To test this, data was gathered using online surveys and automated data collection techniques to capture both self-reported and observed behavioural information across three studies. Psychological and network analytic predictors were considered within the context of the properties of online environments that McKenna and Bargh (2000) proposed challenged the offline assumptions of social psychological theories. Finally, several scales were designed to assess the unique properties of the theoretical approaches. Details on these measures are included in the relevant empirical chapters.

This chapter describes the Second Life sample in this research and outlines the strategy used to recruit the avatar-account holders (section 3.1). It describes the instruments used to measure the outcome and predictor variables and the benefits and challenges of these tools (section 3.2). Finally, it identifies the ethical considerations that arise in online and social network research (section 3.3).

3.1. *Sample*

The participants in this research were the Second Life account holders who responded to online surveys, and the avatars that they were connected with as virtual world ‘Friends’ (this connection criterion is explained in detail in section 3.2). The whole sample included 47,643 avatars of the 15-million accounts that had been

created in the application up to the beginning of 2008. They were identified over a 24-month data collection period as sub-samples across three studies.

This section begins by examining how the account holder and his/her online avatar were conceptualised in this research. It then describes the criteria for selection and the complex sampling design.

Participants

Avatar or account holder?

The online nature of this research had implications for the subject of analysis. Although the participants were identified as the Second Life account holders behind the avatars, the social phenomena under inspection were the avatars' relationships. The duality between the online avatar identity and the offline account holder identity has been examined by psychologists (Bailenson & Yee, 2005), sociologists (Kendall, 1999; Turkle, 1995), ethicists (Reynolds, 2009) and, most extensively, legal scholars (e.g., Lastowka, 2009; Lastowka & Hunter, 2004; Mnookin, 1996). Each discipline has argued for closer or lesser parity depending on the purpose of the research. For example, legal scholars who have sought to understand intellectual property ownership have erred towards the account holder as the focus of research (e.g., Miller, 2003; Chein, 2006; Baldrica, 2007; Hunt, 2007), while sociologists and social psychologists who have sought to understand the agency of the individual in the context have argued that the avatar is the subject of scrutiny (Taylor, 2001; Blascovich *et al.*, 2002). Because of the evidence to suggest that avatar interaction in Second Life physically and interpersonally would reflect influence (Taylor, 2001; Blascovich *et al.*, 2002), but that the influence is experienced by the user at the computer terminal who self-projects into the embodiment of the online persona (e.g., Roberts & Parks, 1999; Turkle, 1995), this research maintained that neither one nor the other was the overall primary source of interest, but that each represented a facet of importance to this study.

Active accounts

The avatar-account holders in this study were active participants in the virtual world at the time of their recruitment. To be implicated in this research, survey respondents and all avatars captured using the automated data extraction technique were required to have logged into Second Life for at least 60 minutes in the preceding six months from the time of data collection in each study⁸. This criterion was used by Linden Lab to identify which accounts were dormant; accounts that were unattended for longer were automatically deleted by the system and avatar names purged⁹. It was chosen throughout this research to reduce the number of potential participants in this sample¹⁰.

Self-selected participants

In Studies 1 and 2, participants responded to an online survey. These survey respondents self-selected their participation, which in the context of the Second Life virtual world had implications for the research.

The difficulty of obtaining participation from a population is reliant upon knowing where to look for them and how to make contact with them once found. Because social virtual worlds are not environments where tests are traditionally administered (LaCousiere, 2003), participants from a potential sample pool may

⁸ This was not required to be a consecutive 60 minutes; participants included account holders who returned to the application for short periods of time.

⁹ Only free accounts were automatically deleted from Second Life; account holders who had paid annual subscriptions retained their avatars until their subscriptions were no longer paid, regardless of how often they logged in to the virtual world.

¹⁰ At the start of data collection, the total number of avatars in this virtual world was 32,484; by its end, the number of account holders had grown to over 15 million. Second Life experienced exponential growth during the period of data collection, and almost 80% of new accounts created during that time did not return to the virtual world after their first encounter. This high number suggests that the self-selection were representative of a specific pool; however, Yee's (1999) research has identified that participants in social virtual worlds, like Second Life, more closely represent the general population than goal-oriented online environments. Further, the demographic analyses of Second Life creators Linden Lab suggested that they achieved a representative sample of Web users.

disregard the research activity. As there was substantial potential for alternative activity in the Second Life online community, the sample that was recruited and stayed throughout the entire research period was likely high in self-selection biases (O'Neil & Penrod, 2001). Unfortunately, counteracting such a confounding variable was extremely difficult both to detect and to ensure against, and offering incentives like compensation may have resulted in a selection of uncharacteristic participants (Reips, 2000; O'Neil & Penrod, 2001).

It was anticipated that the people who would be interested in contributing to and learning more about the research would be Second Life account holders who used the virtual world for real-world business outcomes. The thriving online economy had a real-world USD transfer value, and many people used the online community as a storefront to sell virtual or real goods. These participants actively sought new methods of distributing information about their goods to Second Life consumers and the research questions offered a resource for their marketing activities. To counter this potential bias, recruitment messaging for the Study 1 and Study 2 surveys was distributed in a wide variety of virtual world outlets, aimed at audiences who used the space for social and business ends.

In addition, Whitty's (2002) research indicated that there is a greater likelihood that respondents to online research will be male, as women traditionally are more cautious online. This would have affected the results of this research as the attitudes and behaviours under analysis were sensitive to gender effects. However, there were roughly the same number of men and women who participated in each study, and any variation in the outcomes was likely due to the phenomena under scrutiny.

Sampling strategy

The sampling process in this research was complex because the research aimed to recruit as many Second Life account holders and to generate the most accurate representation of the relationships between their avatars as possible during a period in which the virtual world's population was rapidly expanding. It used a combination of egocentric data collection techniques and whole-network collection

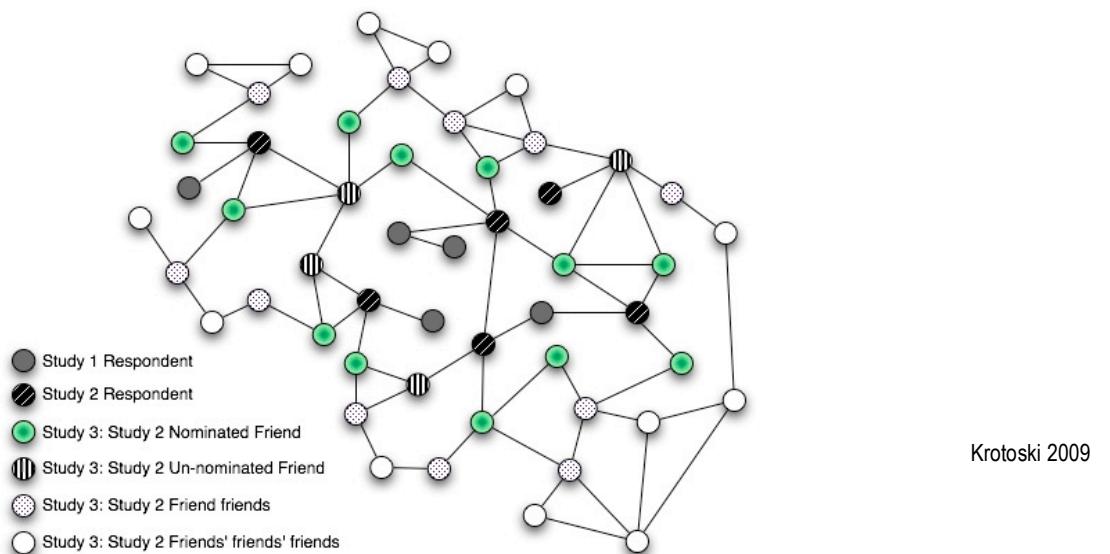
techniques. Egocentric samples describe a social system from the point of view of a single individual who has identified his/her immediate contacts. Whole network samples describe the connections of every actor in the entire system. Studies 1 and 2 described egocentric networks with the data collected in online surveys. Study 3 described a whole network with the data collected from the Second Life computer servers.

Table 1 details the samples in the research in the context of the total population under scrutiny. Study 1 avatars were implicated in the Study 2 sample, and both Study 1 and Study 2 samples were included in the Study 3 sample. To generate the eventual network that had all 47,643 avatars from Studies 1, 2 and 3, there were seven waves of recruitment.

Table 1
Sample Size of Each Study as Proportion of Total Sample in Studies 1, 2 and 3

Study	Sample	
	N	% Total
1	1734	3.6%
2	6563	13.8%
3	47643	100.0%

The first was the Study 1 sample. This included respondents to an online survey and avatars whom they identified as their connections in the virtual world. This sample was used as the starting sample for Study 2. Study 2 used a snowball sampling design to recruit avatar-account holders for participation. Study 2 survey respondents recruited from the pool of Study 1 respondents and connections nominated by this group were asked to nominate their own connections, and these were used to recruit for the next wave, and so on through the five successive waves



of Study 2 survey respondents. Finally, the total population of avatars in Study 1 and Study 2 was used to generate the sixth wave of recruitment, a whole network in Study 3, which additionally included all connections who had not been reported by Study 1 or Study 2 survey respondents, plus the connections of these connections (see Fig. 6). The whole network sample also captured the connectivity information of any avatar-account holders who may have dropped out of Studies 1 and 2 without completing the surveys used to collect data.

This approach proved an effective way to gain as much meaningful information from as large a sample as possible. However, this method had implications for the shelf life of the data. Network connections were collected over 24 months: Study 1 nominations occurred between January to April 2006; Study 2 nominations occurred between May to December 2006; Study 3 connections were acquired from Linden Lab in December 2007 (see Fig. 7).

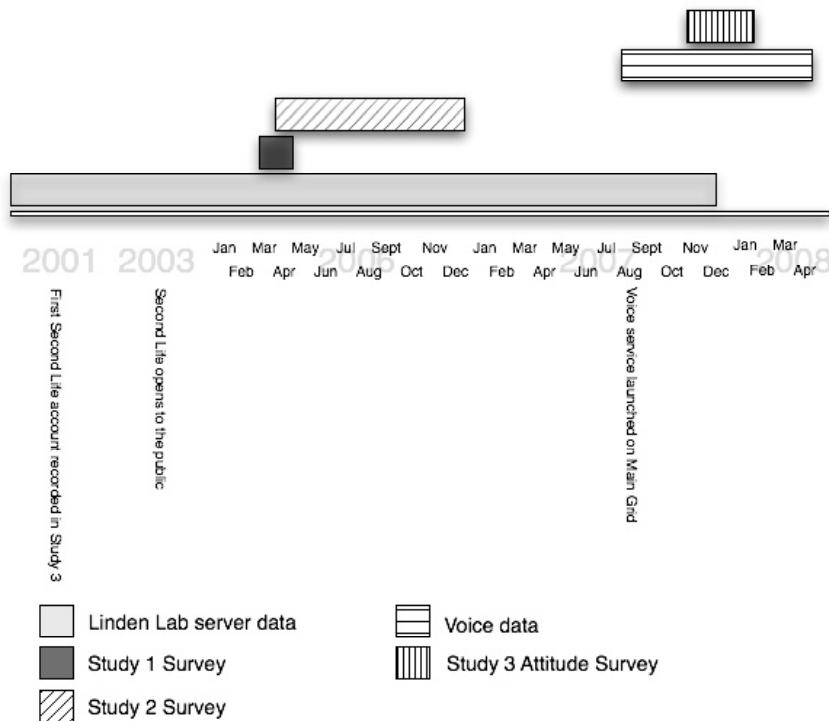


Figure 7. Research data collection timeline by Study and by instrument from 2001-2008

Given the reported transience of online relationships, the shifts in the emotional

closeness of relationships, and the decay of participation in online communities that were described in Chapter 2 (Garton, Haythornthwaite, & Wellman, 1997; Adamic, 1999; McKenna & Green, 2002), the analysis in Study 3 represented an amalgamation of the interpersonal phenomenological social network experiences of Second Life account holders throughout the period of study. It is important to note that there may have been legacy relationships included in Study 3 that had been reported in Studies 1 or 2 that were no longer active because of interpersonal shifts or because one avatar in the connection no longer used the service. In other words, the avatars in the Study 3 sample may have been over-connected because this study included relationships that were recorded in Studies 1 and 2; however, this strategy produced a network that arguably best represented the avatars involved in two years of relationships in this virtual world.

Researcher involvement

To recruit and administer survey data collection from within the virtual world in Studies 1 and 2, steps were taken to establish that the research was credible and the investigators were trustworthy. It was arguably appropriate to conduct the survey research from within the virtual world with avatar identity primed because the data to be collected was unique to the context (Stromer-Galley, 2003; LaCousiere, 2003). As Stromer-Galley (2003) explained, moving from an avenue in which participants were recruited to another online environment, like the telephone or the laboratory, may have disrupted respondents' sense of presence in the virtual world or their perceptions of pseudonymity, increasing their reluctance to participate. Stromer-Galley also suggested that it would have affected the content of their participation.

Hine, 2000 described every online space as having a communication ecology that determines the choices made in each social infrastructure. She argued that by taking part in the community, researchers signal to community members that they understand and respect the practices that occur within it. By engaging with the community from the ground, researchers also provide a service as a token of contribution. Although this exposes the researcher to the population under scrutiny, Kendall (1999) describes a general suspicion of social scientists in online groups, and

recommends that researchers be aware and take steps to counteract difficulties in gathering sufficient valid data.

In this research, these included Second Life-specific work, and the presentation of the research across the World Wide Web.

In Second Life

To present a trustworthy and credible persona, a Second Life-based landmark was established early in the recruitment process. O'Neil & Penrod (2001) and Stromer-Galley (2003) recommend building academic websites with information about the primary researcher to establish trust, but because the culture of the virtual world involved contributing to the community (Book, 2004), a website was supplemented with an asset that projected an understanding of the virtual world's culture.

The Social Simulation Research Lab (SSRL) was a virtual building situated in an area where others with similar interests had located their virtual world projects. It was listed on the public Second Life listings, and was set up as a library. It included over 150 links to online social science and social network research that were freely available on the Web, plus links to the research projects of other Second Life account holders (see Fig. 8). When a Second Life avatar clicked on a virtual book, a webpage opened on his/her computer that linked to the relevant publication or website.



Figure 8. Second Life research location: the Social

Other researchers have similarly created academic personae which they adopted when collecting data from online community participants to signal openness and full-disclosure (Kendall, 1999; Taylor, 2001; Turkle, 1995; Bruckman, 2002), and to ensure that there is no threat of deception

(Donath, 1999). Virtual ethnographers and anthropologists suggest it is important to get involved in the community by engaging in discussion groups, providing ongoing services and ‘hanging out’ in order to demonstrate respect and interest in the community (Hine, 2000).

To meet these needs, the SSRL also offered facilities to host seminars and lectures, with a video screen and space for slide and static social science presentations. Over the course of the research, several invited speakers gave presentations to interested community members, the primary investigator convened meetings for the public to provide feedback on the studies in this thesis, and two Second Life-based conferences took place in collaboration with the University of Manchester’s Computer Simulation research group. It was a popular location for Second Life academics to gather and discuss their work.

Any Second Life avatar was welcome to visit the virtual world resource and prominent links directed them to the online surveys.

On the Web

Virtual world participants are embedded in a network of information, and are able to easily access the Internet in order to support claims and intentions with references from websites. They will publicly challenge those who do not present themselves on the wider Web as credible researchers affiliated with an institution. Following Hine (2000), this research explicitly embedded itself in the Net with a research homepage and a website on the University of Surrey servers for the primary investigator and point of contact. In addition to links to the research tools, the website detailed the investigator’s biography, details of the research undertaken, links to the investigator’s Second Life avatar and virtual world home space, online social science links and a link to the active research weblog. The website can be viewed at <http://myspages.surrey.ac.uk/psplak> and the weblog can be viewed at <http://alekskrotoski.com/tag/academic>.

3.2. Instruments

Because the definition of social psychology has been described as synonymous with the definition of social influence (Hogg & Vaughan, 2002; Turner, 1991), there have been many measures created to identify influence outcomes in the literature. However, operational definitions of ‘influence’ can suffer from problems of generality, multi-dimensionality, and unseen consequences (March, 1955). This thesis chose three hypothesised outcome measures of influence that faced these challenges.

First, it sought to establish a relationship between measures of network strength and interpersonal and normative features that have been associated with influence in the psychological literature. The method used to measure this was a sociometric survey, and the results were analysed in Study 1.

The second measure used to identify influence in this research was a personal attitude rating reported on an attitude survey, the details of which are outlined in Chapter 5. This was compared with the attitudes reported by the respondent’s connections and was hypothesised to relate to network and psychological features associated with influence in the literature. The results were analysed in Study 2.

Finally, the last measure of influence in this research was a behaviour outcome identified by automatically extracting this information from the Second Life servers. Adoption of the behaviour at every month over a nine-month period was hypothesised to relate to psychological and network predictors. This was analysed in Study 3.

In each study, interpersonal, normative and network variables were measured as predictors. In Studies 1 and 2, these were included as part of self-reported sociometric surveys. In Study 3, they were measured using both the automated data extraction method and in an attitude survey distributed to the Second Life population.

This section describes the instruments used to measure the influence outcomes and predictors in each study in Second Life. It focuses in particular on the techniques used to identify the interpersonal connections between community

members because these were the foundations for the network predictors hypothesised to influence attitudes and behaviours in the virtual world. It concludes with a discussion of their benefits and shortcomings.

Surveys

Two types of survey were used in this research: the first was an instrument implemented in Studies 2 and 3 that asked respondents to contribute information about their personal attitudes and behaviours and their perceptions about the attitudes and behaviours of their social group. The second type of survey used in this research was a sociometric survey. This was an instrument that generated egocentric descriptions of the relationships in a respondent's personal network.

Attitude survey

The attitude surveys used in Studies 2 and 3 measured the respondent's personal and perceived views of the attitude and behaviour outcome variables. Surveys have frequently been used to measure attitudes, and self-report is a simple, phenomenologically oriented way of capturing elements of influence that are not apparent in observational studies (March, 1955).

When conditions are designed to maximise response accuracy, self-report procedures have been found to provide useful estimates of attitude and behaviour (Del Boca & Noll, 2000); however, there have been issues raised with inconsistent reporting, particularly in self-report instruments that ask about sensitive topics (O'Sullivan, 2008). Yet the features of online contexts arguably counter this issue: Booth-Kewley, Larson and Miyoshi (2007) demonstrated that computerised questionnaires generated fewer social desirability effects, particularly in relation to risky behaviour, and argued that the sense of disinhibition experienced by online participants that was described in Chapter 2 led to more accurate self-reporting.

The attitude surveys also asked about respondents' perceptions of their reference groups' attitude and behaviours. These items were used as predictors of influence. Surveys that have sought to measure perceived norms to assess their effects on attitudes and behaviours rely on participant perceptions of the group

context. However, this arguably is subject to pluralistic ignorance effects (Bauman & Ennett, 1996), and this may be where the leanness of the online medium does not enhance self-report's validity: Wojcieszak (2008) and Williams (2007) argued that the inability to confirm or deny another's actions or attitudes through observation leads to greater attributions of false norms, particularly in online situations; Matheson and Zanna (1990) found that online participants over-represented their own views because of enhanced private self-awareness. Blanchard (2008) has more recently found that the sense of virtual community a participant feels mediates the accuracy of the perception of group norms.

It was argued that being aware of this was relevant to this research, as it was anticipated that perceptions of social opinion were part of the opinion formation process, and this was explicitly measured in the attitude surveys in Studies 2 and 3.

The attitude surveys were included in this research to measure the respondent's beliefs. However, this was an individual-level measure, and this research also sought to identify relationship-level measures that would predict the influence outcomes. To do this, an attitude survey was coupled with a sociometric survey in Study 2, which measured the network and psychological variables also hypothesised to predict influence in this research in the first two studies.

Sociometric surveys

Sociometry at its most basic generates the data required by network analysts to identify actor positions in the network and, if the sample is complete enough, its structure. This approach, pioneered by Moreno (1934), asks participants to list or demarcate the names of friends and/or acquaintances either in free-response or from a choice of names on a roster. Roster survey systems are used when the whole network is known; free-response asks respondents to provide names of their contacts based upon a criterion determined by the research question. It is often used in large-scale network studies. In this research, free-response was used because the boundary of the network under scrutiny was unknown.

The principle of exposure demands that there must be a direct or indirect structural component in order for influence to occur. Sociometric surveys identify

this by generating data about whom each person is connected with. Because this research hypothesised that interpersonal and normative attributions would influence attitudes and behaviours, the criteria with which the connection was defined was an important consideration in this research; it provided the basis upon which to calculate measures of network position, network density, network exposure and network strength.

The criteria for connection vary according to the research question. Researchers have used instances of communication (Rogers & Kincaid, 1981), trade, physical co-location (Ryan & Gross, 1943) and co-membership of a group, among others. Online, network analysts have connected people based on hyperlinks between websites and weblogs (Efimova & Hendrick, 2004), live chat (Mutton, 2004) and co-location in chat rooms or on forums (Paolillo, 1999). This research used an explicit Second Life connection integrated into the virtual world's design, Friendship.

Criteria for connection: Friendship in Second Life

The meanings of online relationships have increasingly come under scrutiny by communications researchers as online social connectedness has expanded with the social media movement, articulated through applications like blogs and social networking sites. In these spaces, the connections between people have been found to be expressed through publicly accessible profiles and friends' lists, which users browse asynchronously (boyd & Ellison, 2007). Research has found that interpersonal relationships in these spaces have usually been based on friendships that already exist offline, or friends of friends.

However, Second Life adopted a more situated networking approach than most modern web-based social media. Second Life avatars did not have the same names as their account holders¹¹ and so connections were likely based on physical/virtual co-proximity and common interests. Additionally, because Second Life did not make account holders' Friends lists public, unlike in other social

¹¹ It was possible to purchase a “vanity” avatar, which had the same name as the account holder, but this was generally reserved for celebrity appearances.

networking services (boyd & Ellison, 2007), the connections that were established in this virtual world were likely to have been made between people who had met in the online community, rather than because of who they were connected with.

Participants in Second Life were able to choose to maintain contact with other people by adding them to a ‘Friends list’. This allowed each party certain privileges, including the option to see when one another was logged into the application¹². The meaning of the Friend concept was likely to vary between each respondent, and this was apparent from the variation in the number of Friendships that were observed.

Many online network studies that focus on personal networks have found that there is a large variability in an actor’s number of contacts. Adamic, Buyukkokten and Adar (2003) argue that part of the skew may represent different levels of sociability, but it is also likely that it reflects an individual’s commitment to the community and his or her eagerness to connect with others. In most online communities, entry costs are low, which makes people more willing to create linkages they would otherwise not. There is also less social overhead associated with connecting to other people across social hierarchies, and therefore there are opportunities to create more weak ties online than offline (Garton *et al.*, 1997; Wellman & Giulia, 1999; Guadagno & Cialdini, 2005).

Arguably, this has implications for the strength of relationships between people in Second Life, and indeed the literature which describes online anti-social behaviour (e.g., flaming, griefing, trolling) advises that the relationships are transitory in this kind of space (Boase & Wellman, 2006). Garton and her colleagues (1997) suggest that there are more weak relationships online than offline, and therefore greater interpersonal transience. Most analysis suggests that the concept of significant friendship is devalued on the Web, yet it was proposed in this research that online friends would have an interpersonal value strong enough to produce social influence outcomes.

¹² Other privileges, or permissions, included the option to allow the avatar to locate him/her in the virtual-physical world and to modify his/her objects, including the avatar.

Network strength and attributions of interpersonal and normative features associated with influence were also measured in the sociometric surveys by asking respondents to rate each Friend s/he listed, which served to define each relationship as more or less strong. The specific measures collected are detailed in each empirical chapter. It was anticipated that this would serve to address the concerns raised by critics of online relationships (e.g., Sigman, 2009) by identifying the avatars that were considered significant to the respondent.

Shortcomings of online surveys

The attitude and sociometric surveys aimed to generate data about influence outcomes and predictors. Arguably, they captured elements of influence that March (1955) suggested are not possible to gather via observation techniques. However, there are limitations to survey gathering methods.

First, there are general challenges that arise when seeking data from online populations. LaCoursiere (2003) notes that because of the remote nature of Internet data collecting, the researcher cannot guarantee participants are not distracted by other activities while taking part in a study. This is also a factor in other non-face-to-face settings, like with the administration of postal questionnaires, and counteracting dropout or other bias is as problematic. This analysis followed Reips' (2000) advice to establish the most difficult and important data collection early in the research. The names that were collected in the initial questions of the sociometric survey provided network data that supported some of the research questions not reliant on survey completion.

Second, the self-reported nature of the sociometric surveys was anticipated to have implications for the measurement of the network connections in Studies 1 and 2: McCarty (2003) described the tendency of participants to forget contacts, in particular those that were considered very 'close' to the respondent. This was a factor that was expected to present itself in online networks in which respondents had a larger and more transient network of acquaintances than offline. In this research, the surveys asked three different questions to generate the egocentric networks in Studies 1 and 2 to attend to this shortcoming.

Third, there was a network measurement challenge to consider: sociometric surveys are useful instruments for identifying meaningful connections and networks of individuals within a population, but network measures calculated based on the data gathered in this way is hindered by the network's egocentricity. Although not all sociometrics result in a network with missing data, those that are applied in groups of the size of Second Life tend to (Granovetter, 1976).

'Friendship' was explicitly chosen as the criterion for connection in this research to compensate for this. Because it represented a connection that was automatically reciprocated (i.e. both avatars in a Friendship had the other on his/her Friends list), it implicated more people in the sample even if not everyone in the population had completed the survey. This established more connections and, in doing so, provided more information about the interconnectivity of the Second Life social network. However, although the Friendship criterion provided more information about the network than a one-way tie, it was still dependent on survey respondents to report it. Surveying each member of the large population was impractical, resulting in a partial network with missing data.

Burt (1987) and Costenbader and Valente (2003) have cautioned that networks with less than 100% of actor participation are seriously affected by missing data: the links to and from an individual who is not represented in the network are absent, which undermines the accuracy of most network measures. Ignoring the effect of the missing data is not recommended for a number of reasons (Costenbader & Valente, 2003; Robins, Pattison, & Woolcock, 2004): first, it becomes difficult to know how valid the remaining network is, as key players' roles in the system may be undervalued because their connections aren't recorded; second, exclusion underestimates the assortativity of a network, making it more difficult to make conclusions about the similarity of actors or clusters; third, excluded links may be the only connection between two people; finally, there is no way of knowing whether missing data is random.

Some network measures have been found to still be valid even if a network is incomplete. For example, network strength is relevant to the links that have been

identified. It is arguably affected the least by missing data. However, calculations of measures that rely on the rest of the network are compromised. For example, network density is calculated by taking the proportion of observed connections in a measured network from the total possible connections in that network. Absent connections badly affect this measure. Similarly, network exposure is affected by missing data because the absence of a link potentially removes an instance in which an individual is exposed to an attitude or behaviour.

In contrast, the measure of network position, which is calculated by taking the proportion of the number of connections an individual has and the total number of possible connections in the network, can be adapted in such a way as to minimise the absence of connections: in a meta-analysis of partial network studies, Costenbader and Valente (2003) found that degree centrality was still an acceptable descriptor of an actor's position in a network with only a 20% response rate, but only if it was measured by tallying the number of times each avatar was nominated by a survey respondent. This value is known as in-degree centrality, and it was the measure of network position used when the networks were partial because of the sociometric design of the surveys used to collect the data¹³.

In sum, the survey data collection method was used to capture both outcome and predictor variables. To collect individual-level data, attitude surveys were used. To collect relationship-level data, sociometric surveys were used. There were several challenges associated with this type of data collection that arose specifically because it was a self-reported technique. This was expected to have the strongest effect on the measures of the outcome and the network variables.

The other data collection method used in this research, automated data extraction, offered benefits that counteracted the shortcomings of the self-report surveys.

¹³ There are two other measures of network position, betweenness centrality and closeness centrality. However, Costenbader and Valente (2003) observed that the least stable centrality measure in a partial network was closeness centrality, and that the importance of betweenness centrality was undermined by the absence of recorded connections.

Automated data extraction

The computer setting of Second Life offered an opportunity for a data collection technique that automatically extracted connectivity and behavioural data, making it possible to follow the accurate trajectory of an innovation through this cyber-space. Although March (1955) argues that observation of this kind may overlook unobserved influence, like attitudes and perceptions, data extraction is the simplest, most parsimonious way to capture the most complete set of behavioural data when seeking to analyse practices and processes of whole networks: it offers the most succinct and timely option. Additionally, automated data extraction in this research compensated for the egocentricity of the sociometric tools used in Studies 1 and 2, ensuring the accurate measurement of structural and behavioural data within a whole network paradigm.

When Social Network Analysis has been applied online, researchers have used automated tools to identify network connections. By extracting a snapshot of the current system's settings, researchers are able to identify an account of the makeup of the service at any time. This technique has been used in a variety of applied and theoretical contexts, including product marketing (Han & Kamber, 2006), online group and norm formation (Fayyad, 1996) and epidemiological study. It has also been used to assess the structural features of online innovation diffusion in chat rooms (Batorski & Smoreda, 2006).

Network connections collected by automatic data extraction were based on Friendship, resulting in an expanded network from the Study 1 and 2 datasets. The relationship strength measure, described in detail in Chapter 6, was based on the behavioural allowances avatar-account holders granted their Friendship partners.

Although there were non-partisan, open source technologies¹⁴ that allowed researchers to capture Second Life data automatically, there were limitations to these

¹⁴ For a list of Open Source data extraction technologies for the Second Life community, see http://secondthoughts.typepad.com/second_thoughts/2007/04/the_electric_sh.html or <http://clearnightsky.com/taxonomy/term/8>

that inspired the choice in this research to work directly with Linden Lab¹⁵. A direct relationship ensured that the data extracted was complete and accurate. The relationship also offered access to the most up to date content and to information that would otherwise have been inaccessible (e.g., account holder demographics and other information). However, working with a commercial company presented challenges, including how each party negotiated the relationship with participants. The private organisation must protect the rights of its users, and researchers must protect the rights of their participants. These issues are discussed in section 3.3.

Shortcomings of automated data extraction

There has been some criticism levied against automatic data extraction for providing data-driven outcomes that misrepresent the population under scrutiny. Montfort (2004) expressed concern with the ethical implications for the participant, but data scraped from the server may also affect the meaning of connections and groups for participant experience. Such studies often overlook whether the communities that emerge align with reality; the mathematical complexity of the extraction tools and the largesse of the outcomes often infringe on the real-world significance of the outcomes.

In network studies that use automated data extraction, there is no nuanced information about relationships; the content is binary and avatar-centric, with no evidence for the experiences of the account holders concerned. Without the subjective accounts from participants gained through the sociometric surveys, this research would not have been able to make claims about the unique contributions of network analysis and social psychology on influence. For this reason, data scraping techniques were used in tandem with sociometric surveys to identify relevant phenomenological content for analysis.

¹⁵ The tools varied in quality and content, many were proactive rather than retrospective, and it was possible that the technological protocols upon which they were designed could have been undermined or rendered un-workable with the release a new version of the Second Life software. The Second Life application was updated every Wednesday. All participants were required to download the new version of the software and install it on their computers in order to log into the community.

In sum, the two data collection methods chosen for this research were identified to complement the weaknesses inherent in each. The design of the method balanced the need to accurately describe the Second Life social network (automated data extraction) in a meaningful way (sociometric surveys). The multiple-method data collection strategy ensured that this research captured the psychological features that influenced attitudes and behaviour within the context of the meaningful groups that Second Life participants interacted in. It was unique in this approach, particularly because the final sample comprised cumulative information about the network across all studies, ensuring a robust micro-macro perspective on the influential features of the population of this online community. It also allowed for the accurate measurement of behavioural outcomes of influence, which was used to assess the unique and complimentary phenomenological and structural measures that predicted uptake of an innovation. A summary of the data collected in each study, and the method used to collect it, is listed in Table 2.

3.3. Ethical considerations

Online research and sociometry add complications to the study of human subjects that are not already addressed in existing ethical guidelines (Ess & AoIR ethics working committee, 2002). First, online settings like Second Life challenge the concept of identity; anonymity renders the offline self unknown, but the online self is pseudonymous. This has implications for sociometric data gathering techniques and outcomes that use non-anonymised identity indicators to create the tools of analysis. Second, both online and social network research present challenges for gaining consent from secondary sources, those people implicated as relationships in the Second Life network. Third, whole network analyses that use automated data extraction techniques challenge identity ownership for the participants, the virtual world owners and the investigator¹⁶. These issues are discussed in this section.

¹⁶ An additional issue arises in online research, particularly in social virtual worlds that attract populations from around the world: a variety of philosophical approaches are implicated in personal ownership, making national distinctions relevant. What may be considered good practice by one country could offend the sensibilities of another. Different countries have different ethical research

Table 2
Dependent and Independent Variables Measured in Each Study

	Study 1 ^{a, c}	Study 2 ^a	Study 3
	Outcome variables		
Personal Attitude To Sex			
Voice Use			
			x ^b
	Demographics & Community Involvement		
Avatar Gender	x	x	✓
Real life Gender	x	x	✓
Second Life DOB	x	x	✓
Real Life DOB	x	x	✓
Country of residence	x	x	x ^b
Hours per week in Second Life	x	x	x ^b
	Network predictors		
Communication mode	x	x	
Modification	x		
Second Life partnership	x		
Network position		x	x ^b
Network density		x	
Network exposure			x ^b
	Psychological predictors		
Trust scale	x		
Credibility scale	x		
Social comparison	x	x	
Prototypicality	x	x	
Trust/Credibility scale		x	
Perceived attitude to sex		x	
Experience of sex		x	
Attitude to voice			x ^a
Relationship strength (permission)			x ^b
Perceived experience of voice service			x ^a
Restriction to using voice service			x ^a

Note. DV and IV measures calculated for each study are detailed in the relevant empirical chapter

x: Study included measure for variable. ✓: variable measured in previous Study included in analysis

^aMeasure was self-reported. ^bMeasure was automatically extracted. ^cThe outcome variables in Study 1 were the psychological measures trust, credibility, social comparison and prototypicality.

philosophies that guide good practice. For example, the Association of Internet Researchers' Ethical Guidelines (Ess & AoIR ethics working committee, 2002) describes the 'utilitarian' point of view of European countries as distinct from the 'deontology' of the US. The former refers to a perspective where the research is justified regardless of potential harm to the participants if the benefits outweigh the risks. The latter suggests that research is ethically unjustified if privacy, autonomy and other ethical protocols are breached. This research, based in the United Kingdom, took the former approach and submitted an ethical protocol application to an independent University of Surrey ethics committee.

Anonymity

Sociometric surveys ask specific questions to provide the most benefit for determining the makeup of relationships (e.g., Who are your three best friends?) or the flow of expertise information (e.g., Who would you go to for information on X?). These questions challenge the ethical prerequisites for anonymity and confidentiality.

In traditional social science, this can be assured using common precautions; for example, attribute information can be collected without the need to know participants' identities. Further, as Klovdahl (2005) explains, personal network information and contacts' attributes can also be collected in a way as to assure anonymity of the respondent.

However, Social Network Analysis is predicated on the identities of respondents and the identities of those people they list as friends/acquaintances/sources of information, and therefore the conditions of anonymity become problematic. Anonymity is not possible in the network collection paradigm as identifying information is used to facilitate the development of the network map (Nyblom, Borgatti, Roslakka, & Salo, 2003; Borgatti & Molina, 2005). As Kadushin (2005) argues, "the collection of names of either individuals or social units is not incidental to the research but its very point" (p. 141).

Social network analysts argue that the lack of anonymity in data collection should not deter social network research from going forward, but the onus for establishing the ethical use of sensitive identifying information is on the researcher. Of particular importance is the removal of any identifying features or attributes from the data as soon as possible, and certainly before dissemination of findings. While this has relevance for raw, "as collected" data in databases, this also has implications for network maps. As Nyblom and colleagues (2003) explain, the network graphs used to deduce important information such as position and structure has "a 1 to 1 correspondence with that person's filled out questionnaire, completely revealing that person's responses," (p. 341).

Although in Second Life, participants were not identified by their offline names, pseudonyms function as real names in the online community. Offline,

researchers would change the names of participants to protect respondents from potential harm, however, some researchers have assumed that the pseudonym used in the virtual community can be used identifiably in the research (Dibbell, 1999; Walsh, 2004). The results can be both embarrassing and harmful to actors' social reputations in their communities.

In addition, Internet methodologists have described virtual communities as extremely sensitive; a breach in trust can destabilise the foundations upon which the online group rests, and some research and media activity has caused the undoing of previously thriving online interactions (Whiteman, 2007; White, 2002). Goal-oriented online communities and social networking sites have a stronger sense of stability than social virtual worlds because they are predicated upon the pre-determined goal systems bestowed by the designers or upon relationships developed offline. Social virtual worlds rest upon the social collectives that exist within their boundaries. Ethical transgressions can result in power shifts and mass migrations in protest of research activity to other sites can change the fabric of the community.

In this thesis, all pseudonyms were anonymised. Analyses only referred to unique user IDs, and no identifying features were included to serve as clues for both insiders and for outsiders unfamiliar with the social context.

Secondary sources

Participation in Social Network Analysis is not confined to the primary participants. It is reliant upon the non-anonymous named contacts provided by respondents to social network surveys. While this information presents valuable information for analysis of who relates to whom, it can be argued by ethics committees that the named parties are now participants in the research who have not given their informed consent.

The argument lies with the true ownership of responses to sociometric surveys: Borgatti and Molina (2003) explain that information gleaned about secondary sources is the primary respondent's perception of a relationship s/he has with another person, "which is clearly something respondents have a right to do: every respondent owns their own perceptions," (p. 339).

Further support for this position comes from Klovdahl (2005) who explains that under the terms defined by US Institutional Research Boards' (IRBs) definitions of human subjects, those people named by participants who do not participate themselves do not fall into this category, particularly when attribute information is gleaned from publicly available sources. These perspectives rely upon parallels with observational research, like participant observation and ethnography, arguing that collecting data on individuals is not ipso facto unethical, or studies which utilise these methods would need to gather consent from all parties observed.

However, it is plausible that a relationship is comprised of two actors, and neither party can ethically report on it without the consent of the other (Borgatti & Molina, 2003). Further, while the perceptions of a contact are owned by the primary respondent, Klovdahl (2005) argues that the information which may be divulged in the course of sociometric interview or survey may be believed to be private by the secondary source, and so these parties are human subjects under the IRB's Common Rule. It then becomes the researcher's responsibility to obtain consent from all parties included in the analysis (primary respondents and contacts) or to obtain waivers of consent.

Gaining consent from egocentric, large-scale social network research studies like those proposed in this thesis was unfeasible because of the sheer numbers of potential contacts arising from survey responses who may or may have not been contactable. Klovdahl (2005) suggests that there is no convenient way of accessing consent from parties listed by participants unless the collection method is a snowball sample.

In this research, the approach was taken that participants owned the rights to report on their contacts. However, as part of the sampling strategy (see p. 66) a random sample of contacts that were generated in the sociometric surveys was contacted to inform them of their involvement in this research to offer them an opportunity to participate¹⁷. This was limited by the practicalities of the contact

¹⁷ Steps were taken to contact all secondary subjects in this research. However, of the 7,793 people implicated, 4,215 were informed of their participation via Instant Message.

method in Second Life, which featured reduced space for typed messages. Potential participants were directed to the consent forms at the beginning of the online surveys, which offered an overview of the research and an opt-out clause.

The problem remained with those parties who could not be contacted or, when approached for consent, ignored the request. Unless potential participants explicitly opted-out of the entire study, non-response did not mean that their names did not come up in this thesis' sociometric analysis. In other words, if others included the non-respondent's name on a list of contacts, s/he was represented in the resulting relationship matrix for analysis. Klovdahl, 2005 argues that in studies of this scale, it is possible to waive consent requirements by meeting four criteria: the research must not involve greater than minimal risk, the research must not be practical without a waiver, waiving consent does not adversely affect participants' rights and pertinent information is fed back to the community in an anonymous format that does not implicate any single individual in the network (Bruckman, 2002). These were met in this study, as participation was voluntary, with an opt-out option at any time. Participants who chose to opt-out were granted true opt-out: the participant and all record of his or her connections (including those produced by other participants) from the final analysis (Borgatti & Molina, 2005) was removed from the final analysis within 14 days of the receipt of the request (Klovdahl, 2005).

It operated under a confidentiality agreement and no identifying information was released. Further, it was impractical to obtain consent from every account holder in the large dataset of contacts and/or the non-traceable parties in the virtual world. Finally, generalised findings were fed back to the community at the SSRL and via the research website and blog.

Special ethical considerations for automated data collection techniques

The use of Linden Lab data from the databases of the commercial company inspired new ethical questions. The Linden Lab Terms of Service (ToS) did explicitly state that the company collected personal information about their customers and that the company did not disclose personal information to third parties without the permission of the customers. Some of this data was knowingly generated

by the customers themselves and other information was generated from their actions during their use of the Second Life application; however, the data collection techniques used in this study required closer inspection of the privacy issues surrounding automatic data extraction, data warehousing and data access for four reasons

The first issue concerned ownership of online community account data (Estivill-Castro & Brancovitch, 1999). Companies collect information about their consumers for market outcomes, but in virtual worlds, where people readily exchange social and economic information, personal data ownership is exchanged for the service in the End-User License Agreement which customers must consent to in order to create an account. Individuals may understand and accept company use of their personal data to an extent, but privacy concerns arise when this data is used for secondary purposes for which the individual has not provided authorisation. Businesses like Linden Lab may claim a right to mine the data, as described in Item 6.2 of their Terms of Service¹⁸, but their customers may still have viewed this as an infringement of their personal privacy¹⁹.

¹⁸ Item 6.2 of the Linden Lab Terms of Service states, “Linden Lab may observe and record your interaction within the Service, and may share aggregated and other general information (not including your personal information) with third parties. You acknowledge and agree that Linden Lab, in its sole discretion, may track, record, observe or follow any and all your interactions within the Service. Linden Lab may share general, demographic or aggregated information with third parties about our user base and Service usage, but that information will not include or be linked to any personal information without your consent.” The full Terms of Service can be viewed at <http://secondlife.com/corporate/tos.php>

¹⁹ Brancovic & Estivill-Castro (1999) argued that data privacy is constructed as the right of individuals to control information about themselves. They argued that automated data extraction contributes to secondary use of personal information, opens the personal information up to mis-handling, and is in danger of generating detrimental social costs through de-individualisation and stereotyping (Van Wel & Royakkes, 2004; Danna & Ghandy, 2002). It further makes it difficult for an individual to anonymously control the unveiling and dissemination about his or her private life (Van Wel & Royakkes, 2004).

Second, automatically extracted data becomes ethically sensitive when the interests of the data users (e.g., businesses and organizations) are not balanced with the interests of the data subjects (e.g., customers). Fule and Roddick (2004) argue that this becomes an ethical issue when the results of analysis are used in decision-making that affects the people concerned, or when the mining compromises privacy.

The data content that was gained from Linden Lab included a combination of the personal data that new customers provided at account creation (e.g., demographics) and Second Life usage data (e.g., network relationships, community involvement). It was accessed from the data warehouse where account information for each customer was stored²⁰.

Third, there was concern that this kind of content may have been confounded both in terms of research validity and usefulness when the data accessed was granulated or obscured in such a way as the recipient would have been unable to gain any insight from it (Van Wel & Royakkes, 2004). For this reason, Linden Lab associated avatar names with the data until such point as it could be matched with existing user IDs, or new ones could be created for them. Any association between these IDs and the avatar names was destroyed by the primary researcher, as were the original files that associated the avatar names with the account content.

Finally, the issue of informed consent arose in automatic data extraction. The stipulations outlined by the OECD's Principles on Data Collection (2009) state that

²⁰ Another ethical issue is the use of ‘mined’ data, a method that seeks patterns or correlations in data stored in large databases and analyses it. The aim in mining is to unearth patterns and relationships that were previously unknown. It would have included information on live interactions in the virtual world, like chat logs, movements and locations. It should be noted that such activity already occurs in Second Life with and without the consent of Linden Lab. In February 2007, the company opened its software protocols and servers to the Open Source community, allowing the service to be hosted on non-Linden Lab servers and for the Second Life client (the application that runs Second Life on individual computers) to be mirrored (replicated) by private parties. This research did not exploit these new Open Source opportunities; instead the data extracted was from Linden Lab’s customer information servers using information actively generated by account holders who changed the status of their permanent accounts.

data collection requires that the subjects give their written consent, or that the data may not be processed. Indeed, the sample of account holders of Second Life implicated in the automatic data extraction process were not informed that their data was being used for the purposes of this research. However Linden Lab's Privacy Policy²¹ stated, "Access to your personal information is limited to those Linden Lab employees who require the information in order to provide products or services to you or perform their jobs." At the request of Linden Lab, the primary researcher had been employed as a contractor during the period of data collection to provide services to the company that utilised the network analyses undertaken in Study 3. The purpose of this employment was to understand the research questions of this thesis. The access was considered acceptable to the Linden Lab team, and within the bounds of their Privacy Policy.

3.4. Conclusion

In sum, this research sought to create a methodological design that best described the factors of influence in Second Life, balancing the benefits and shortcomings of the data gathering techniques by using a multi-method approach situated in the cultural context of the virtual world. It aimed to do this in as ethical a way as possible.

This chapter identified the techniques this research used to measure influence and the interpersonal, normative and structural variables expected to predict it, and described how they considered the effects of the virtual environment. The next chapter describes the first empirical study, which sought to assess the degree of overlap between network measures of closeness and the psychological factors of influence to examine why network strength has been successful at predicting attitudes and behaviours in network studies.

²¹ <http://secondlife.com/corporate/privacy.php>

4. Social Network Strength and Social Influence in Second Life

Chapter 2 outlined the interpersonal (individual), normative (group) and structural (network) factors that influence the uptake of an innovative attitude or behaviour, and proposed that these factors contribute complimentary but unique explanations for the processes by which people affect others' thoughts, feelings and actions (Turner, 1991). Trust, credibility, social comparison and prototypicality were described as psychological features of influence, while network strength, network exposure, network position and network density were described as structural features that helped to identify the pathways that influence travelled.

This chapter examines the relationship between psychology and network analysis in the online community Second Life by exploring why network strength has been effective at predicting attitude and behaviour change in network studies. It is hypothesised that it can be used to measure constructs that are closely related to interpersonal and normative features of influence in this virtual world, and in doing so, serves to identify what these psychological attributions mean in online spaces. It was predicted that online social network strength indicators will predict participants' perceptions of their connections' trustworthiness, credibility, prototypicality, and the degree to which they compare themselves with their connections.

Three virtual world behaviours were selected to be measures of social network strength: the likelihood an avatar would be designated a Second Life partner, the likelihood s/he would be assigned modification permissions, and the frequency with which two account holders interacted via three modes of communication (in public in the virtual world, via Instant Message in the virtual world and outside the virtual world). Each was hypothesised to predict degrees of perceptions of trustworthiness, credibility, social comparison and prototypicality.

These network strength indicators were additionally chosen because they raised two issues relating to the presentation of self in this virtual world. First, they highlighted the negotiation of the public and the private self within Second Life; they

described activities that occurred in public and private spheres of this online community, between groups of Friends and strangers and on a one-to-one basis. Second, they described how account holders negotiated the offline self in the online world by varying the amount of information that s/he disclosed to online friends about his/her offline identity. It was argued that this reflected how much an account holder wished the virtual self to be an accurate or reconstruction of his/her offline identity in the online space.

This study was undertaken because, as argued in Chapter 2, network analysts have rarely considered the underlying interpersonal and normative reasons why their measures are effective at describing sub-group homophily or the uptake of innovations. Their measures of network strength are constructed using criteria that imply psychological phenomena (e.g., friendship, opinion leadership, expertise), but these concepts have not been unpacked. By focussing on network strength in this study using three measures that implicate complimentary interpersonal functions, this analysis sought to assess the relationships between social psychology and Social Network Analysis, aiming to clarify the psychological explanations for the effectiveness of network strength in predicting influence.

The chapter first describes how network strength has been conceptualised in online analyses and outlines the behavioural indicators that were hypothesised to measure stronger and weaker relationships between avatar-account holders in Second Life (section 4.1). It was proposed that the degree to which each implicated a negotiation of the public-private and the online-offline self through intentional or implied self-disclosure would predict interpersonal and normative features of influence. The hypotheses are presented in section 4.2.

This study assessed the egocentric relationships of 52 Second Life account holders using attributions of interpersonal and normative influence scales developed for this analysis. The details of the scale development and the instruments they were based on are outlined in section 4.3. The analytic process is outlined in section 4.4. The results are presented in section 4.5 and are discussed in section 4.6 with reference to their theoretical contributions in the context of the methodological

considerations. Finally, the conclusion of this chapter (section 4.7) presents the questions that arise from these results that are further explored in the second study, reported in Chapter 5.

4.1. *Network Strength in Second Life*

It was argued in Chapter 2 that online communities like Second Life have the potential to support interpersonal and normative features of influence despite the differences between online and offline contexts that were outlined by McKenna & Bargh (2000). Yet, influence between online friends is, at least, mediated by the features of the lean communication medium. Arguably, attributions of trustworthiness, credibility, social comparison and prototypicality in environments where users are encouraged to create new virtual identities separate from their offline selves are associated with performances of behaviours in that context. These may be based on the capability of people to deliver resources in a way that meets the expectations and needs of recipients (Hemetsberger, 2002), the amount of content shared and the perceived accuracy and honesty of the information exchanged (Feng, Lazar, & Preece, 2004), common linguistic patterns (Paolillo, 1999), characterisations (Lyman, Scott, & Harre, 2009), or other public displays of contextually appropriate group normative behaviours (Lam & Schaubroeck, 2000; Hogg & Hains, 1996).

An additional interpersonal element affecting attributions of trustworthiness, credibility, social comparison and prototypicality was proposed in this research: the extent to which an individual disclosed information about him/herself to an online other by exposing offline aspects of his/her identity.

As raised in Chapter 2, the online identity was an active construction of the self generated by the account holder and presented to the Second Life community. In this environment, online identity developed virtual social capital independent of offline reputation. It could be kept separate from any association with the offline self and, indeed, the official Second Life information encouraged this duplicity of

identity by suggesting, “Ready to create a new digital you?”²². It was anticipated that certain interpersonal activities would reduce the control the individual had over their online presentation of self, by actively or passively disclosing offline identity content, potentially increasing the degree of social risk to the account holder. This was hypothesised to predict attributions of interpersonal and normative features of influence.

In this research, three behaviours were identified: assigning virtual partnership to another account holder, granting modification rights over one’s virtual objects (including the avatar) to another account holder and communicating in private channels of communications (e.g., in non-public contexts, like via Instant Messaging or outside the virtual world), with another account holder. The likelihood each of these would occur was constructed as exemplars of interpersonal relationship, or network, strength. The communication mode measures were prioritised against one another, but partnership and modification were not. Each was an indicator of network strength. This section describes these measures.

Partnership

Second Life account holders had the option to designate another avatar as a ‘Partner’. Although partnerships needed not originate online, the Partner was a virtual world construct. This feature acted like an indicator to the online environment that two avatars were in a public romantic relationship. Partners were identified on account holders’ virtual profiles and were often formalised in ceremonies that were similar in format to offline commitment celebrations. They were not required for participation in the virtual world, but many took part in the experience. There was no built-in virtual gain for Second Life Residents to create partnerships; in fact, there was a financial commitment for becoming a Second Life partner: a nominal Linden dollar fee was required to add a partner to the profile, and to remove it.

It was hypothesised that the designation of a virtual world partner had several implications for the perceptions of interpersonal and normative source attributions.

²² <http://secondlife.com/whatis/>

First, the designation of a virtual world partner in Second Life was an indicator that two people may have developed a strong emotional bond. In offline research, greater attributions of trust have been associated with relationship partners than to friends or co-workers (Holmes, 1991; Smith, 1998). Indicators of trust in partnerships have included mutual self-disclosure and intimate sharing. Indeed, the same outcomes have been observed online (Levine, 2000). However, Merkle & Richardson (2000) demonstrated that mutual self-disclosure and intimate sharing occurred more often and to a greater degree online than in offline relationships.

Second Life partners were expected to share more about their private, offline selves with one another than with non-Partner Second Life avatars on this basis, generating increasingly stronger bonds because of the consistent openness with which they shared personal information. Attributions of trust based on formal virtual relationships have not been examined online but the development of online romantic relationships has (Levine, 2000). It was hypothesised that account holders would attribute greater degrees of trust in their Second Life partners than to their online Friends.

Second, online research has tentatively associated attributions of credibility with virtual relationship partners, specifically associating it with the degree of self-disclosure at an early stage in the relationship. Although, Yum & Hara (2005) found that this destabilised some views of partner-credibility because too much information that undermined assumptions of expertise was disclosed too soon, the development of generalised credibility based on the establishment of trust through online self-disclosure, attributions of similarity, or behavioural attributions based on experiences of consistency and fairness were expected to result from partnership assignments (Renn & Levine, 1991).

Third, Pinkus, Lockwood, Schimmack and Fournier (2008) found that social comparison between offline relationship partners occurred more frequently than with non-partners and were often more positive, upward and represented desired selves (Amodio & Showers, 2005).

Gardner, Gabriel and Hochschild (2002) also noted a tendency of relationship partners to attribute more similarity to one another than to others, generating a confound between the self and the other. They observed that the partner's successes became the self's successes, and that attributions of in-groupness was projected onto the partner (Aron, Aron, Tudor, & Nelson, 1991; Coats, Smith, Claypool, & Banner, 2000). This was anticipated to be even more pronounced in virtual encounters because of the similarity biases that were projected onto online others in general, and onto virtual relationship partners in cyberspace in particular (Levine, 2000; Bargh, McKenna, & Fitsimmons, 2002).

This review results in the following hypothesis:

H₁: A Second Life contact that was more likely to be designated an account holder's virtual world partner would be perceived as trustworthy, credible and prototypical and viewed as a source of social comparison more than contacts who were unlikely to become virtual world partners.

Modification

The second exemplar of network strength in this study was the likelihood a virtual world contact would be assigned the right to modify an account holder's objects (including avatar). Often this was offered for the purposes of avatar personalisation or object construction, but overall this was a rare permission. It was expected that connections that had modification rights would be more influential because they would be granted access to the online identity: they would receive higher ratings on facets of both interpersonal and normative influence.

Granting modification rights to another account holder was hypothesised to generate attributions of trust for three reasons. First, as discussed in Chapter 2, the avatar and objects created by the account holder acted as the representation of the account holder's online identity and was aligned with the presentation of self in this virtual world. His/her actions and output were recognised through the avatar name, characterisation or objects s/he built, and his/her social capital, based on the social attributions of trust projected through similarity or behavioural attributions of trust developed over time.

Allowing another account holder access to this resource was thus a risky behaviour because of the potential implications for the ego's virtual world reputation and his/her role in the social network. Granting modification rights was expected to require trust in the other person to perform discretion with these permissions.

Second, some users identified very closely with their online counterparts, using the virtual space as identity 'laboratories' (Turkle, 1995) and proving grounds for possible offline selves (Krotoski, 2004). Offering another account holder modification rights was expected to implicate attributions of trust based on the expectation that s/he would uphold the consistency of the online self, so the continued negotiation of the offline self could be maintained.

Third, online accounts in virtual worlds that have real-world transferable economies, like Second Life, included all assets that the Resident had built or earned²³. These accounts had proven fiscally valuable (e.g., Dibbell, 2006; Castranova, 2002; Castranova, 2003); for example, in China, accounts in online communities are protected by law against theft. Second Life community members arguably offered modification rights to those connections whom they trusted not to exploit the financial opportunities afforded by access to account assets.

Modification also had a practical purpose in the virtual world and it was anticipated that the skills associated with object personalisation would result in attributions of credibility. Professional virtual builders were employed to create designs to personalise avatars or objects. This exchange transaction would have implicated information about the other's reputation, based on communicated experiences of other account holders, previous personal experience or other observable source features like the quality of showcased material. Modification rights granted for these reasons were expected to represent the belief that an expert was capable of translating the offline identity desires into the online virtual self. This was anticipated to be context-specific, and that influence outcomes in these cases would have been associated with attributions of expertise.

²³ The virtual world's currency.

Similar expectations were raised with the anticipated positive relationship between modification and social comparison. The successful avatar and object personalisation economic structure in Second Life was arguably based on the cultural desire to adequately express oneself through these physical-virtual representations to the virtual world population (Stern, 2004; Wood, Solomon, & Englis, 2005). Upward and downward social comparisons based on the pragmatic functions of Second Life modification were hypothesised to contribute to the relationship between these variables.

Finally, this research proposed that there would be a positive relationship between Friends perceived as representing the group prototype and modification permissions because of the trust associated with members of the in-group. Hogg (2007) described the prototypical member as a group opinion leader who was viewed as more trustworthy because she was likely to be doing the best for the group. As modification rights were hypothesised to require trust because of the personal and social risks involved for the account holder, it was anticipated that these well-liked and high status group members would more likely be granted the ability to amend avatars and objects.

H₂: A Second Life contact that was more likely to be assigned the right to modify an account holder's objects would be perceived as trustworthy, credible and prototypical and viewed as a source of social comparison more than contacts who were unlikely to receive this right.

Communication mode

The third behavioural measure of network strength was communication mode closeness. This was described on a scale of the frequency of interaction between two account holders in increasingly private channels.

There were two virtual world communication channels available to Second Life account holders during Study 1: public chat, a proximity-based, text system automatically streamed to every community member in the immediate area; and Instant Message (IM) chat, a private text system that could be used to communicate with anyone in the virtual world wherever they were located. In addition, this study

considered the effects of non-Second Life communication between two account holders, hypothesising that observed interaction in these three modes of communication had implications for attributions of interpersonal and normative influence.

Rogers & Kincaid (1981) proposed that communication-based networks are valuable resources for understanding influence because they represent active pathways where information can be transferred. They conceptualised stronger ties as those that featured more communication, increasing the possibility for the flow of experiences and word-of-mouth behaviours. Although that approach did not take into account normative influences from a reference group that a network actor was not directly connected with (Deutsch & Gerard, 1955), it had relevance to Second Life because the virtual world was a communication medium first and foremost.

In addition, Internet researchers have theorised that virtual environments have the potential to be both public and private channels of communication, and that this implicates the interpersonal closeness between the pair. Correll (1995) and Garton, Haythornthwaite, & Wellman (1997) have proposed that these distinctions articulate degrees of closeness based on the degree of privacy each mode of communication affords. In other words, attributions of normative and interpersonal features of influence were expected to increase as communications grew from least to most private. In this research, the least private mode was considered public Second Life communication; the most private was non-Second Life communication. Instant Message communication privacy was conceptualised as between the two: operating on a one-to-one basis or a one-to-small group basis, but remaining within the boundaries of the Second Life context.

This research sought to test the relative contribution of each communication mode to attributions of trustworthiness, credibility, social comparison and prototypicality.

Public communication

Offline self-presentation theories (e.g., Goffman, 1959; Oldenberg, 1989) identify different channels of communication that represent different levels of

closeness between the people who engage in them. 'Front channels', where the public self is on display, are the most open. Interactions in this space are likely superficial and often unemotional. However, Hogg (2001) has theorised that it is in these spaces that social identity is constructed: the public presentation of group belonging helps to define the boundaries of the in- and out-groups, and to mutually designate prototypical group members. Public chat was conceptualised as Second Life's front channel, the least private mode of interaction.

Any avatar within twenty virtual metres of a "speaking" avatar could read his/her public chat. It was a communication mode that was frequently used during meetings, entertainment gatherings or in popular hangouts. It occurred between virtual strangers and close friends.

The public chat environments were expected to represent 'third places' (Oldenberg, 1989), spaces that served as meeting points for shared events. Conversation via this channel was neutral, playful and allowed participants from different virtual social classes to mix. It was peppered with humour, as in other virtual environments of this type (Ducheneaut & Moore, 2004), and, as Correll (1995) described, allowed participants to create a shared reality.

Public chat arguably produced the least risk for the account holder's construction of online identity, as s/he retained control over how s/he was presented in the virtual world; however, it offered an opportunity to interact with other avatar-account holders and to observe them and how they presented themselves. In the lean environment, this was expected to generate the basis for attributions of similarity and, through the public discourse, perspectives on how others in the environment viewed attitudes and behaviours. It was hypothesised that public communication would predict mutually-determined social attributions of the interpersonal features of influence (trust, credibility, social comparison), the occasion to identify sources of comparison in the social context, and the designation of prototypical actors; however as the communication channel that offered the greatest control over the presentation of self, public communication would predict interpersonal attributions of trust the least of the three communication modes.

H₃: Contacts who communicated frequently via public communication channels would be rated more highly as prototypical than contacts that communicated via Instant Message and outside Second Life, but would be less highly rated on trustworthiness, credibility and social comparison.

Instant Message communication

Goffman (1959) also described offline ‘back channels,’ safe spaces where people were able to express more affective communication. In practice, this was anticipated to be where people performed increased disclosure practices and were more open and honest. While some have argued that Internet communities themselves are back channels (Ducheneaut & Moore, 2004), others have identified that these environments have distinct front and back channels where different strengths of friendship are formed and expressed (e.g., Garton, Haythornthwaite, & Wellman, 1997; Correll, 1995).

Goffman (1959) argued that the back channels were more significant in terms of emotional closeness and featured relaxed and intimate sociability. Correll (1995) observed this distinction in a text-based online community. In her ethnography of an online community, she observed the practice of members moving to private chat to express a deeper level of commitment, increasing interpersonal solidarity. Garton and her colleagues (1997) also observed this in other mediated communities. Using private channels, like that offered by the Instant Message facility in Second Life, was expected to indicate that network ties were stronger.

In this research, it was anticipated that the frequency of Instant Message communication between people in the online environment would result in greater attributions of trustworthiness, credibility and social comparison because the practice of communicating one-to-one or in small groups without observation allowed participants to present themselves more intimately, sharing more private information about their offline selves. However, because the contextual location of Instant Message communication was still situated within the virtual world and remained part of its consensual hallucination (Gibson, 1984), it was expected that the online identity would remain salient, even if the communication mode increased closeness.

Because of this negotiation between online and offline self, it was hypothesised that Instant Message communications in the Second Life world would also predict attributions of group prototypicality, although not to the degree that public communication would. This relative effect was proposed to be due to the increased information that was shared in private contexts, reducing the stereotyping that was expected to occur in online public contexts (Spears & Lea, 1994).

H₄: Friends who communicated frequently via Instant Message would be rated more highly in trustworthiness, credibility and social comparison than public communication partners, but less highly than non-Second Life communication partners. They would be rated more highly in prototypicality than non-Second Life communication partners, but less highly than public communication contacts.

Non-Second Life communication

Finally, it was hypothesised that non-Second Life communication between two virtual community account holders would identify the strongest relationships based on communication because it represented the greatest risks to the target. Transferring the interaction from the anonymous/pseudonymous space required a disclosure of some aspects of the offline self to the online world. This was expected to be particularly relevant in Second Life in which both the design of the space and the culture of the community encouraged a separation between the ‘second’ and the ‘first’ lives.

By tying the online account to an offline email address, a real name, a voice or a time zone, participants exposed information about their non-Second Life identity to a member of the online community both socially and, potentially, physically. This arguably enhanced the potential risk for the community member, but offered more cues for contacts to assess their similarity. For these reasons, non-Second Life communication was expected to result in greater attributions of trustworthiness, credibility and social comparison, but the least attributions of prototypicality.

H₅: Friends who communicated frequently outside the Second Life virtual world would be rated more highly in trustworthiness, credibility and social

comparison than public and Instant Message communication partners. They would be rated the least highly in prototypicality than observed for the other communication modes.

4.2. **Hypotheses**

In sum, the Second Life network strength measures presented in this section were hypothesised to predict ratings of trustworthiness, credibility, social comparison and prototypicality. Network strength has been an effective way of predicting influence in network studies, but there had been little research that has explained the psychological processes that may be involved. The last section outlined the proposed relationships between the likelihood an account holder was to designate a Friend as a virtual world partner, assign a Friend modification rights, the frequency of interaction between avatars in increasingly private modes of communication and interpersonal and normative factors of influence. The hypotheses in this study were as follows:

H₁: A Second Life contact that was more likely to be designated an account holder's virtual world partner would be perceived as trustworthy, credible and prototypical and viewed as a source of social comparison more than contacts who were unlikely to become virtual world partners.

H₂: A Second Life contact that was more likely to be assigned the right to modify an account holder's objects would be perceived as trustworthy, credible and prototypical and viewed as a source of social comparison more than contacts who were unlikely to receive this right.

H₃: Contacts who communicated frequently via public communication channels would be rated more highly as prototypical than contacts that communicated via Instant Message and outside Second Life, but would be less highly rated on trustworthiness, credibility and social comparison.

H₄: Friends who communicated frequently via Instant Message would be rated more highly in trustworthiness, credibility and social comparison than public communication partners, but less highly than non-Second Life

communication partners. They would be rated more highly in prototypicality than non-Second Life communication partners, but less highly than public communication contacts.

H₅: Friends who communicated frequently outside the Second Life virtual world would be rated more highly in trustworthiness, credibility and social comparison than public and Instant Message communication partners. They would be rated the least highly in prototypicality than observed for the other communication modes.

4.3. Method

Participants and procedure

52 Second Life account holders responded to an online sociometric survey and generated 1,162 names of their current Second Life Friends²⁴. They were recruited using advertisements and recruitment calls across several Second Life weblogs and digital newspapers, via listings on the Official Second Life Forum (<http://forums.secondlife.com/>), on the in-world Classifieds board and on other independent popular digital weblogs with content about virtual worlds. The breadth of distribution served two purposes: first, the widespread coverage was initiated in order to identify a probability sample of actors with no connections between one another. The recruitment method increased the probability that the nature of the network collected did not lead to an over-emphasis on central individuals (Frank & Snijders, 1994; Spreen & Zwaagstra, 1994). Second, the distribution schedule was intended to capture as many potential participants from across the population of the virtual world as possible within the short, one month data collection period. Finally, only one degree of collection was surveyed as the aim of this study was to identify the content of influential relationships, rather than to explore network structures.

²⁴ Respondents were asked how often they interacted with each of the listed avatars by selecting responses from a 5-point Likert Scale. Any avatar who received a rating of *I do not speak with this person at all nowadays* was removed from subsequent scrutiny. However, his or her name was retained as an historical contact for the respondent in future analysis.

Materials

Data for this study came from the responses to a 24-item online survey distributed to participants of Second Life between March and April 2006 (see Appendix 1 for survey text). The survey was built using a PHP application framework by a third party²⁵ to a remit demanded by this research. It included three sections: Demographics (free-response fields and drop-down menus), the social network items, including the name generator (free-response fields) and the questions that assessed the relationships identified by the name generator (drop-down menus) including the outcome variables (trust, credibility, social comparison and prototypicality) and the predictor variables (likelihood of being designated a partner, likelihood of being assigned modification rights, frequency of communication in public, via IM and outside Second Life). The Name Generator and relationship evaluation sections followed Fischer's (1982) sociometric method, in which network connections were first identified using a generic criterion (Friendship) and were individually assessed to determine which contacts were perceived to be closer to or more distant from the respondent.

When participants clicked on the survey link from within the virtual world, they were taken to the front page of the survey. This included information about the research, instructions on how to complete the survey, contact information for the research team and an informed consent clause. Participants who clicked the 'I Agree' button were considered to have given their consent (Ess & AoIR ethics working committee, 2002) and entered the body of the questionnaire tool.

Instruments

The content of the survey was divided into three sections: Demographics and community involvement, social network items and social psychological items. Details and descriptives of each measure and are outlined in Table 3 at the end of section 4.4.

Demographics and community involvement

²⁵ The survey was built by John McMurtrie, an independent computer consultant.

The Demographics section consisted of three sets of questions: one question established a unique identifier for the survey respondent, two questions assessed Community Involvement (number of hours spent in Second Life per week and length of time since his or her account was created), and four questions asked about the respondent's age, country of residence, offline gender and online gender. See questions 1 to 7 of Appendix 1 for details of these questions.

Social network name generator

The survey consisted of two parts: 1) the social network name generator and 2) relational strength assessment. The name generator established the connections and the relational strength assessment defined the outcome and predictor measures.

The name generator item asked respondents to type the names of avatars on their Friends lists and those whom they expected to include on their Friends lists in the future into a free-response field to produce a list of their contacts (see Section 1 of Appendix 1). If an account holder had more than 50 Friends, participants were asked to list only those with whom they communicated with most regularly, and to submit screenshots of their full Friends list via email to the research team. Names submitted via screenshot were included in later research to generate the network structures under scrutiny in Studies 2 and 3, but were not included at this time. The delineation of the Friends listed by respondents as active (i.e. activated most regularly) ensured that the relationships described were current and had the greatest opportunity for potential influence.

All names inputted into the survey were automatically integrated into the next sections, where respondents answered questions about their relationships with their nominated Friends. The questions that followed had responses along 5-point Likert scales. Respondents were required to answer each question about each nominated avatar.

Outcome measures

There were four outcome measures in this research. The first three – trust, credibility and social comparison – were the interpersonal attributions. The final outcome measure, prototypicality, was a normative attribution.

Trust

The trust scale developed for this study (questions 21-24 in Appendix 1) emphasised social trust at an interpersonal (rather than an institutional) level, taking into account the features of online interaction that were likely to enhance the development of relationships: perceived similarity (*This person and I share similar values and beliefs*), trustworthiness (*This person is trustworthy*), caring (*This person cares about me*) and honesty (This person is honest; Earle & Cvetkovich, 1995). Measuring trust online or offline is challenging; balancing the nuances outlined by researchers while ensuring that trust scale items are not redundant for respondents means that many scales have been developed which incorporate some, but not all of these aspects. While arguably a scale should incorporate each element, Renn and Levine (1991) argued that the absence of any feature of trust can be compensated for by a greater degree of another.

The four questions formed a strongly reliable scale (See Table 3).

Credibility

The four-item scale in this study (questions 14-17 in Appendix 1) focussed on past performance (*This person is reliable*), believability (*I tend to believe what this person says*), competence (*I consider this person to be well-informed about a wide range of issues*) and identification (*I like this person*). These categorisations were informed by Renn and Levine (1991). The scale was strongly reliable.

Social comparison

Two items asked respondents to rate their Friends on how much they compared themselves with each avatar. They were included to help specify which actors in the respondent's social network were sources of reference (questions 18 and 19 in Appendix 1). Lennox & Wolfe's (1984) ATSCI scale was reduced from 13 questions to the two items which loaded highest on the two Factors in Lennox and

Wolfe's analyses: attention to social comparison (*If I am the least bit uncertain how to act in a social situation, I look to the behaviour of this person for cues*) and adaptability of behaviour (*I find that I tend to pick up slang expressions from this person and use them as part of my vocabulary*).

These two questions were chosen because they represented the items that accounted for the greatest variance on the two components of attention to social comparison: the emotional and the behavioural aspects. These complimentary aspects of social comparison were important to include in this construct's measurement to affirm that online interaction in Second Life was comprised of both affective (e.g., Dibbell, 1999) and behavioural (e.g., Book, 2004; Correll, 1995) qualities (see Table 3).

Prototypicality

One item asked survey respondents to identify the actors whom they viewed as typical members of a reference group (question 17 in Appendix 1). This measure identified the relative prototypicality of the most and least benchmark individuals in their networks (Hogg & Hains, 1996; Hogg & McGarty, 1990; Hogg & Terry, 2000). It asked the individual to consider the group context (*This person has qualities that are typical of the people in my Second Life network*) rather than those individual avatars that they actively referred to in behavioural or affective situations, which was addressed by the social comparison items. The question was appropriate to ask each respondent as research has suggested that there is agreement amongst individuals on the prototypicality of both in- and out-group members (Fleeson, Zirkel, & Smith, 1995).

Predictor variables

Five questions asked respondents about the network strength measures that were the predictor variables in this study. The first two, the likelihood a respondent would assign a Friend as a Partner and the likelihood s/he would grant the Friend Modification rights, were constructed to capture the intention to behave, and related to Hypotheses 1 and 2. They were rated on 5-point Likert scales with items ranging

from *Strongly Agree* to *Strongly Disagree*. These measures were not prioritised but were examples of two designations of closeness in this context.

In contrast, the three communication mode variables sought to measure network strength on a scale from least to most close by asking about the frequency with which each respondent communicated with each of his/her Friends in public in Second Life, via Instant Message in Second Life and outside the virtual world. These communication mode measures were related to Hypotheses 3-5. The communication items were rated on 5-point Likert scales from *Once a day to several times a day* to *I do not speak with this person in this context at all nowadays*.

4.4. Analytic Overview

Data organisation

The data was organised into two tables: 1) the individual-level information about the survey respondent, including demographic and community involvement variables, and 2) the relationship information from respondents identifying each connection and his/her ratings. In this sample, 19 Friend nominees were also respondents.

All respondents and avatars in the study were assigned unique user IDs used throughout the research process. At no point were avatar names associated with these user IDs.

Multilevel modelling

This research aimed to describe the variation in scores of trust, credibility, social comparison and prototypicality, as predicted by behavioural indicators. It tested the hypotheses using multilevel modelling because the 1,162 ratings on these independent variables were nested within the 52 online survey respondents.

In this study, the ratings of interest were the measures the respondents gave to each of their Friends. However, there may have been variation between respondents in their rating patterns. Multilevel modelling controls for variation at the respondent

level: this analytic technique takes into consideration the differences in how each respondent interpreted the survey items and his/her individual differences in ratings.

There was a two-level hierarchical structure: Friends were at level 1, nested in survey respondents at level 2. The amount of variance in the interpersonal or normative features of influence explained by the behavioural indicator was partitioned into two components: respondent and Friend. To assess the variance between survey respondents, the model's intercept was identified as random at level 2. In other words, the means of the interpersonal and the normative features of influence were allowed to vary across survey respondents. The mean for the behavioural predictors was able to raise or lower randomly from the overall mean by an amount that was assumed to be normally distributed (Rasbash, Steele, Browne, & Prosser, 2004). Additionally, categorical and continuous variables were added to the model; their effects did not confound the residual of the Respondents group, like in a fixed effects model.

The analytic process is similar to an ANOVA model, except that the differences between scores Friends received from respondents were anticipated to be random variables coming from a normal distribution (Rasbash *et al.*, 2004).

The data was analysed for group effects using the commercial software MLWiN (Rasbash, Browne, Healy, Cameron, & Charlton, 2005). The beta values in the model represented the overall population mean (u_0) and each avatar's score variation ($e^{ij}\sigma_e^2$), the residuals representing each Friend's difference from that mean. In the multi-level approach, the Friends in the sample were treated as a random sample from a population.

The models were estimated iteratively using iterative generalised least squares (IGLS).

Table 3

Descriptive Analysis of the Study 1 Variables

Variable	Response options	M	SD	α	N
Demographics and Community Involvement					
Respondent gender	Male: 75.0% Female: 25.0%				52
Respondent avatar gender	Male: 67.5% Female: 32.5%				52
Country of residence	Australia: 2.5% Canada: 7.5% England: 15.0% Italy: 2.5% Taiwan: 2.5% USA: 70.0% Netherlands: 2.5%				52
Age		32.88	8.04		52
Respondent hours spent in Second Life	1-5: 35.0% 5-10: 5.0% 10-15: 15.0% 15-20: 10.0% 20+: 35.0%				52
Respondent length of time since account created	< 3 months: 12.5% 3-6 months: 22.5% 6-9 months: 20.0% 9 months-1yr: 2.5% 1-1.5yrs: 5.0% 1.5-2yrs: 15.0% 2+ yrs: 22.5%				52
Social Network items					
Nominated Friends					829
Total no. Friends rated					1162
Interpersonal features of Influence					
Trust		3.72	0.07 ^a	0.87	829
Credibility		3.97	0.06 ^a	0.88	829
Social Comparison		2.82	0.12 ^a	<i>r</i> = 0.70 <i>p</i> < .00	829
Normative features of Influence					
Prototypicality		3.62	0.09 ^a		829
Network strength					
Partnership		2.13	1.29		1106
Modification		2.67	1.5		1106
Public communication		2.88	1.1		1162
Instant Message communication		2.85	1.13		1161
Non-Second Life communication		1.7	1.2		1148

Note. ^aStandard error

4.5. Results

Between March and April 2006, 201 Second Life account holders clicked the link from the Social Simulation Research Lab to the first page of the survey instrument. Of these, 52 people contributed responses to relationship attribution scales (behavioural indicators, interpersonal and normative features of influence items)²⁶. The maximum number of Friends nominated by a survey respondent who contributed ratings on at least one relationship scale in the name generator question was 148. The average number of nominated Friends in the sample of 52 survey participants was $M = 51.9$ ($SD = 11.1$).

Respondents generated information about 1,162 relationships and about 829 unique avatars. One avatar was nominated by 10 respondents; 60 avatars were not nominated by any survey respondents²⁷.

All avatars listed were rated on the predictor and outcome variables. The total number of ratings ranged from 1,162 (public communication) to 829 (Trust). The variation in scale completion rates was a result of participant dropout; if the respondent did not complete the survey in full, subsequent ratings for the relationship attributes for the avatars s/he nominated were not recorded. Any existing ratings avatars received prior to dropout were retained in the analysis.

Descriptives

Full details of the descriptive information for respondents are listed in Table 3.

There was a tendency in this sample for male respondents to complete the survey in full, and the strong relationship between online and offline gender identity ($r = 0.83$, $p < .00$) suggested a limited amount of ‘gender bending’ occurred in the

²⁶ Names that were generated by people who did not complete the survey in full were not discarded as the contacts they listed represented part of the social network implicated the research design for Studies 2 and 3. In total, 79 respondents submitted 2,025 Calling Card contact avatar names, of which 1,734 were unique.

²⁷ These avatars were survey respondents who received no nominations from other respondents.

sample population in this study. There was a small relationship between the number of hours spent per week in Second Life and gender, with men in this sample slightly more likely to spend longer online than women ($r = 0.35, p < .00$).

The majority of participants were relative newcomers to the virtual world, with 55.0% of respondents reporting that they had been involved with Second Life for fewer than nine months preceding their participation in this research. There was a moderate cohort who had been Second Life account holders for some time: 22.5% reported that they had been involved with the virtual worlds for more than two years. There was no relationship between the number of hours spent in the virtual world and how long participants reported that they had held an account, but a third of the respondents spent fewer than five hours per week in the virtual world.

Respondent variation on ratings of interpersonal and normative influence

A test of four multilevel models established a baseline, assessing the amount of variance between respondents' scoring patterns on the outcome variables in this analysis. This provided the evidence that multilevel modelling analyses were required for the later operations.

Trust

After two iterations, the Trust model with no predictors and the intercept set at random demonstrated that the overall mean of Trust ratings was $\beta = 3.72$ ($SE = 0.07$), with the means for the different respondents distributed across the overall mean with a variance of $u_{0j} = 0.18$ ($SE = 0.05$). The variance between the Friend ratings by each survey respondent was $e^{ij}\sigma_e^2 = 0.40$ ($SE = 0.02$). The variance between respondents' attributions of their Friends as trustworthy appeared to be significantly different from 0 ($Z = 0.40/0.02 = 20.00, p < .00$). This normal test provided an approximation that acted as a rough guide; because the distribution of the estimated variances is only approximately normal in multi-level models, the likelihood ratio test was used to compare the log-likelihood of the multi-level model with the log-likelihood of a model in which the variance of the intercept was constrained to 0. The value of the likelihood ratio statistic in this case was 236.29

($1921.14 - 1684.85 = 236.29$). This statistic is comparable with a chi-squared distribution with one degree of freedom. 31.0% of the total variance in ratings of Trust was attributed to differences between respondents.

Credibility

After three iterations, the model demonstrated that the overall mean of Credibility ratings was $\beta = 3.97$ ($SE = 0.06$), with the means for the different respondents distributed with a variance of $u_{0j} = 0.15$. ($SE = 0.04$). The variance between the Friend ratings by each survey respondent was $e^{ij}\sigma_e^2 = 0.41$ ($SE = 0.02$). This variance, between ratings of Friends on Credibility, appeared to be significantly different from 0 ($Z = 0.41/0.02 = 20.50, p < .00$). The value of the likelihood ratio statistic was 230.43 ($2361.50 - 2131.07 = 230.43$). 26.8% of the total variance in ratings of Credibility was attributed to differences between respondents, the least of the ratings on the facets of interpersonal and normative influence. This suggested that ratings of Credibility were most consistent among respondents, an attribution independent of the subjective experience.

Social comparison

After two iterations, the model demonstrated that the overall mean of Social Comparison ratings was 2.82 ($SE = 0.12$), with the means for the different respondents distributed with a variance of $u_{0j} = 0.68$ ($SE = 0.15$). The variance between the ratings of each Friend as a source of Social Comparison by each survey respondent was $e^{ij}\sigma_e^2 = 0.49$ ($SE = 0.03$). This variance, across ratings of Friends as a source of Social Comparison appeared to be significantly different from 0 ($Z = 0.49/0.03 = 16.33, p < .00$). In this case, the value of the likelihood ratio statistic was 702.96 ($2799.99 - 2097.03 = 702.96$). 58.1% of the total variance in ratings of Social Comparison was attributed to differences between respondents, the strongest of the ratings on the facets of interpersonal and normative influence. This suggested that ratings of this attribute were the more unique of the outcome variables to each respondent.

Prototypicality

After three iterations, the model demonstrated that the overall mean of Prototypicality ratings was $\beta = 3.62$ ($SE = 0.09$), with the means for the different respondents distributed with a variance of $u_{0j} = 0.34$. ($SE = 0.08$). The variance between the Friend ratings by each survey respondent was $e^{ij}\sigma_e^2 = 0.73$ ($SE = 0.03$). This variance, between attributions of Friends' Prototypicality, appeared to be significantly different from 0 ($Z = 0.73/0.03 = 24.33, p < .00$). The value of the likelihood ratio statistic was 238.14 (2660.21 - 2422.07 = 238.14). 31.8% of the total variance in ratings of Prototypicality was attributed to differences between respondents.

The results of these initial analyses indicated that multilevel modelling was appropriate for the predictive models

Relationships between outcome variables

A partial correlation analysis was conducted to assess the relationships between the dependent variables. One relationship between the dependent variables was remarkable in its strength: the correlation between Trust and Credibility ($r = 0.81, p < .00$) offered evidence that these constructs implicated one another. However, these two scales were not integrated to form a single variable because it had been hypothesised that they would be differently predicted by the network strength variables, a conceptual rather than an empirical decision outlined in the introduction to this chapter. Particularly in Hypotheses 3-5, it was anticipated that there would be a public element to attributions of Credibility: the development of a reputation based on a generalised expertise performed in a more public and contextual situation. However, any variance observed in Trust and Credibility as a result of the network strength measures took into account this relationship.

Another strong correlation was observed between Social Comparison and Prototypicality ($r = 0.48, p < .00$), suggesting that these two variables also measured similar properties. However, because the Social Comparison measure was conceptualised as relating to the individual's perception of another actor rather than an individual's perception of the group, the distinction between these two measures was maintained.

Relationships between predictor variables

Correlation analyses between the behavioural predictors demonstrated two strong relationships of note: between Partnership and Modification ($r = 0.61, p < .00$) and between public and Instant Message communication ($r = 0.78, p < .00$) in the virtual world. The former suggested that the likelihood of distinguishing an avatar as deserving of a special role – i.e. of becoming a relationship partner or being granted modification rights – drew on similar processes, and it was anticipated that these network strength measures would produce similar effects on the variances in scores of interpersonal and normative features of influence. This was taken into consideration in the multilevel modelling analysis described in section 4.5 by adding a model to identify the unique variation in the interpersonal and normative features of influence measures explained by each of these variables when considered together.

The relationship described between Instant Message and public communication suggested a contextual element of virtual world communication. The very strong correlation highlighted a virtual world practice in Second Life that the frequency of public communications was related to the frequency of Instant Message communication, indicating that engaging in one more or less regularly meant that avatars engaged in the other as often or as infrequently.

There was very little relationship between non-Second Life communication and public communication, as anticipated, and, although the relationships were significant, no other noteworthy relationships emerged between the communication modes and the remaining behavioural indicators. The strong relationships are taken into consideration in the models that predicted the unique variance of each independent variable on the interpersonal and normative features of influence, described in section 4.5.

Relationships between predictor and outcome variables

Finally, results of the partial correlation analyses between the measures of network strength and the interpersonal and normative features of influence, controlling for participant variation, are detailed in Table 4. Modification

Table 4

Correlations Between Interpersonal and Normative Features of Influence and Network Strength Measures

Outcome variable	Partnership	Modification	Public Communication	Instant Message Communication	Non-SL Communication
Trust	0.42	0.50	0.41	0.42	0.49
Credibility	0.41	0.48	0.42	0.39	0.42
Social Comparison	0.42	0.50	0.18	0.22	0.20
Prototypicality	0.37	0.40	0.18	0.19	0.08

Note. The control variable in the partial correlation was the survey respondent. df = 826

$p < .01$

demonstrated the strongest relationships in the analysis overall, between ratings on the Trust scale ($r = 0.50, p < .00$) and ratings on the Social Comparison scale ($r = 0.50, p < .00$). It was the network strength measure most closely related with scores on the Credibility scale and the Prototypicality item in the sample, offering support for Hypothesis 2. Non-Second Life communication was also notable for its moderate relationship with Trust ($r = 0.49, p < .00$), and the relative strength of this relationship compared with the relationships observed between Trust and other communication mode measures. This lent support to Hypothesis 5.

Predictors of interpersonal and normative features of influence

Eight multi-level models that included only one network strength predictor were tested to assess the relationships between the network strength indicators and Modification and Partnership, the two non-prioritised examples of network strength. Each of the four outcome variables was tested once with Modification and Partnership measures. They tested the hypotheses outlined on pages 96 and 98 directly.

Additionally, several multiple item multi-level models were tested with the communication mode variables to assess the relative predictive power of each on perceptions of Trust, Credibility, Prototypicality and source of Social Comparison. They tested the hypotheses outlined on page 99.

Finally, to assess the unique contributions of the Modification and Partnership network strength criteria relative to one another, these predictors were tested together against the interpersonal and normative features of influence. The results offered additional insight into the hypotheses described on pages 96 and 98.

Partnership

The results of the multi-level modelling analyses assessing the effect of the likelihood of designating a contact as a Second Life partner on the interpersonal and normative features of influence are listed in Table 5. This model tested Hypothesis 1.

The beta values for Partnership represented the mean differences in ratings of each dependent variable. In each case, the models were significant and the mean scores in Partnership increased attributions of Credibility, Trust, Prototypicality and Social Comparison by between $\beta = 0.33$ (Credibility: $SE = 0.02$; and Prototypicality: $SE = 0.03$) and $\beta = 0.34$ (Trust: $SE = 0.02$; Social Comparison: $SE = 0.02$) standard deviation units, on average.

Comparing the variation in the models of interpersonal features of influence, scores on their own with the variation in Trust and Credibility scores when Partnership was included (u_{0j}), indicated that very little of the differences in scores was explained by the variation in respondents' scoring patterns for Trust and Credibility; this was evident from the small increase in variance between the models

Table 5

Multilevel Model Single Predictor Analysis of Effects of Second Life Partnership and Modification on Trust, Credibility, Social Comparison and Prototypicality

DV	β_0	β_I	u_{0j}	$e^{\beta} \sigma_e^2$	LogL	% Responde nt variance	N
Partnership							
Trust ^b	2.90	0.34	0.18	0.29	264.77	38.3%	829
Credibility ^a	3.18	0.33	0.16	0.31	290.3	34.0%	1049
Social Comparison ^a	2.83	0.33	0.23	0.62	138.69	27.1%	926
Prototypicality ^b	1.99	0.34	0.59	0.38	216.76	60.8%	926
Modification							
Trust ^a	2.68	0.35	0.16	0.24	421.41	40.0%	829
Credibility ^a	3.00	0.33	0.13	0.27	436.59	32.5%	1049
Social Comparison ^b	1.83	0.33	0.54	0.35	291.91	60.7%	926
Prototypicality ^a	2.71	0.31	0.27	0.61	166.14	30.7%	926

Note. ^aModel resolved after 3 iterations. ^bModel resolved after 2 iterations

all values $p < .00$

that included the predictors and those that did not (Credibility: $u_{0j} = 0.15$; Cred+Partner: $u_{0j} = 0.16$; Trust: $u_{0j} = 0.18$; Trust+Partner: $u_{0j} = 0.18$). However, Social Comparison did demonstrate a strong respondent effect, reflecting earlier

descriptive results of Social Comparison, described on page 114 (SocComp: $u_{0j} = 0.68$; SocComp+Partner: $u_{0j} = 0.59$).

There was also a difference between respondents in their ratings for the normative feature of influence when Partnership was included: changes were observed with respondents' ratings of Prototypicality (Prototypicality: $u_{0j} = 0.34$; Proto+Partner: $u_{0j} = 0.23$).

These results indicated that the likelihood a Friend would be designated a partner increased the variation in respondents' Prototypicality scores, but reduced the variability in Trust scores. This suggested that the variance explained in perceptions of Trust ratings when a partner was more likely was more consistent across respondents. This supported Hypothesis 1 in that Trust was a common attribution in perceptions of partners.

In contrast, the Prototypicality scores became more inconsistent between respondents, suggesting that the perception of a partner as Prototypical was a personal attribution, like the ratings of Social Comparison.

Variation in the ratings that Friends received ($e^{ij}\sigma_e^2$) demonstrated consistent reductions observed between the variance between avatars in the basic models and those that included Partnership (Trust: $e^{ij}\sigma_e^2 = 0.40$ and Trust+Partner: $e^{ij}\sigma_e^2 = 0.29$; Cred: $e^{ij}\sigma_e^2 = 0.41$ and Cred+Partner: $e^{ij}\sigma_e^2 = 0.31$; SocComp: $e_{ij} = 0.49$ and SocComp+Partner: $e^{ij}\sigma_e^2 = 0.38$; Proto: $e^{ij}\sigma_e^2 = 0.73$ and Proto+Partner: $e^{ij}\sigma_e^2 = 0.62$). This means that the differences in attributions of avatars as Trustworthy, Credible, Prototypical and sources of Social Comparison could be explained by knowing the likelihood a Friend would become a Second Life partner. Avatar ratings of Prototypicality were best explained when Partnership was included, where the percent of variance attributed to the respondent was the least (27.1%) and, conversely, the percent of variance attributed to the scores between avatars was the most (72.9%).

The model that demonstrated the largest log likelihood ratio change was with Credibility (290.30), indicating that the model with Partnership explained variance in Credibility better than Credibility on its own.

In sum, the likelihood an avatar would be designated a Second Life partner had consistent positive effects on the interpersonal and normative facets of influence. There was a stronger relative effect in predicting Credibility.

Modification

The results of the multi-level modelling analyses assessing the effect of Second Life modification rights only on the interpersonal and normative features of influence are listed in Table 5.

In each case, the models were significant. There was only a small increase in the variance between these scores and the betas observed in the Partnership models: the mean scores in Modification increased average attributions of Credibility, Trust, Prototypicality and Social Comparison by between $\beta = 0.31$ ($SE = 0.02$; Protoypicality) and $\beta = 0.35$ ($SE = 0.02$; Trust) standard deviation units.

As observed in the Partnership model analysis, comparing the variation in the interpersonal features of influence scores on their own with the variation in scores when Modification was included (u_{0j}), indicated that very little of the differences in scores was explained by the variation in respondents' scoring patterns; this was evident from the small increase in variance in Credibility (Credibility: $u_{0j} = 0.15$; Cred+Mod: $u_{0j} = 0.13$) and in Trust (Trust: $u_{0j} = 0.18$; Trust+Mod: $u_{0j} = 0.16$). However, there was a larger differences in respondent ratings observed between the basic models and in the models that included Modification as a predictor of Social Comparison. This was consistent with the outcomes described in section 4.5.1. Changes were observed with respondents' ratings of Social Comparison (0.68 - 0.54 = 0.14), suggesting that the variation in Social Comparison was due to respondent differences. This was consistent with the results outlined in the section describing the Social Comparison descriptives, on page 114.

69.3% of variance in ratings of Prototypicality were explained by Modification scores independent of respondent effects, and the reduction in between-avatar variation for the model including this network strength measure and the basic model, indicated that the variation was able to be explained by designation of

Modification rights. Only 39.3% of the differences in attributions of Social Comparison could be explained by the avatar's Modification ratings; instead, these scores were better explained by differences between respondents. As with the Partnership model, this suggested that Prototypicality became a more individualised attribution as the likelihood an avatar would be granted Modification rights increased.

Variation at the avatar level, in the ratings attributed to Friends ($e^{ij}\sigma_e^2$) demonstrated consistent differences, suggesting that variation in the means of scores in the interpersonal and normative features of influence could be attributed to the inclusion of the network strength measures. There were stronger changes when Modification was included in the models: designating an avatar with Modification rights demonstrated the greatest change in variance in Trust scores (Trust: $e^{ij}\sigma_e^2 = 0.40$ and Trust+Mod: $e^{ij}\sigma_e^2 = 0.24$). 60.0% of the total variance in the Modification model was attributed to these scores, while Modification changed the variance in the mean of Prototypicality scores the least (Proto: $e^{ij}\sigma_e^2 = 0.73$; Proto+Mod: $e^{ij}\sigma_e^2 = 0.61$). The model that demonstrated the highest log likelihood ratio statistic change was Credibility (436.59), when compared with the log likelihood statistic from the model with no predictors, indicating that Modification best explained variation in Credibility.

In sum, the likelihood an account holder would grant Modification rights to a Friend was a significant predictor of the interpersonal and normative features of influence. This had a particularly strong effect on ratings of Trust; the weakest effect was observed with ratings of group Prototypicality.

Partnership and Modification

A multiple item model was implemented to test the unique variance Partnership and Modification had on each of the dependent variables, an outcome of the correlation analyses described in the descriptives results section. This set of models sought to identify the unique variance explained by the likelihood a Friend would be designated a Partner or would be granted Modification rights when the other variable was controlled for. Although these measures were constructed as non-

prioritised, this test offered a more robust analysis in support of Hypotheses 1 and 2. Four models were tested, including both the likelihood of granting Modification rights and the likelihood of designating a Second Life Partner as predictors of Trust, Credibility, Social Comparison and Prototypicality.

All the models were significant, and in each, Modification was the stronger predictor, described by the beta weights in Table 6. This variable explained the largest proportion of variance in each interpersonal and normative feature of influence in standard deviation units, when the effects observed for Partnership were taken into consideration. This effect was most pronounced in the model that predicted Trust (Modification: $\beta = 0.27$, $SE = 0.02$; Partnership; $\beta = 0.17$, $SE = 0.04$). However, the largest change between the models was consistently observed in the difference in the log likelihood ratios for Partnership; models that included Modification and this predictor variable demonstrated the greatest shifts from the single Partnership predictor models.

The very small differences observed in the variance residuals at the respondent level between the single predictor models and all four multiple predictor models indicated that the addition of Modification or Partnership explained the variation in the dependent variables. In other words, the additional variance explained by the addition of the second predictor was small; although the two variables were related, they adequately explained the variance in the facets of interpersonal and normative influence on their own and did not require that the other be taken into consideration. However, there were larger differences observed in the variation in avatar scores between the models with no predictors and the multiple predictor models, which identified that the addition of both Partnership and Modification explained differences in the measures of the independent variables. This outcome lent support to Hypothesis 1 and Hypothesis 2.

This was particularly the case with the model predicting Trust (Trust: $e^{ij}\sigma_e^2 = 0.40$; Trust+Partner+Mod: $e^{ij}\sigma_e^2 = 0.22$), although a similar difference was observed with Credibility (Cred: $e^{ij}\sigma_e^2 = 0.41$; Cred+Partner+Mod: $e^{ij}\sigma_e^2 = 0.24$). In both of these cases, the difference in the variation effects based on respondent factors were

very low, suggesting that the addition of Partnership and Modification explained any observed variation.

In contrast, Social Comparison and Prototypicality demonstrated stronger respondent effects on measures of the dependent variables when Modification and Partnership were included (SocComp: $u_{0j} = 0.68$; SocComp+Partner+Mod: $u_{0j} = 0.53$; Proto: $u_{0j} = 0.34$; Proto+Partner+Mod: $u_{0j} = 0.27$). This outcome was consistent with the results described for the single-predictor Partnership and Modification models.

Communication mode

Finally, four models were tested with multiple predictors to assess the relative contributions of the network strength measures to attributions of Trust, Credibility, Social Comparison and Prototypicality. These models assessed Hypotheses 3-5.

Table 6
Multilevel Model Multiple Predictor Analysis of Modification and Partnership on Measures of Trust, Credibility, Social Comparison and Prototypicality

	β_0	β_1	LogL	u_{0j}	$e^{ij}\sigma_e^2$	Respondent variance %	N
Trust							
IV							
Partnership ^b	2.5	0.17	226.74	0.17	0.22	43.6%	829
Modification		0.27		70.1			
Credibility							
Partnership ^a	2.79	0.18	235.89	0.15	0.24	38.5%	1049
Modification		0.25		89.6			
Social Comparison							
Partnership ^b	1.63	0.18	131.83	0.53	0.33	61.6%	926
Modification		0.25		56.68			
Prototypicality							
Partnership ^a	2.51	0.19	64.65	0.27	0.58	31.8%	926
Modification		0.22		37.2			

Note. ^aModel resolved after 3 iterations. ^bModel resolved after 2 iterations

$p < .00$

The only model that was not significant when all three communication modes were included as predictors was the analysis assessing Prototypicality. Non-Second Life communication did not significantly contribute to the variance in Prototypicality scores when Public and Instant Message communication were already included, lending support to the relationships between communication mode measures and Prototypicality outlined in Hypotheses 3-5. When non-Second Life communication was removed, the model was significant and parsimonious (see Table 7). The beta values were low when compared with a model with only one predictor (Public: $\beta = 0.16$, $SE = 0.04$; IM: $\beta = 0.15$, $SE = 0.04$), each explaining only small but positive changes in standard deviation in the variation of Prototypicality. Analysis of the change in variance attributed to the avatar scores were also low (Proto+Public: $e^{ij}\sigma_e^2 = 0.66$; Proto+IM: $e^{ij}\sigma_e^2 = 0.66$; Proto+Public+IM: $e^{ij}\sigma_e^2 = 0.65$), indicating that Prototypicality scores were little affected by the inclusion of the other communication modes instead of only a single communication predictor. The addition of the two communication modes similarly did not explain the difference in Prototypicality scores compared with the model without predictors (Prototypicality: $e^{ij}\sigma_e^2 = 0.73$; Proto+Public+Private: $e^{ij}\sigma_e^2 = 0.65$). In other words, unlike the Partnership and the Modification network strength measures, communication mode did not affect the differences between respondents in their ratings of Friends as Prototypical. This suggests that there was little variation in Prototypicality attributions based on communication mode in the virtual world, lending support to the normative development of Prototypicality outline in Hypotheses 3 and 4.

The beta weights across all variables in the three three-item predictor significant models (Trust, Credibility, Social Comparison) were low, but varied in power (see Table 7). The beta weights of non-Second Life communication indicated the largest mean differences in interpersonal or normative attributions between avatars rated as Trustworthy ($\beta = 0.22$, $SE = 0.02$), Credible ($\beta = 0.17$, $SE = 0.02$) or sources of Social Comparison ($\beta = 0.18$, $SE = 0.02$). This had been hypothesised in H₅. Public communication also explained the variation in the Social Comparison scores ($\beta = 0.15$, $SE = 0.03$) and the Credibility model ($\beta = 0.13$, $SE = 0.03$). It explained the least variation in the mean scores of Trust, but its log likelihood

statistic change from the model in which Public communication explained scores in Trust on its own was the largest, suggesting that including the other two communication predictors has the greatest effect on the predictive quality of this variable on the interpersonal features of influence. This result described the anticipated effects of the different front and back channel constructions of Public, Instant Message and Non-Second Life communication modes described in Hypotheses 3-5.

The log likelihood ratios for all models demonstrated differences between the additions of all network strength measures in predicting the independent variables, demonstrating significant differences between them. The biggest changes in the likelihood ratio statistic were observed with Public communication (Trust: 189.32; Credibility: 320.73; Social Comparison: 100.44).

Across all the models, the variances attributed to respondent difference and avatar scores were low which indicated that very little of the additional differences in interpersonal or normative feature ratings from the models in which each communication mode was included individually was due to the inclusion of all network strength measures together. Compared with the models with no predictors, the variations in Trust and Social Comparison scores were best explained by the differences in avatar ratings when all communication variables were included (Trust: $e^{ij}\sigma_e^2 = 0.40$; Trust+Public+IM+Non-Second Life: $e^{ij}\sigma_e^2 = 0.27$; SocComp: $e^{ij}\sigma_e^2 = 0.49$; SocComp+Public+IM+Non-Second Life: $e^{ij}\sigma_e^2 = 0.12$). Little of the variance in Trust, Credibility or Social Comparison scores was explained by respondent differences. This suggested that such attributions were consistently informed by the frequency of communication between virtual world Friends. This was particularly interesting for the Social Comparison outcome, as this measure had experienced the greatest variation between respondents in earlier models. Although the variance in this measure was still high, the result suggested that it was consistent and did not change when communication modes were included.

Table 7

Multilevel Model Analysis of Communication Mode on Measures of Trust, Credibility, Social Comparison and Prototypicality

	β_0	β_I	LogL	u_{0j}	$e^{ij}\sigma_e^2$	% Respondent variance	N
Trust							
IV							
Public communication	2.6	0.1	189.32	0.15	0.27	35.7%	829
IM communication		0.13	150.3				
Non-Second Life communication		0.22	107.46				
Credibility							
Public communication	3.02	0.13	320.73	0.08	0.33	19.5%	926
IM communication		0.09	313.98				
Non-Second Life communication		0.17	312.68				
Social Comparison							
Public communication	1.73	0.15	100.44	0.75	0.37	67.0%	926
IM communication		0.1	97.71				
Non-Second Life communication		0.18	96.44				
Prototypicality							
Public communication	2.71	0.16	13.99	0.38	0.65	36.9%	926
IM communication		0.15	14.19				
Non-Second Life communication		NS					

Note. Models resolved after 3 iterations

p < .00

In sum, the outcomes hypothesised in H₅ were observed: an increase in the privacy of communications increased the attributions of features of interpersonal and normative influence. However, the outcomes anticipated by Hypotheses 3 and 4 were not supported; although the effects on ratings of Trust, Credibility, Social Comparison and Prototypicality were positive, the distinctiveness between the frequency of communication in public and the frequency of communication via Instant Message was not. Specifically, Credibility, expected to increase relative to the privacy of the communication was actually better predicted by Public communications than Instant Message communications. This supported the rationale for retaining the separation between these two variables, despite their close relationship in the correlation analyses.

4.6. *Discussion*

This study examined the affective content of online relationships to assess the effects of three measures of network strength in Second Life on facets of interpersonal and normative influence. The aim was to use the outcomes to explain how Social Network Analysis outcomes based on network strength have identified pathways of social change, and to understand the construction of interpersonal and normative attributions in the virtual world.

This section first details the results of the analyses, focussing on the interpersonal and normative features of network strength measures. It then draws out the theoretical contributions of this study for research that describes influential outcomes based on source attributes, social comparative processes and representations of prototypical group members. It expands on the features of the virtual environment described by McKenna and Bargh (2000) that have challenged theories based on physical interaction. It elaborates on research that has described the virtual environment as a medium that does not facilitate easy attributions of interpersonal or normative features of influence, increasing the potential risk for participants in these online communities when they seek others to trust, to identify as credible, to compare themselves with or to refer to as the representation of a social identity. It argues that the negotiation of online and offline identity through disclosure of information about the offline self to an online Friend implicated attributions of closer and more influential relationships.

This section subsequently addresses the methodological challenges of conducting sociometric data collection in online environments and proposes a solution for future research. Finally, further questions are posed that lead to the aims of the study described in Chapter 5.

Overview of the analysis

Overall, the results outlined in section 4.5 offered support for the hypotheses: the anticipated relationships between the likelihood a respondent would grant Modification rights, designate a contact as a Partner and the frequency of chatting in

virtual Public, via Instant Message or outside the online community predicted interpersonal and normative features of influence. The degree to which these measures of network strength affected attributions of trustworthiness, credibility, group prototypicality and that a contact was a source of social comparison varied in accordance with most hypothesised expectations.

Briefly, the strongest predictor of the psychological attributions associated with influence was the likelihood modification rights would be assigned to a contact. In other words, this network strength indicator measured the greatest variance in scores in trust, credibility, social comparison and prototypicality, suggesting they were indicators of the same variable. Partnership was also a strong predictor. Finally, the communication mode measures predicted the precursors of influence, but varied in how much based on the amount of privacy each mode offered. These results are described below.

Partnership and interpersonal and normative features of influence

Partnership was an effective predictor of the interpersonal and normative features of influence in general. The models described in Tables 5 and 6 lent support to the first hypothesis: establishing a Second Life partnership with another avatar consistently explained the variance in trust, credibility, social comparison and prototypicality, predicting ratings on these scales. An in-world partner was viewed as trustworthy, credible, prototypical and as a source of social comparison. The effect was positive, increasing their ratings. Extending this, it can be argued that contacts that were more likely to be partners would be more persuasive than avatars that were unlikely to receive this designation. In other words, virtual world partners were conceived as more significant Friends than non-partners.

The positive effect Partnership had on Trust had been anticipated, as offline research has observed trust outcomes between people who share a significant relationships. It had been expected that this would occur more frequently across all contacts because the lean medium facilitated greater mutual self-disclosure, but the results described in Table 5 suggested that virtual world partnership was indeed a

meaningful designation: it would identify pairs who would experience an enhanced trust bond.

This effect was replicated for credibility, prototypicality and social comparison, suggesting that partnership in Second Life indicated a more influential relationship than avatars that were simply designated Friends. It was, however, a designation that was very personal for the account holder. Partnership did lead consistently to more attributions of trust and credibility across all respondents, but attributions of social comparison and prototypicality were more nuanced, suggesting that the degree to which a partner was viewed as a source of reference – both personally and within the context of the in-group – varied for each person.

It may have been because partners were attributed with varying degrees of perceived similarity than Friends who were less likely to be in-world partners. In some cases, the partner may have been viewed as a member of the in-group more readily than if the pair had been offline (Guadagno & Cialdini, 2005). As perceived similarity is an outcome of web-based communication because of the medium's lean communication facilities in general, individuals who were considered particularly like the self, perhaps because of repeated interaction or increased self-disclosure, were more likely to be designated partners and to become trusted sources and viewed as experts, sources of social comparison and sources of social identification (Kelman, 1961).

Modification and interpersonal and normative features of influence

The likelihood a contact was given the freedom to modify a Friend's objects, including his/her avatar, was the strongest indicator that the Friend was perceived as trustworthy, credible, a source of social comparison and representative of the group prototype. These results provided support for Hypothesis 2. As observed in the Modification model described in Table 5, an increase in the likelihood a contact would be assigned modification rights generated stronger predictions of the interpersonal features of influence than the normative features.

The relative effectiveness of this measure of network strength in predicting the facets of interpersonal and normative influence supported the research that places

emphasis on the importance of the presentation of self in Internet community contexts. As described in Chapter 2, the presentation of self in the online environment is implicated in the development and maintenance of close virtual relationships: the online self is the identity that represents the social capital of the account holder in the virtual community, and participants in these spaces may negotiate the amount of offline self that is imported into the online space.

Strong identification between the user and his/her avatar has been described in many analyses of virtual environments; for example, Dibbell (1999) documented the offline emotional response a user of the text-based LambdaMOO community experienced when another participant illegally accessed her account and performed sexual acts in a public (virtual) environment. The implications implied by the offline reaction to the online indiscretion were that the account holder feared the loss of relationships and social standing in the community.

The negotiation of the duality of the online and offline self, described by Taylor (2006), Kendall (1999) and Biocca (1997), designates the online self as a construction of the offline, and considerable personal and interpersonal risk is involved for the account holder if the online self is misrepresented. The consistent predictive power the modification variable had on the interpersonal and normative features of influence suggested that that the online self closely represented the way the offline account holder sought to present him/herself, and that the likelihood of assigning modification rights was a carefully considered behaviour.

Communication mode and interpersonal and normative features of influence

The aim of this section of the study was to assess the relative contributions of the communication modes as measures of influence. Garton and her colleagues (1997) had theorised that online community members who reported greater frequency of interaction via private modes of communication would represent stronger relationships. The outcomes of this analysis suggested that this relationship was more complex than hypothesised. In particular, the relationship between public and Instant Message online interaction was very strong, which suggested that

account holders who were likely to communicate with contacts via public channels were also likely to communicate with contacts via Instant Message facilities.

In general, knowing the type and frequency of communication between two Second Life avatars did predict attributions of trust, credibility, social comparison and prototypicality. These outcomes, described in the communication mode model described in Table 7, supported Hypotheses 3-5. However the strength of the prediction overall was relatively less than knowing if a Friend was assigned modification rights or was designated an in-world partner. This result contradicted Rogers & Kincaid's (1981) communication network analysis model: the effect of knowing the communication practices of participants did not offer information to explain influence outcomes in Second Life that was better than knowing the likelihood an account holder would allow a Friend to modify his/her online identity. This was a surprising finding, as the Web is an explicit communication medium; yet as demonstrated with the Modification and Partnership results, Second Life offered other ways for network neighbours to represent network strength that was more relevant to the features of influence measured in this study.

It had been hypothesised that there would be a linear relationship between measures of communication modes from the least private (in-world public chat) to the most private (non-Second Life interaction) and attributions of interpersonal and normative features of influence given to Friends. Ratings of trust, credibility and social comparison were expected to be higher for Friends that interacted offline, and lower for those who only interacted in Second Life in public. Indeed, in the communication mode model non-Second Life chat was the strongest predictor of higher scores on these scales; however the in-world communication modes, public and private chat, were very closely related to one another and did not produce a clear effect. The very small difference between the predictive power of chatting in public versus chatting in private on ratings of trust that did support the privacy hypothesis in practice would have had a negligible effect on the outcome, and the inverse relationship between public and private communication in predicting social comparison did not meet the criteria of the expected result. Further, attributions of

social comparison and credibility were associated with stronger ratings of public communication than private communication.

A similar outcome was observed when considering ratings of prototypicality. It had been anticipated that non-Second Life communication would be the least relevant interaction mode and public communication would be the most relevant interaction mode because attributions of group prototypes would be performed and observed in public environments. While non-Second Life interaction was observed to be irrelevant in assigning prototypicality to Friends, and supported Hypothesis 5, the in-world communication modes were again not distinctive in their predictive power. This result did not support the research outcomes described by Garton and her colleagues (1997) or Correll (1995), rather it intimated that communication patterns in this virtual environment offered different meanings and protocols that did not conform to a pattern of increased communication mode privacy.

Theoretical contributions

This study applied social influence research to an online community to examine the relationships between network strength and perceptions of trust, credibility, social comparison and prototypicality. The aim was to look at the effects of measures of network strength on facets of interpersonal and normative influence in order to assess the relationships between Social Psychology and Social Network Analysis by clarifying the psychological explanations for the effectiveness of network strength attributions in predicting influence. The results suggested that the measures of network strength in this study implicated attributions of trustworthiness, credibility, sources of social comparison and group prototypicality in ways that offered insights into what these constructs meant in this online environment.

In particular, attributions of interpersonal and normative influence in Second Life appeared to be associated with negotiations of the presentation of the self in the virtual environment, a space that was described in Chapter 2 as high in personal risk for participants because the leanness of the medium made it more difficult to corroborate whether other participants were trustworthy or credible, should be sources of social comparison or represented the in-group. The results of this research

suggested that the degree to which community members disclosed information about their offline identity to other virtual world users indicated which avatars were trusted.

Perceptions of credibility were associated with attributions of generalised expertise, and social comparisons and descriptions of online group prototypes were associated with the attributions of similarity conflated by the features of the online medium. This section briefly outlines the contributions this research has made to the theoretical understanding of trust, credibility, social comparison and prototypicality in the virtual world.

Defining trust, credibility, social comparison and prototypicality in Second Life

Trust

Attributions of trust in this virtual world were outcomes of community members' control of risk. As described in Chapter 2, Internet environments are risky spaces because of the uncertainties associated with anonymity, the absence of physical cues, the mediated format and the lack of physical proximity (McKenna & Bargh, 2000). It was argued that in the online community of Second Life, and arguably in other pervasive social networks, in which online identity is practiced over time, the development of social capital and reputation embodied by the avatar and other owned content go some way in counteracting these risks.

However, because the online identity represented the locus of social capital, as generated through interpersonal social and behavioural interactions and on the users' investment of time and attention, relinquishing control of the virtual self carried risks for the offline account holder. Activities that resulted in offline self-disclosure or the surrender of aspects of the identity inside the community consistently defined trust in this virtual world.

These findings corroborated the extensive online identity research which emphasises that the virtual self is a symbolic representation of the offline self (Postmes & Baym, 2005; Turkle, 1995). This had implications at the interpersonal

level when considering who to entrust with modification rights, and at group level, when seeking to identify prototypical individuals.

This research additionally extended existing theories about online trust in other virtual environments because it emphasised the importance of online social capital and reputation in virtual worlds as the currency that resulted in attributions of features of influence (e.g., Hemetsberger, 2002; Chiu, Hsu, & Wang, 2006). Although analysis in other online environments that have been studied has highlighted the development of hierarchical structures based on virtual reputation by assessing, for example, Open Source communities through the framework of peer review (e.g., Bergquist & Ljungberg, 2001), the results of this study situated this in the social virtual world environment.

Credibility

Attributions of credibility appeared to be generated in two ways in this research: through publicly generated concepts of generalised expertise, and through personal attributions of trust.

This interpersonal attribute was the least likely to be affected by respondent variation in measurement, which indicated that credibility was a mutually-constructed attribute in this environment, conceptualised by Second Life account holders in a similar way. This situated credibility within a paradigm of opinion leadership (Valente & Davis, 1999), extending this extensive body of research into the online environment. The consensual nature of generalised credibility was an unexpected outcome, as it indicated that there was a common estimation of validity generated through the normative practices in Second Life that would have been expected with attributions of prototypicality (Hogg & Hains, 1996).

However, the relationship between trust and credibility went some way in explaining why there was no clear distinction in the effects of behavioural indicators in predicting this outcome. Trustworthiness has been implicated in definitions of credibility offline and the strong relationship observed between the two in the virtual world environment suggested that they interacted to produce the effects on this facet of interpersonal influence. More research that examines the distinction

between trust and credibility in online environments area is recommended, but what these results imply is that attributions of credibility are community-generated, situated in the public sphere and based on observable actions, or the communicated experiences of trusted others.

Social comparison

The attributions of social comparison suggested upward comparisons with other account holders' avatars based on public demonstrations and perceived similarity. Yet identifying a Friend as a source of social comparison was a very personal attribution; it was the measure that experienced the most variation between respondents.

The network strength measures that resulted in social comparison outcomes most strongly implicated how online identity was represented in public situations. Modification and public communication offered account holders the opportunity to self-represent in a way that was more like a desired self, whether by allowing another account holder to change their physicality, or by adjusting the way they performed themselves in public interaction.

These results extended existing research by situating the predictors of social comparison in the online environment. There was arguably evidence of upward comparison operationalised thorough modification practices and partnership assignments that resulted in personal change towards or away from desired or undesired reference groups. These appeared to be both observed and practiced in the online public space, where group norms were expected to be constructed and reconstructed, allowing for real-time moderation and self-generation.

This research presented the unique aspects for social comparison provided by the online environment that supported Turkle's (1995) description of the virtual world as an identity laboratory, and other analysis that has explored the use of these communities as safe contexts in which to practice possible selves. It defined who are the sources that have the greatest influence, with implications for offline identity. For example, McKenna and Bargh (1998) described the offline implications of an online group that supported the expressions of homosexual identity for participants who felt

it was unsafe to come out offline; the social comparison outcomes arguably had implications for the body of research that has sought to examine the link between the online and the offline self.

Prototypicality

Hogg & Hains (1996) suggested that prototypical people dictated attitudes and perceptions, as they were viewed as representative of the group to which they belonged. Indeed, there was a moderate relationship between attributions of social comparison and prototypicality, indicating that the actors rated as sources of social comparison in this study may have been expected to serve as benchmarks as to how actors evaluated themselves and others in novel situations (Hogg & McGarty, 1990; Hogg & Terry, 2000; Hogg & Hains, 1996).

Attributions of prototypicality appeared to be outcomes of the conflation of the in-group as the self (Gardner, Gabriel, & Hochschild, 2002), based on public performances in the Second Life environment. This had implications for attributions of social comparison, which was expected to have the greatest effect on attitude when respondents were aware of or believed they were aware of the attitudes held by people they compared themselves with. This suggested that the choice of prototypical Friends might have depended upon how closely an individual self-identifies with a group, and further which identity is salient at the time. Further research is recommended.

The results of this research supported SIDE (Postmes, Spears, Sakhel, & deGroot, 2001) because it strongly implicated attributions of similarity with prototypicality outcomes. This was particularly relevant in this lean online environment. However, the cues that were arguably drawn upon were not from offline; rather they emerged from the in-world communication performed in public and from those practices that defined the self within the boundaries of the online space.

Methodological considerations

This research benefited from a method that identified online interpersonal relationships and measures of phenomenological experiences of trust, credibility, social comparison and prototypicality in a virtual community. However, there were two methodological considerations that arose.

Network strength measures

First, the Second Life variables identified as network strength were chosen for the degree to which they implicated the negotiation of the public and private online self and the extent to which they disclosed information about the offline account holder identity to the online Friends. As outlined, research has described the conflict that has arisen between the online and offline self in virtual environments that do not allow for online-offline fluidity of identity like Second Life, suggesting that the online persona becomes a compartmentalised representation of the offline self, actively constructed to display the best self-presentation for increased positive feedback from other virtual community members (e.g., Taylor, 2002; Biocca, 1997). The strong relationships between the network measures chosen and the interpersonal and normative outcomes were arguably therefore more likely than, for example, network strength based on different criteria. For example, other Second Life behaviours that could have been chosen included economic transactions between avatars, business relationships versus social relationship, virtual-physical proximity or common group affiliations. These types of features, also relevant to the participants in the online community, have been used in offline network research, and may have demonstrated different outcomes in this analysis.

However, given the research question, the aims of this study and the recommendations by Fischer to identify a network strength criterion that is relevant to the intended influence outcomes, the measures chosen were appropriate. The communication mode variables also specifically tested the network strength that had been hypothesised by Garton and her colleagues (1997) and described Correll (1995) in her ethnography of a text-based community, but had not been empirically assessed. This research offered an opportunity to do so.

Additionally, the measurement of these variables drew on the likelihood that the nominated Friend would be the recipient of an assignment or the frequency of communication practices; future research may wish to identify actual behaviour rather than intended or retrospective behaviours. This is implemented in the third study in this research and the outcomes are described in Chapter 6.

Survey drop-out

Second, the Study 1 survey completion rate was very low: there was evidence of significant dropout during the course of the survey, resulting in a low total response rate. Forty-six of the seventy-nine respondents who provided their avatar names did not complete the instrument in its entirety, and thus the number of ratings on each scale decreased dramatically with the loss of the respondent and his/her ratings on each of his/her contacts. To maintain the integrity of the data with the small sample size, all responses to completed scales were retained in analysis.

The reason for this was likely time. Although the survey had only twenty-four questions, respondents were asked to generate names of people in their social networks and then to answer questions to define each of them by choosing their answers from drop down menus. In some cases, like for the respondent who listed 331 Friends (but did not complete any of the relationship scales), this resulted in over 2,000 questions that required responses. This had not been anticipated, as a pre-test of 10 Second Life participants had not identified any account holder-avatars who had more than 20 Friends.

The result was variation in the number of ratings on each scale, by a different number of respondents. To address this, all the partial responses to the scales were discarded, and only complete scales were included in the analysis. This meant that there were different Ns, at both Level 1 (Friend) and Level 2 (Respondent) to be considered in each predictive model. However, the multilevel modelling method controlled for this difference, and the data was analysed based on the content that was available.

The participants who did not complete the survey in full, or who only supplied contact information on the name generator question were not discarded, as

this connectivity information was essential for building the egocentric network sample used in Study 2, which was the basis for the whole network sample in Study 3.

4.7. Further Questions and Conclusions

This study sought to describe the meaning of interpersonal closeness in the virtual world Second Life with the aim of establishing a psychological basis for network analysts' estimations of influence outcomes based on network strength. There was evidence of a connection between network strength and psychological features associated with influence; several Second Life-specific criteria explained interpersonal and normative processes in complex ways that implicated both the online context and how the account holder negotiated the disclosure of offline identity information via the virtual self. This was an important finding for the next phase of this research because it reiterated the need to retain measures of affective relationship qualities rather than binary, automatically generated relationships that would result from automated data extraction. This study provided support for the argument that the latter would generate attributions of influence outcomes based on un-measured psychological processes. Rather, sociometric data collection would allow the research to assess the relative importance of psychological and structural features of influence in this online community.

The results of the analysis indicated that Second Life was constructed as an environment where the online identity represented the social capital of the account holder, and that attributions of features of social influence involved the negotiation of control of this virtual persona. The virtual world challenged assumptions of expertise, and it afforded identity play based on social comparisons and the conflation of the in-group as part of the self. This arguably led to greater attributions of trust, credibility and social comparison for Friends who were assigned modification rights, designated partners, and with whom a target frequently communicated via more public or private channels. The outcome of these attributions was anticipated to lead to more rapid uptake of influential content in this

environment. The next study extended these findings and assessed their relative effects on the development of online attitudes.

The results of this study provided a basis for understanding the psychological interpretations of network strength. It identified the personal and normative facets of influence that contributed to the success of Social Network Analysis research that described influence using network strength measures. However, this is only one descriptor used by social network analysts. They also define influence pathways by examining the structures of social systems: the density of the network and the position of the target within it.

This research next sought to identify the interactions between network and psychological closeness and structure as they predicted an influence outcome.

5. Social Network and Social Psychological Predictors of Attitudes to Sex in Second Life

The last chapter examined the affective meanings of Friend relationships in Second Life, drawing connections between social network analytic notions of network strength and psychological facets of influence. The network strength measures were operationalised as indicators of closeness in the virtual world that implicated the public and private selves in Second Life and offline; the likelihood an individual would grant a Friend modification rights, designate a Friend an in-world partner and the frequency with which two Friends communicated via public chat, Instant Message or outside Second Life were found to implicate varying degrees of source attributions, social comparisons and perceptions of who embodied group norms. It was proposed that Second Life account holders' negotiations between the online and offline self based on the degree they disclosed information about their non-virtual identities emerged as a possible contributor to this effect, as the presentation of the self in the virtual world embodied the social capital the individual had in the online community.

While the Study 1 results offered support for the connection between network measures and psychological theory, Social Network Analysis also explains influence outcomes based on structural concepts like network density and network position. These features of connection describe the speed with which social change occurs in a population, by defining the composition of interpersonal relationships within a system, and the individuals within networks who facilitate this. These structural elements have not been assessed in relation to social psychological influence research, yet the network explanations of social systems describe the pathways a catalyst for change takes to arrive at a target, and propose that this has an effect on an influence outcome.

Study 2 aimed to identify why network density and network structure have been effective predictors of attitudes in social network research. Unlike Study 1, which tested a direct relationship between the network and psychological measures,

this study examined both the network and psychological features that best explained the variations in an attitude. It asked what role each played in Second Life account holders' beliefs about cybersex, one of the activities some members of the community engaged in. Building on the results of Study 1, it tested models of personal attitudes and three structural predictors (network position, network density and network strength), and four groups of psychological predictors (ratings on interpersonal and normative facets of influence, perceived attitudes and previous personal experience).

The results demonstrated that network strength and network position indirectly predicted attitudes, by describing what kinds of perceived attitudes were likely to form. Both accurate and inaccurate perceptions of what close friends were believed to feel about cybersex strongly predicted the personal attitude. Individuals also appeared to cluster into groups that perpetuated inaccurate perceptions of homogeneity.

This research uniquely offered support for network effects on perceptions rather than on reported attitudes, and proposed that false norms maintained the group's cohesion, particularly in light of the leanness of CMC. Relationships and attitudes were based on what local networks were thought to feel about sexual activity in Second Life. It was proposed that these perceptions emerged because participants sought similar others to form communities with, and projected similarity based on stereotypes that emerged from cues available in the deindividuated space.

The chapter begins by describing the interpersonal and normative aspects of sexual activity in Second Life (section 5.1). Although it was one of the interpersonal opportunities afforded by the virtual world's real-time text and voice communication, its 3D representation and its personalisation options, there was also an element of anxiety associated with sexual activity in this space. There were concerns about its appropriateness, as well as concerns about the potential effect it might have on personal accounts and personal computers if a virtual infection was to spread. The potential affective outcomes of engaging in intimate acts in the virtual

world were prescient, given the unsubstantiated nature about the consequences of sexual activity in this online space.

Section 5.2 introduces the hypothesised predictors of attitudes to sex in Second Life. It begins by describing the structural predictors, focussing specifically on network density, the measure of the amount of interconnectivity between groups of people, and network position, the measure that identifies where the individual is located in the network relative to everyone else. It outlines the psychological predictors, including the interpersonal and normative features of influence discussed in the last chapter, and the effects of personal experience and perceived attitudes on personal attitudes. Finally, it proposes three models that integrate structural and psychological processes of influence. The hypotheses are presented in section 5.3

This study assessed the egocentric relationships of 734 account holders in the online community using a sociometric survey with items and scales developed for this research. The details of these are outlined in section 5.4 and the analytic overview is presented in section 5.5. The results are presented in section 5.6 and are discussed in section 5.7, with reference to the methodological considerations that arose during data collection and analysis. Finally, the chapter concludes by proposing further questions and identifying the themes that will be addressed in Chapter 6.

5.1. *Sex in Second Life*

Cybersex is a well-documented phenomenon in online communities, from text-only, asynchronous listservs and bulletin boards to multi-media worlds like Second Life. As early as 1995, researchers like Stone (1995) and Durkin and Bryant (1995) described text-based, asynchronous cybersex encounters between online community members who were keen to exploit the medium's anonymity, accessibility and affordability for intimate endeavours (Cooper, Delmonico, & Burg, 2000).

Research that has examined sexual activity in online environments suggests that it implicates both the online and offline self; the encounter between the account

holders involved is mediated via the computer, taking place at once in Internet space and in the physical environment. Interpersonally, the sexual encounters have been described as creating emotional bonds between participants; Turkle (1995) proposed that the Internet sex experience was an exchange of signifiers, reflecting a post-modern separation between the physical act and the social impact. In this description, she emphasised the affective, social bonding function of the activity in an environment where physicality was wholly socially constructed.

There were no statistical data documenting how often people in Second Life engaged in sexual activity, yet it appeared to be an active part of many community members' Second Life experiences, featuring in public and private social events, and several sexual subcultures established high-profile groups in the online environment. Cybersex was facilitated by avatar animations and prosthetics, and by the communication tools that were offered by the Second Life service (e.g., text). There was an active consumer trade in avatar adaptations and modifications used to enhance the reality of sexual activity in the virtual world.

However, Account holders who did not wish to take part in cybersex were not required to, nor were they penalised in any way if they chose to pursue non-sexual activities, unlike in some other virtual environments in this genre of Internet interaction²⁸. Second Life community members were able to filter out events, shops and areas classified as 'Mature' in order to enjoy their time without engaging in any sexual cultures that existed there.

In sum, sexual activity was a part of the Second Life culture. Even if account holders did not engage in it, they were undoubtedly aware it occurred because it was publicly debated and, in some circles and at some events, was actively celebrated. For these reasons it was an interesting virtual world phenomenon that was anticipated to generate both positive and negative attitudes.

²⁸ See Sociolotron for an example: <http://www.sociolotron.com>

5.2. *Predictors of Attitudes to Sex in Second Life*

Structural and psychological processes were hypothesised to be predictors of the variation in Second Life account holders' attitudes to sexual activity. They were expected to act independently and in tandem with one another. This section reviews these predictors.

Structural predictors of attitudes to sex in Second Life

As has been outlined, network analysis identifies the interpersonal connections along which influence is predicted to flow. Attitudes are expected to be influenced via the direct pathways that connect people based on a target's exposure to it from a source. deNooy, Mrvar & Batagelj (2005) described a maximal progression of this effect: the more sources a target is connected with who express an attitude, the more likely the target will also express the attitude. This follows a contamination, or contagion, paradigm, often used to describe influence in diffusion research as an explanation for how beliefs and practices spread around a social system (e.g., Burt, 1987; Kerckhoff, Back, & Miller, 1965; Scherer & Cho, 2003).

There is evidence that supports this effect from the psychological literature. Guerra, Huesmann and Spindler (2003) and Bornstein, Leone and Galley (1987) have observed that exposure to ideas and behaviours results in adoption; however, exposure is arguably as deterministic: it proposes that contact is equated with influence, rather than taking into consideration the experience of the individual.

Network analysts have maintained that direct connections are precursors to attitude change, and research in this field has focussed on the effects of three structural descriptors, network density, network position and network strength, to explain why an actor will be influenced by a connection's attitude. They were outlined in Chapter 2; their relationships with attitudes are briefly discussed here.

Network density

A network's density is the ratio of observed connections to possible connections in a population. In Chapter 2, density was described as the network

process that facilitated the process of homophily, or the similarity of attitudes and behaviours amongst groups of people who have many connections between them.

Although the Web's networks have been characterised as loose and transient, there is evidence that sub networks gather around concepts. Wellman, Boase and Chen (2002), Haythornthwaite (2001) and others have observed online communities of practice and have argued that the virtual world is rich in pockets of similarity. Indeed, there has been concern raised amongst some researchers who propose that the Web encourages confirmation biases, that individuals seek only information and others to interact with online that support existing points of view. Van Alstyne & Brynjolfsson, 1996 proposed that the result is a cyberbalkanisation, dense groups of networked individuals who generate strong and exclusive homophilous links with one another, to the exclusion of non-group members. These rationally bound communities represent dense fragments of interests and attitudes online, and it has been found that the looseness and transience of the wider Web that encouraged this (Adamic, 1999). Similar structures and similarity biases have been discussed by network analysts who study very large populations, like sub networks that form in cities (e.g., Whyte, Jr., 1954).

Although Second Life is one community in the wider web that itself might be described as rationality-bound because it represented a particular community of practice on the Internet, signalling belonging to its paradigms and social structures by signing up for an account (Malaby, 2009), the population was arguably sufficiently large²⁹ to demonstrate sub-fragmentation and dense network structures of its own. In other words, its population size potentiated further fragmentation of interests, status, class, attitudes and practices. Within these dense clusters, it was anticipated that similar attitudes would emerge and would generate a homogeny of attitudes based on attributions of similarity. It was proposed that more dense networks would generate greater opportunity for confirmation of personal attitudes, and more conformity to its perceived norms.

²⁹ There were over one million people registered with the virtual world service at the start of Study 2, and over six million people registered at its end.

It was hypothesised that Second Life account holders in denser interpersonal networks would demonstrate a homogeneity of attitudes to sex that would predict their personal attitudes better than exposure alone.

H₁: Personal attitudes would be more similar to Friends' attitudes if they belonged to a dense cluster, with many interconnections, than if they belonged to a disparate cluster, with few interconnections.

Network position

It was proposed in Chapter 2 that an individual's position would have implications for how innovative s/he could be with relation to his/her network. Analysts like Rogers (1962) argue that innovativeness is due to both structural features and the normative implications of an attitude or practice. He found that peripheral actors were able to hold attitudes that were different from more central individuals because they were on the outskirts of a social group and were less bound by its structural and normative constraints.

Although central actors, with more connections, are described as having better access to network information and are better informed about network attitudes (Rogers & Kincaid, 1981b; Coleman, Katz, & Menzel, 1957; Garton, Haythornthwaite, & Wellman, 1997), it has also been observed that they are more conservative, and there is debate about whether they are the drivers of attitudes, or if they reflect the group norms. Friedkin (1991) proposed that they have high status, power and prestige that is influential in determining the consensus of attitudes of a group, but Rogers and Kincaid argued that central actors have more to lose, in terms of connections that maintain their positions, by expressing attitudes that do not reflect those of the system.

Yet their central position has been proposed to drive others' attitudes for two reasons. The first is structural. On the principle of exposure, they have more connections with the rest of a network, and are better located to "contaminate" many others. Diffusion studies have indeed offered evidence that innovations that emerge from central individuals do spread around networks more quickly.

The second explanation is normative. If, as Rogers argued, central individuals are more bound by the norms of a social group than peripheral individuals, an attitude expressed by a central person will signal that it is an acceptable phenomenon for the rest of the network. Indeed, Rogers and Kincaid (1981b) described this in the diffusion of a birth control innovation in rural villages in South Korea, observing that peripheral actors were more likely to adopt attitudes and behaviours that did not reflect the overall group norms.

This research did not set out to test the reasons why central actors reflected their group norms, but it did propose that these findings offered evidence to suggest that account holders in Second Life who were more central in their networks would reflect the norms of their group more accurately than peripheral actors. Centrality and peripherality in online communities on the Web appear to be relatively static constructs despite the description of online interpersonal connections as transient (Efimova & Hendrick, 2004). In a long-term virtual community like Second Life, which arguably traded in social as well as economic capital, it was anticipated that there would be position consistency. It was proposed that central Second Life actors' attitudes would be more similar to the average of reported attitudes in their local networks than peripheral Second Life actors' attitudes.

H₂: Actors who held central positions would have attitudes that were more similar to the average attitudes of their network than actors who held more peripheral positions.

Network strength

Finally, network strength was hypothesised to have an effect on the similarity between two people's attitudes. In this study, communication mode was identified as the measure of network strength.

Specifically, interaction via multiple communication modes was expected to result in more frequent relationship activation, which was anticipated to result in more exposure-based influence. Activation was expected to engender more word of mouth transmission of private personal attitudes about sex, which would inspire similar attitudes between two people. Brown and Reingen (1987) highlighted the

importance of social communication in attitude similarity, particularly social communication that occurred in both the public and private spheres. In their research, incidental conversation afforded the exchange of attitude cues and recommendation practices; the stronger ties reified through more frequent communication were more influential.

It was anticipated that communication mode would also predict attitude because of the relationship with the interpersonal and normative features of influence that was observed in Study 1. It varied the least in its relationship with influence factors across respondents; other relationships observed were affected by respondent bias, suggesting that a greater proportion of the predictive effects of Partnership and Modification on influence outcomes was due to the subjective experiences of the participants more so than was observed with communication mode. In addition, communication mode also predicted the variation in the outcome scores the least, indicating that it was the measure of network strength most independent of the psychological predictors.

In sum, it was hypothesised that an individual's personal attitude to sex would be more similar to his/her Friend's attitudes if the two were strongly connected via communication practices.

H₃: Second Life account holders who communicated across multiple modes and via more private means would be more likely to have similar attitudes to sex in the virtual world than account holders who communicated via in-world only means.

Proposed psychological predictors of attitudes to sex in Second Life

This last section described three structural features of social networks that were anticipated to predict an actor's personal attitude to sex in Second Life. It was proposed that knowing the network density of a community member's local group and the degree to which s/he was integrated within it would explain how similar his/her attitude was to the group's. Further, knowing the amount of communication between two friends was expected to predict the amount of attitude similarity between them.

There were three shortcomings to explaining attitude influence using only the structural approach presented in this section. First, it did not consider the effect of personal experience on the personal attitude. Research examining the factors that contribute to the development of attitudes has identified the predictive role of personal experience over the attitude object (e.g., Fazio & Zanna, 1976; Chen, 1985; Toohey, 2007).

Second, although interpersonal and normative features of influence were implicated in network strength, the specific attributions of trust, social comparison and prototypicality would arguably offer additional information about how exposure to an attitude may have resulted in attitude similarity or dissimilarity.

Third, the structural predictors suggest that influence was transmitted in whole from one person to another. This approach does not consider the effects of perceptions – or misperceptions – about attitudes that close friends were believed to have.

This section describes the psychological research that has explored the effects of experiences, interpersonal and normative attributions and perceptions on personal attitudes.

Personal experience

Kern & Marbach (2001) and Fazio and Zanna (1976) proposed that subjective experience is an essential feature in the development of a personal attitude. Notions of self-efficacy, confidence and the self-image as a ‘doer’ were found to instigate a recursive relationship between attitude and behaviour. For example, in Chen’s (1985) analyses, attitude was found to be a function of actors’ beliefs that they had the practical skills to carry out the behaviour again.

This was reflected by the Theory of Planned Behaviour (Fishbein & Ajzen, 1975), which proposed that behaviour outcomes are the result of personal and normative attitudes to an activity, as well as personal beliefs about efficacy. Although constructed around an outcome of behaviour, this theory and its later

adaptations strongly link experiences and attitudes, which this research argues inspires the development of future attitudes and behaviours.

Clinical exposure therapies also work from this approach, helping patients to overcome phobias (Marks, 1979), reduce aggression (Lövaas, 1961) and encourage social integration (Taylor, 1996) through controlled experiences. For example, cognitive-behavioural techniques have reduced anxiety responses associated with fear by exposing patients to fearful objects or events.

Additionally, cognitive dissonance research has explained the development of attitudes by focussing on the justification and rationalisation processes associated with holding contradictory ideas. This has been associated with experience, for example in the rationalisation of smoking behaviours (McGuire, 1985) or emotional attachment to an in-group after an indoctrination ritual (Osgood, 1960). Dissonance has been criticised for its focus on unpleasant tension (e.g., Bem, 1967), and reformulations of the original theory proposed by Festinger (1957) have attempted to associate elaboration based on the position of the self-concept within the social environment (e.g., Perez & Mugny, 1996).

These outcomes have been explored in online environments, and have been used to explain confirmation biases leading to the formation of distinct in- and out-groups in pockets of virtual interaction (Foster, 1996). Additionally, the online experiences of identity performance within like-minded communities have been observed to result in offline attitude change (Bargh, McKenna, & Fitsimmons, 2002). It was proposed that experience of virtual sexual activity would explain in part why an individual held an attitude about it.

H₄: Second Life account holders who reported previous virtual sexual experiences would hold more positive attitudes towards the activity than account holders who did not report sexual experiences in the virtual world.

Interpersonal and normative features of influence

In Chapter 2, trust and credibility, social comparison and prototypicality were described as features of influence. In this chapter, the effectiveness of these source

attributes was tested. However, due to the close relationship between trust and credibility in Study 1, these two facets were combined. More details are discussed in Section 5.4.

In particular, it was anticipated that these features would have localised effects on the attitudes between Friends, and that the degree of interpersonal trust and social comparison would predict similar positive or negative attitudes to sex.

H₅: Respondents would have more similar attitudes about sex in Second Life to Friends they viewed as more trustworthy than Friends they viewed as less trustworthy.

H₆: Respondents would have more similar attitudes about sex in Second Life to Friends they compared themselves with than Friends they did not compare themselves with.

Additionally, the normative feature of influence described in Study 1, prototypicality, was anticipated to predict similarity of attitude, as the news of in-group members' attitudes would inform the perception of the social identity, resulting in conformity to that norm.

H₇: Respondents would have more similar attitudes about sex in Second Life to Friends whom they viewed as more typical of their virtual group than Friends they viewed as less typical of their virtual group.

A further normative variable was included in the analysis: avatar gender similarity. This variable sought to operationalise a salient social identity in this virtual world reflecting the research that has linked perceived gender with influence in deindividuated settings (Lee, 2002). It was anticipated that avatar gender would offer identity cues that would prime attributions of similarity. Flanagan (1999), Holzwarth, Janiszewski & Neumann (2007) and others have observed gender stereotypic effects in virtual communities and online situations, and (Lee, 2002) described the salience of this category in online environments. Particularly in computer-mediated communication, where social identity cues have been found to be

based on apparent similarities (Spears & Lea, 1994), it was expected that the same online gender would generate similar attitudes towards sexual activity.

H₈: Avatars of the same gender would have more similar attitudes to sex in the virtual world than avatars of different genders.

Perceived attitudes

Finally, the last psychological variable expected to predict attitude to sex in Second Life was the perception that one's in-group held the attitude. Social identity theorists have described attitudes as socially oriented phenomena, integrated into the self-concept through a process of self-identification with a reference group, assessment of how an attitude would fit within the perceived norms of that collective, and own experience with the attitude object (e.g., Katz & Rice, 2002). Perceived attitudes have been found to be effective predictors of personal attitudes: the concordance between the attitudes of a source a target have been better explained by the belief that a Friend holds an attitude, than observations that the two report the same or similar attitude.

Indeed, it has been found that accurate projections of attitudes are rare (Acock & Bengtson, 1980), which may generate false norms of a social identification. This has been associated with the target of the attribution - more favourable perceptions than one's own beliefs have been attributed to the perceptions of 'others', while false perceptions that are less favourable than one's own have been attributed to close friends' or spouses' attitude (Hoch, 1987) – and with the personal attitude - Gardner, Gabriel and Hochschild (2002) observed that the extent to which an individual identifies with a group causes projections of one's own attitude onto other members, conflating the self with the in-group. In these situations, personal attitudes have tended to be devalued, resulting in beliefs that others in the in-group held more 'extreme' attitudes than one's own (e.g., Daugherty & Burger, 1984). It was argued that perceptions of social opinion contributed to the opinion formation process (Taylor, 1982).

H₉: Personal attitudes would be more similar to attitudes respondents believed their Friends hold about sex in Second Life than the attitudes the Friends reported.

This section outlined the psychological processes that were anticipated to predict personal attitude better than solely measuring exposure. Specifically, it hypothesised that personal experience, interpersonal and normative attributions and perceived attitudes would predict personal attitudes to sexual activity in Second Life better than a Friend's reported attitude because the subjective personal and social meanings of the attitudes were situated within the interpersonal and normative context.

However, structural and psychological explanations considered in tandem were expected to generate more accurate predictions of an individual's attitude. Specifically, network descriptives were anticipated to describe the conditions for pluralistic ignorance outcomes, and would identify which actors would have more accurate perceptions of their network norms.

Proposed structural and psychological relationships

This research sought to integrate the proposed structural and psychological predictors of attitude to sex in Second Life to better understand how they worked together to produce influence effects. Because network density was hypothesised to describe the similarity of its members' attitudes as a function of the amount of interconnectedness between them, it was argued that knowing how loose or dense the social topography of a group was would inform psychologists of how accurate or inaccurate members' projections of others' attitudes would be.

O'Gorman & Garry (1976) described the extent to which an individual correctly or incorrectly attributed an attitude to a reference group as pluralistic ignorance. This phenomenon has been found to operate as an adhesive for groups that are threatened (Miller, Monin, & Prentice, 2000); in the virtual world, where group belonging is challenged by the leanness of the medium, believing in a false consensus has been found to increase self-expression and decrease isolation, supporting the function of the online community (Williams, Kaplan, & Xiong, 2007).

It ensures that the online community's members feel they are part of an ideological in-group.

The computer-mediated environment would arguably have implications for perceived attitudes to sexual activity in the virtual world, where, as has been described throughout this thesis, projections of similarity occurred more frequently than offline. It was anticipated that dense networks would produce greater accuracy because more links would generate accessible evidence about what others believed. In contrast, loose networks would create more pluralistic ignorance due to the uncertainty of others' attitudes, because of the lack of possible corroboration available through the structural makeup of the virtual network. In other words, in looser networks, one's own attitude would be over-represented in perceptions of others' beliefs because of the absence of contradictory evidence.

An activity as prevalent in the public discourse of the population of Second Life as cybersex was anticipated to result in greater pluralistic ignorance effects on attitude perception (Packard & Willower, 1972; Lambert, Kahn, & Apple, 2003). The result was expected to be greater influence of the perceived attitude on the personal attitude rather than attitudes actually held by network connections.

H₁₀: Perceptions of Friends' attitudes would be more accurate as network density increased.

Finally, because a person well integrated into a social network was believed to have better access to information from around the network than a person who held a peripheral position (e.g., Hypothesis 2), it was expected that knowing where an individual was situated in the network would identify people who had attitudes that were more similar to the rest of the group's attitudes. Arguably, the density of the network would affect this, with more dense networks increasing the similarity between the individual's personal attitude and the average attitude of the rest of the group. Further, it was argued that the density of the network would affect this (Friedkin & Johnsen, 1999).

H₁₁: As an actor's position in a network became more central, his/her beliefs about the attitudes Friends hold about sex in the virtual world will become more accurate to what they report.

5.3. **Hypotheses**

This review resulted in the following hypotheses:

H₁: Personal attitudes will be more similar to Friends' attitudes if they belong to a dense cluster, with many interconnections, than if they belong to a disparate cluster, with few interconnections.

H₂: Actors who hold central positions will have attitudes that are more similar to the average attitudes of their network than actors who held more peripheral positions.

H₃: Second Life account holders who communicated across multiple modes and via more private means were more likely to have similar attitudes to sex in the virtual world than account holders who communicated via in-world only means.

H₄: Second Life account holders who report previous virtual sexual experiences will hold more positive attitudes towards the activity than account holders who do not report sexual experiences in the virtual world.

H₅: Respondents will have more similar attitudes about sex in Second Life to Friends they view as more trustworthy than Friends they view as less trustworthy.

H₆: Respondents will have more similar attitudes about sex in Second Life to Friends they compare themselves with than Friends they don't compare themselves with.

H₇: Respondents will have more similar attitudes about sex in Second Life to Friends whom they view as more typical of their virtual group than Friends they view as less typical of their virtual group.

H₈: Avatars of the same gender will have more similar attitudes to sex in the virtual world than avatars of different genders.

H₉: Personal attitudes will be more similar to attitudes respondents believe their Friends hold about sex in Second Life than the attitudes the Friends report.

H₁₀: Perceptions of Friends' attitudes will be more accurate as network density increases.

H₁₁: As an actor's position in a network becomes more central, his/her beliefs about the attitudes Friends hold about sex in the virtual world will be more accurate to what they report.

Table 8 outlines the variables in each.

Table 8

Hierarchy of Study 2 Models, Outcome Variables and Predictor Variables

Model	Outcome variable	Predictors					H
		1	2	3	4	5	
1	Personal-Network concordance	Network density					H ₁
2	Personal-Network concordance	Network position					H ₂
3	Personal-Friend attitude concordance	Network strength					H ₃
4	Personal-Friend attitude concordance	Trust					H ₅
4	Personal-Friend attitude concordance	Social Comparison					H ₆
4	Personal-Friend attitude concordance	Prototypicality					H ₇
4	Personal-Friend attitude concordance	Avatar Gender similarity					H ₈
5	Personal attitude	Perceived attitude	Personal experience				H ₉
6	Pluralistic ignorance	Network density	Network position				H ₁₀ H ₁₁
7	Personal attitude	Network density	Network position	Personal experience	Perceived attitude	Avatar Gender similarity	

5.4. Method

Participants and procedure

This study aimed to identify a network of representative avatars using an egocentric design. Spreen and Zwaagstra (1994) proposed that fourth-degree (or, actor A knows actor D via actors B and C), was a logical boundary at which to stop egocentric network data collection, as actors beyond these degrees had little social significance for the individuals initially selected.

Sociometric survey respondents were recruited using a snowball sampling method over five waves of data collection, which lasted from April to December 2006 to ensure that the greatest number of fourth-degree relationships had the opportunity to participate in the research. In total, 734 current Second Life account holders responded to the survey and generated 9,561 names of their virtual Friends.

To recruit participants, a random sample of 1,084 avatars out of the 1,444³⁰ names listed by Study 1 respondents were located on the public listing in Second Life and were contacted using the virtual world's Instant Message facility. The

content of the Instant Message was brief, due to the limitations of space (250 characters; see Fig. 9).

It informed the selected avatars they had been identified in a previous phase of the research and were invited to participate in the next phase by clicking on a link or by accessing the survey at the Social Simulation Research

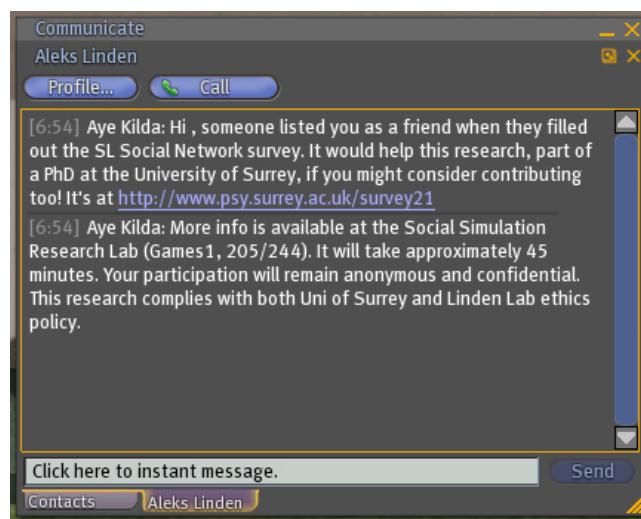


Figure 9. Study 2 recruitment text in an Instant Message

³⁰ The pool of Study 1 names that made up the starting sample for Study 2 included the names generated by Study 1 survey respondents, including those that did not finish completing that survey.

Lab. In total over the nine-month period of data collection, 4,907 avatars of the 7,523 listed by respondents were contacted to inform them of their participation in the research (see Table 9). In other words, 65.2% of the avatars nominated as Friends by respondents were contacted to inform them that their identity was implicated in the study, a proportion that was considered reasonably attainable in the time period of collection given that each avatar was contacted individually, and process was not automated. If any account holders implicated in the research chose to opt out, their avatar names were removed from the data and were placed on a “remove” list until the end of the research period in order to ensure that they were not contacted to participate in future studies. Eight avatars opted out; this list was destroyed at the end of the project.

There was no way to determine how the respondents found the survey, whether from a direct IM from the primary investigator, or through their own discovery (e.g., an in-world advertisement, a public post to the Second Life forum, via word-of-mouth, a visit to the Social Simulation Research Lab, or other means); however, all participants accessed the instrument from within the virtual world, ensuring that they were active in the online community.

Table 9
Study 2 Sampling and Recruitment: Sampling Pool and Source

Study 2 Wave	Source	Sample pool	N contacted (%)	N new names	N
1	Study 1	1,444	1,084 (75.1%)	2,570	2,930
2	Wave 1	2,930	1,015 (55.0%)	942	3,872
3	Wave 2	2,857	1,108 (62.5%)	1,644	5,516
4	Wave 3	3,393	1,086 (47.0%)	1,193	6,709
5	Wave 4	3,500	614 (25.4%)	2,528	7,793
Total (% of Total N)			4,215 (54.1%)		

Materials

Data from this study came from the responses to a 28-item online survey (see Appendix 2-1 for the Study 2 survey text). The content of the survey was built using a PHP application framework adapted to the specific needs of sociometric data collection: free-response fields were used for participants to list names of contacts,

and radio buttons and drop-down menus were used for respondents to define the psychological and network strength of those relationships. The results were available for the research team to download to a local computer from the secure University of Surrey server in a .csv format by using a password at any time during the research period.

Instruments

The survey was divided into six sections: Demographics and Community Involvement, Social Network name generator, Network Strength based on communication practices, psychological attributions of interpersonal and normative facets of influence, Experience of sexual activity in Second Life and attitudes to sexual activity in Second Life. Descriptive details of each measure are outlined in Table 8 at the end of the section 5.3.

Demographics and community involvement

As research has indicated, only 2% of people have experienced cybersex, with young men more likely to engage in the activity than young women (Wolak, Mitchell, & Finkelhor, 2002). This demographic balance has been a consistent trend for over a decade (Turkle, 1995; Cooper *et al.*, 2000), and for this reason Daneback, Cooper and Mansson (2005) recommend looking at demographic variables (e.g., age and gender) when investigating the phenomenon.

These questions were identical to the Demographics and Community Involvement questions included in Study 1. See Chapter 4 for details.

Social Network name generator

The Name Generator asked respondents to type in the names of the avatars on their Friends lists. As in Study 1, if respondents had more than 50 Friends, they were asked to include those with whom they had interacted socially most recently and to send screenshots of their Friends lists for manual importing by the research team. All names generated were included in the network analysis to identify the structural measures. However, to reduce participant response load, a sub-sample of up to ten

Friends was identified out of each respondent's pool of nominated Friends for detailed assessment of psychological strength based on respondents' responses to the network strength items. This is described later in this section.

Outcome measures

There were four outcome measures in this research. The first measured the respondents' personal attitudes to cybersex. The remaining three were variations of the personal attitude variable, considered relative to either a Friend who had also reported his/her attitude to sex because s/he was also a respondent (Personal-Friend Attitude concordance), or to the network: the similarity between the respondent's reported attitude and the average reported attitude of his/her local network (Personal-Network attitude concordance), and the degree to which the respondent accurately predicted the average attitude of his/her local network (Pluralistic Ignorance).

Personal attitude

The questions about attitude to Second Life sex were adapted from conversations about sexual activity raised by the virtual world's Residents in the official Second Life forums between March 2005-April 2006. This outcome measure was tested for its relationship with all the predictor variables and specifically was included the models that assessed the predictive power of personal experience of cybersex in the Second Life virtual world (Hypothesis 4) and the perceived attitudes of close Friends (Hypothesis 9).

The Personal Attitude scale had three questions. One question focussed on attitude towards an example of sexual activity (*I believe it is safe to engage in sexual activity in Second Life*), one question focussed on anxiety associated with potential negative outcomes (*I believe it is safe to engage in sexual activity in Second Life with avatars I have just met*) and one on attitude to engage in sexual activity regardless of risk (*I feel being exposed to sexual activity is a risk worth taking*). The scale was reliable ($\alpha = 0.76$). The scale was framed within a risk ontology that aimed to generate attitudes based on projected activity, regardless of personal direct experience.

Personal-Friend attitude concordance

The second outcome measure was the amount of agreement between a respondent's personal attitude and a respondent-Friend's personal attitude. It is referred to in this research "Personal-Friend attitude concordance".

The concordance between two individuals' attitudes has been considered a measure of the direct process of social influence that takes into account the relative importance of each network associate's reported personal attitude on the other's reported personal attitude (cf.,Forgas & Williams, 2002). This approach considers Dodd and Klein's (1962) emphasis on the relationship of common parts in social phenomena.

Personal-Friend attitude concordance was an outcome indicator of network exposure: by comparing each respondent's attitude to sexual activity the virtual world with his or her Friends' attitudes, the analysis was able to identify the degree to which a Friend's reported attitude predicted the Ego's personal attitude, and vice versa. This outcome was tested in relation to network strength (Hypothesis 3) and the psychological interpersonal and normative features of influence, outlined in Hypotheses 4-8.

The variable was calculated by subtracting the Friends' attitude scores from the respondent's attitude score (Chung, Small, & McLanahan, 2004). The absolute value was taken from the difference and 1 was added to each score. A resulting value of 1 indicated identical attitudes to sex between the pair. Higher scores represented disparities between the pair, with the greatest disparity at the top of the scale.

Outcome network variables

To calculate the outcome measures that considered the personal attitude in relation to the average attitude of a respondent's network, two routines were required. First, it was necessary to reduce the population into meaningful groups for the individual community members. Second, an average sub-network attitude was calculated for each of the small groups in the new sample.

Sub-network extraction

A series of social network analytic processes were performed to extract clusters of interconnected Second Life participants from the whole, loose network captured in Study 2. They represented groups of local Friends who each had at least two connections with other members of the group. This approach was designed to provide a more representative contextual view of attitude development.

To identify a random selection of unique networks, the whole network's average number of incoming Friend nominations was identified (Costenbader & Valente, 2003). Incoming ties were used in this approach to compensate for the ego-centric data collection method: respondents had nominated their Friends, but the Friends may not have completed the survey themselves, under-representing their positions in the network due to absent ties, and over-representing the respondent's role in the network because their ties had been reported. This average, $2.86 (SD = 17.74)$ was then used to extract a random selection of actors as the basis for the cluster.

351 avatars were identified as having exactly three incoming connections, using an in-degree centrality routine in software package Pajek. Of this group, every 10th person was identified. This routine was run four times.

The selected actors' networks within 2 degrees – i.e. his/her own friends and their friends – were extracted from the whole network using Pajek. The resulting networks from this first stage of cluster identification had many pendants, or people

who were connected to only one other person in the network. In order to maximise the connectivity, create networks of interest with the greatest density, and to reduce the likelihood of highly centralised networks, these pendants were trimmed using a bi-component analysis.

A bi-component is a group of at least three actors in a network who



Figure 10. A bicomponent is a network in which each node has at least two connections.

are maximally connected, or make the third actor in a triad, a three-person network (see Fig. 10). No one person in the group can block the pathway to any other person in the network, as there is always another path that can circumvent a potential blockade. Bi-component analyses identify these network clusters, removing people who are less optimally connected. They represent cohesive groups of interconnected actors within a large network.

In total, 68 networks were extracted in this way from a pool of the 68 randomly sampled actors. There was an average of 33.94 people in each bi-component network ($SD = 25.23$). The outlying networks, those with Ns of less than 9 and greater than 59, were removed.

The actors in each of the remaining 49 bi-component networks were compared in Excel for population uniqueness using a bespoke software programme. Those with the highest overlap were removed in stages until there were a maximal number of sub-networks with no actors in two or more groups in the network sub-sample.

The final sample of 17 unique sub-networks each had an N greater than 10, with an average of 22.12 people and an SD of 11.13. A sub-sample of 376 avatars was included in this population with an average of 3.24 respondents in each group ($SD = 1.88$). The range of respondents represented in each of the networks was between five and 16. The percentage of responses in each group ranged from 30.8% to 78.6%. Across all rating categories, 10 of the 17 groups had an over 50% rating rate (see Table 10 for sub-network descriptives).

Analytic routines that involved structural measures (network density, network position) were based on this sub-sample. A new variable indicating which sub-network an actor who was identified as part of this sub-sample was appended to his/her case in the data table. Actors who did not belong to any sub-network were identified with a 0.

Sub-network average attitude to sex

The second routine required to calculate the remaining outcome measures was to calculate each sub-network's attitude to sex in the virtual world. The respondents in each network had provided information about their personal attitudes to sex. This was used to generate an average reported attitude measure for every actor in a network who had responded to these questions. The resulting value was added as a variable for each actor according to his or her relevant networks. Actors who did not belong to any sub-network were identified as missing.

Personal-Network attitude concordance

The first attitude outcome measure developed for each sub-network member using these results was a concordance measure between the survey respondent's personal attitude and his/her network's average attitude to sex in Second Life. This outcome was tested in relation to sub-network density and sub-network position, outlined in Hypotheses 1 and 2.

To calculate this measure, the network average was subtracted from the respondent's reported attitude, the absolute value was taken and 1 was added. A 1 value for the resulting variable identified a match between the actor and his/her network average, while a higher score indicated a larger disparity between the actor and his/her network's average. Actors who did not belong to any sub-network were identified as missing.

Pluralistic ignorance

The second attitude outcome variable developed for each sub-network member was the pluralistic ignorance score. This measure was tested in relation to sub-network density and sub-network position, outlined in Hypotheses 10 and 11.

It was calculated by subtracting the respondent's perceived attitude to sex score from his/her network's average³¹. A value of 1 was added to the absolute difference. The result was a score between 1 for accurate predictions of Friends'

³¹ The perceived attitude to sex score was based on the beliefs about the Friends whom the respondent communicated with the most; it was argued that these actors were likely in the local network extracted with the bi-component analysis.

attitudes to sex and 3.67 for the most inaccurate predictions. This variable was added as a measure for every respondent in the sub-sample. Actors who did not belong to any sub-network were identified as missing.

Predictor measures

In Study 2, there were both structural and psychological predictor variables.

Structural predictors

Network density and network position

Each sub-network cluster underwent analyses to determine their network densities and each included actor's network position within them. As described in Chapter 3, density is calculated by taking the proportion of the observed links in each sub-network and the total number of possible links. The density analyses compared sub-networks and so each person included in this sample received a density value corresponding to his/her local group. Density was considered in Hypotheses 1 and 10.

In contrast, the network position measures were unique for each actor: they were calculated by taking the proportion of all ties an individual had with other members of his/her sub-network and the total possible connections. All relationships were implicated in this routine: both incoming and outgoing links were considered equal because the sub-sampling had standardised the basic number of links. This was a value that could be compared across the sub-networks. Network position was considered in Hypotheses 2 and 11.

Actors who did not belong to any sub-network were identified as missing.

Network strength

The second network predictor variable was network strength. This predictor was considered in Hypothesis 3.

Table 10
Descriptive Analysis of the Study 2 Sub-Network Sample

Network	Bi-component N	N Respondents	N Attitude	M Attitude (SD)	Experience %	N Relationships	M Friends (SD)	Highest degree centrality	N friends in ~80% of network population	Bi- component density ^a
Network 1	26	11	11	2.58 (0.76)	0.42	42	3.23 (2.47)	12	2-3 (80.8%)	0.13
Network 4	13	5	3	2.67 (0.67)	0.23	23	3.54 (2.90)	12	2-3 (84.6%)	0.29
Network 9	45	13	10	2.77 (0.70)	0.22	95	4.22 (6.96)	45	2-4 (82.2%)	0.1
Network 25	24	11	11	2.33 (1.27)	0.46	50	4.17 (3.12)	13	2-5 (79.2%)	0.18
Network 27	15	7	7	2.76 (0.71)	0.47	38	5.07 (5.63)	25	2-4 (86.7%)	0.36
Network 31	14	6	6	2.78 (0.75)	0.43	25	3.43 (2.44)	11	2-4 (78.6%)	0.04
Network 34	24	10	10	3.10 (0.67)	0.42	43	3.58 (2.80)	15	2-4 (83.3%)	0.16
Network 38	40	16	14	2.48 (0.98)	0.35	102	5.10 (6.57)	32	2-5 (80.0%)	0.13
Network 42	44	15	11	2.00 (0.70)	0.25	98	4.45 (4.74)	31	2-5 (79.5%)	0.1
Network 44	13	6	5	2.73 (0.76)	0.38	21	3.23 (2.12)	9	2-3 (84.6%)	0.27
Network 47	14	7	6	2.89 (0.72)	0.43	23	3.29 (2.28)	10	2-3 (78.6%)	0.25
Network 53	12	6	6	2.89 (0.34)	0.5	22	3.67 (3.04)	13	2-4 (83.3%)	0.33
Network 61	10	7	7	1.71 (0.85)	0.7	20	4.00 (1.84)	9	2-4 (80.0%)	0.44
Network 62	18	8	5	2.40 (1.04)	0.28	34	3.78 (3.69)	18	2-4 (83.3%)	0.22
Network 64	25	12	8	2.79 (0.78)	0.32	48	3.84 (4.64)	25	2-3 (72.0%)	0.16
Network 65	19	8	7	3.14 (0.57)	0.37	34	3.58 (2.62)	10	2-4 (78.9%)	0.2
Network 69	20	7	7	3.00 (0.94)	0.35	50	5.00 (5.18)	24	2-5 (80.0%)	0.26

Note. ^aNo loops.

Three questions asked about participants' communication practices specific to each Friend. This criterion was chosen because it overlapped the least with the features of influence in Study 1 and represented a more unique network measure than the other proposed strength indicators. Additionally, communication was theoretically anticipated to relate to the similarity between an individual's and his/her Friend's attitudes.

Communication practices were also common for all Second Life account holders and this measure allowed for a behavioural variable that was relevant for all participants. The research survey was able to ask respondents to stipulate their actual communication activities with each Friend, rather than a frequency measure or a likelihood measure. The communication mode-based network strength variable in this study directly represented how 'strong' or how 'weak' a Friendship was in relation to the respondent.

Respondents identified their selections using a corresponding radio button. Each response was assigned a weighting to generate a scale that described the respondent's relative network strength with the nominated avatar (see Table 11): the results from Study 1 and research by Correll (1995) and Garton and her colleagues (1997) suggested that public online communication was the most frequent communication choice (value 1), and that outside communication represented close relationships that predicted both interpersonal and normative features of influence (value 4). Private communication was considered more intimate than public communications theoretically (value 2), although the Study 1 results suggested there was a confound that was based on its contextual similarity to public communication. To take this into consideration, another question asked respondents to indicate which Friends they considered 'close', using a sociometric item developed by Fischer (1982) and used by McCarty (2003), Grosetti (2004) and Kirke (1996) to identify cohesive relationships. This question was included to take into account respondents who chose to keep their Second Life friendships inside the virtual context and did not cross communication media between inside and outside the virtual environment. It offered an opportunity to identify which Second Life Friends they felt more intimately connected with. It was also rated a value of 2, as it was important to

emphasise the contribution of the Instant Message communication format in conjunction with the reported perceived closeness of the relationship. Thus, it was decided that an avatar that a respondent considered a close friend but only communicated with via Instant Message or in public was rated with a status equal to that of outside communicators. This ensured that the relative psychological importance of close friendship was taken into consideration regardless of whether Residents interacted outside Second Life or not.

The total of the four weights represented the network strength of the relationship between the respondent and his/her Friend (see Table 11).

Table 11

Study 2 Network Strength Ratings

Rating	Network Strength
0	No current contact: legacy relationship
1	Communicates with nominated Friend in public in Second Life only
2	Communicates with nominated Friend via Instant Message only OR Considers nominated Friend to be a close friend
3	Communicates with nominated Friend in public in Second Life and via Instant Message OR Communicates with nominated Friend in public in Second Life and considers him/her to be a close friend
4	Communicates with nominated Friend outside the Second Life world OR Communicates with nominated Friend via Instant Message and considers him/her to be a close friend
5	Communicates with nominated Friend in public in Second Life and outside the Second Life world OR Communicates with the nominated Friend in public in Second Life and via Instant Message, and considers him/her to be a close friend
6	Communicates with nominated Friend via Instant Message and outside the Second Life world OR Communicates with nominated Friend outside the Second Life world and considers him/her to be a close friend
7	As in 6, but also communicates with the nominated Friend in public in Second Life
8	Communicates with nominated Friend via Instant Message, outside the Second Life world and considers him/her to be a close friend
9	Communicates with the nominated Friend in public, via Instant Message and outside the Second Life world, and considers him/her to be a close friend

Response weighting and sub-selection

Network strength was also used to sub-select a cohort of Friends that would receive further ratings on scales of interpersonal and normative attributions.

Avatars whose strength values totalled either between 4-9 or 1 were retained in ‘network high’ (4-9) and ‘network low’ (1) lists. The cut-off point for ‘network high’ (value 4) was established because this was the first value that identified non-Second Life interaction between two community members. It also included those avatars whom the respondent considered a close friend and with whom s/he communicated via Instant Message. Avatar relationships with values 2 and 3, or relationships with no communication scores reported (value 0) were excluded from further questions. The network strength scores from the excluded avatars were used subsequently only to assess its relationship with the Personal-Friend attitude concordance outcome measure.

Of those ‘network high’ relationships valued between 4-9, the five Friends with the strongest relationships were selected for rating by the respondent in the next section of the survey. They represented actors who were considered part of the respondent’s immediate reference network. If there were more than five avatars with the same value score, five avatars were randomly selected to be included in the rest of the survey. If there were fewer than five relationships in the ‘network high’ category, all of the avatars that were awarded a relationship value between 4-9 were selected.

Five avatars with relationship strengths of value 1 were randomly selected to represent actors who were considered weak ties for the respondent. These actors were anticipated to be less influential, but were expected to offer valuable new information and alternative perspectives than the immediate network connections. They were included to provide a balance of psychological attributions without requiring participants to complete responses for all of their listed Friends.

If there were fewer than five actors with ratings of 1 in the network strength assessment, all of the actors in the respondent’s ‘network low’ category were selected to be rated for interpersonal and normative features of influence. In total, up

to ten avatars were selected to be rated by the respondent in the next section of the survey.

Psychological predictors

There were two categories of psychological predictors. The first was the set of individual-level measures of personal experience and perceived attitude.

Individual-level psychological predictors

Personal experience

One question asked if the respondent had engaged in sexual activity during his/her time in the Second Life. In addition to a hypothesised relationship with personal attitude, this question also provided an opportunity to measure the amount of sexual contact in the community. It was a reliable scale ($\alpha = 0.76$).

This predictor was considered in Hypothesis 4.

Perceived attitude

The perceived attitude scale was identical to the personal attitude measure outlined above, except that the subject in the sentences was changed from “I” to “My close friends”. The questions asked respondents to consider their Friends’ attitudes towards engaging in sexual activity. It was a reliable scale ($\alpha = 0.77$), and was considered in Hypothesis 9.

Relationship-level psychological predictors

The second category of psychological predictors included the relationship-level measures of the interpersonal and normative features of influence. These predictors were implicated in Hypotheses 5-8.

Interpersonal features of influence

The first interpersonal feature measure was a 5-item trust scale developed for the study based on the Trust and Credibility scales used in Study 1. This scale integrated these two measures because of their observed overlap. As described in Chapter 4, the correlation between the trust and credibility scales was remarkable in

its strength ($r = 0.81, p < .00$) and the inter-item correlations also demonstrated strong, significant relationships (see Table 12).

An exploratory principle axis Factor Analysis with oblimin rotation for the Trust and Credibility items produced one Factor, and so in order to represent both the Trust and Credibility scales equally in a final scale, the strongest correlations between the items in Factor I were examined. The five strongest loading items were closely inter-related. In order to counteract multicollinearity effects and to ensure that future analyses would not result in confounds based upon inter-IV correlations, the questions, ‘This person is trustworthy’ and ‘This person is reliable’ were discarded. This produced a strongly reliable scale ($\alpha = 0.88$).

The resulting scale adapted Poortinga and Pidgeon’s (2003) definition of trust, which proposed that trustworthiness is based on two categories: care and competence. However, the theoretical approach that this study used to operationalise trust and credibility were adaptations of multiple theoretical findings (Kramer, 1999; Poortinga & Pidgeon, 2003; Renn & Levine, 1991; Cvetkovich, 1999; Petty & Cacioppo, 1986b) which Frewer, Scholderer & Bredahl (2003) argue is enough to encapsulate the lay understandings of trust and credibility.

The adapted scale included two questions from the original Trust scale (honesty, similarity) and three from the original Credibility scale (likeability, knowledgeability and similarity). This approach was informed by data analysis but adapted by theory, and ensured that the theoretically important significant elements were included in the final trust measure.

The second interpersonal feature measure was social comparison. Two items were used to assess the amount of social comparison the respondent engaged in with the nominated avatars based upon Lennox & Wolfe’s (1984) Attention To Social Comparison Information Scale (ATSCI).

The Social Comparison scale items included in Study 2 were identical to the measures in Study 1. For more information on the development of this item, please refer to Chapter 4. Respondents selected their answers on a 5-point Likert scale from Strongly Disagree to Strongly Agree.

Normative features of influence

There were two normative feature measures in Study 2. The first was one item that assessed how much the respondent felt his or her nominees were typical of their reference group. This Prototypicality item was identical to the measures in Study 1. For more information on its development, please refer to Chapter 4. Respondents selected their answers on a 5-point Likert scale from Strongly Disagree to Strongly Agree.

Finally, the second normative feature measure was an indicator that identified whether the respondent and his/her Friend had the same avatar gender in the virtual world. Each respondent in the study had listed his/her online and offline genders on the survey. A new categorical variable was calculated by comparing each respondent's and his/her Friends' avatar genders to indicate whether the pair presented their online genders in the same way. 1 indicated different gender, while 2 indicated the same gender.

5.5. *Analytic Overview*

Data organisation

The data in this study was organised into two tables. The first included the individual-level information about every avatar in the study, including:

- Demographics
- Community involvement
- Experience
- Personal attitude
- Sub-network ID
- Sub-network density
- Sub-network position
- Sub-network average attitude to sex
- Personal-Network attitude concordance
- Pluralistic ignorance

Table 12
Inter-Item Correlations Between Study 1 Trust and Credibility Scale Items

	Credibility 1: This person is reliable.	Credibility 2: I consider this person to be well-informed about a wide range of issues.	Credibility 3: I like this person.	Credibility 4: I tend to believe what this person says.	Trust 1: This person is honest.	Trust 2: This person cares about me.	Trust 3: This person and I share similar values and beliefs.	Trust 4: This person is trustworthy.
Credibility 1: This person is reliable.	1	.59**	.62**	.72**	.69**	.55**	.52**	.72**
Credibility 2: I consider this person to be well-informed about a wide range of issues.	.59**	1	.51**	.62**	.49**	.48**	.51**	.55**
Credibility 3: I like this person.	.62**	.51**	1	.68**	.63**	.58**	.57**	.65**
Credibility 4: I tend to believe what this person says.	.72**	.62**	.68**	1	.65**	.55**	.57**	.72**
Trust 1: This person is honest.	.69**	.49**	.63**	.65**	1	.55**	.55**	.83**
Trust 2: This person cares about me.	.55**	.48**	.58**	.55**	.55**	1	.58**	.60**
Trust 3: This person and I share similar values and beliefs.	.52**	.51**	.57**	.57**	.55**	.58**	1	.59**
Trust 4: This person is trustworthy.	.72**	.55**	.65**	.72**	.83**	.60**	.59**	1

Note. N = 829

**. Correlation is significant at the 0.01 level (2-tailed).

The second table included relationship information based on the responses of survey participants, detailing:

- Respondent-Friend connection
- Each Respondent-Friend network strength
- Each Respondent-Friend psychological closeness
- Each Respondent-Friend avatar gender similarity
- Personal-Friend attitude concordance

Correlations

Correlation analyses were performed at the individual-level to identify whether there were any relationships between the demographic, community involvement, experience and attitude variables.

In addition to the exploratory correlation analyses, this research specifically sought to establish the relationship between the dependent and independent variables outlined in the hypotheses (see Table 16).

Regression

This research aimed to describe the variation in scores of personal attitude as predicted by both single-level and multilevel variables. The first sought to identify the variance in the similarity between personal attitude scores and their local network's attitude explained by the respondent's network density. The second was implemented to identify the variance in the similarity between personal attitude scores and their local network's attitude and the respondent's network position. Two models assessed the effects of personal experience and perceived attitudes on the personal attitude. Finally, the last three regression models were designed to explain the variance in the similarity between the perceived attitude and the local network's average attitude with the structural variables (see Table 8).

Multilevel models

Three multi-level models were designed for this research, analysed to take into account the two-level hierarchical structure of the data: Friends were at level 1,

nested in survey respondents at level 2. As in Study 1, the variance in the outcome variable explained by the predictors was partitioned into two components: respondent and Friend.

Two of the models sought to explain the variance in the similarity between the reported attitudes of respondents and their Friend-respondents. The first sought to identify how the network strength variable explained the variation between a Friend's reported attitude and the respondent's personal attitude. The second set of models examined the psychological measures of relationship strength on this outcome measure. The final model, Model 7, was a composite of the significant single and multilevel predictors of personal attitude. It was used to identify the relative power the structural and the psychological variables. It explored the relative predictive power of the predictors that had been significant in the previous models. Specifically, Personal Attitude was the outcome measure for Model 7 because it was implicated in all the other outcome measures, having been an integral part of the calculation of Personal-Network attitude concordance, Personal-Friend attitude concordance and Pluralistic ignorance.

To assess the variance between survey respondents on the multi-level predictors, the intercept was identified as random at level 2. This allowed the means of communication closeness, avatar gender concordance, and ratings of trust, social comparison and prototypicality to vary across the survey respondents in a way that was assumed to be normally distributed.

The models were estimated iteratively using iterative generalised least squares (IGLS).

Table 13
Descriptive Analysis of the Study 2 Variables

	N	Item(s)	Response options	M	SD	Min	Max
Survey respondents	734						
Demographic and Community Involvement							
Respondent gender	734	<i>What is your gender (offline)?</i>	male (N=348) female (N=386))				
Respondent avatar gender	734	<i>What is the gender of your avatar?</i>	male (N=314) female (N=420)				
Respondent-Friend gender concordance	1,169		-	yes (N=624) no (N=545)			
Respondent-Friend avatar gender concordance	1,169		-	yes (N=638) no (N=531)			
Respondent Hours spent in Second Life	734	<i>On average, how many hours are you in Second Life per week?</i>	1-5 (N=123) 5-10 (N=131) 10-15 (N=91) 15-20 (N=101) 20+ (N=288)				
Respondent Length of time since account created	734	<i>How long have you been a resident in Second Life?</i>	Less than 3 months (N=60) 3-6 months (N=102) 6- months – 1 year (N=90) 1 year – 1 ½ years (N=134) 1 ½ - 2 years (N=94) 2+ years (N=204)				

Table 13 (continued)

Descriptive Analysis of the Study 2 Variables

	N	Item(s)	Response options	M	SD	Min	Max
Social Network Items							
Nominated Friends	9,561	<i>Please list each of the avatars on your friends list with whom you have communicated SOCIALLY (i.e. your interaction must have been primarily social, rather than primarily business-centred).</i>		13.3	17.74	1	322
Respondent sub network position	52			0.18	0.14	0.05	0.71
Sub network density	52			0.19	0.09	0.04	0.36
Respondent to Friend Network strength ^a	9,561	<i>Please select those avatars you are likely to speak with in public in Second Life;</i> <i>Please select those avatars you are likely to speak with via IM in Second Life;</i> <i>Please select those avatars you are likely to speak with outside of Second Life;</i> <i>Please select those avatars whom you consider to be a close friend;</i>	0 (N=1619) 1 (N=667) 2 (N=393) 3 (N=3093) 4 (N=76) 5 (N=866) 6 (N=71) 7 (N=829) 8 (N=35) 9 (N=1912)				
Sub network average attitude to Sex	52			2.19	0.76	1.05	3.84
Psychological Variables							
Personal experience of Sex	641	<i>I have experienced sexual activity in Second Life</i>	Yes (N=189) No (N=452)				

Table 13 (continued)

Descriptive Analysis of the Study 2 Variables

	N	Item(s)	Response options	M	SD	Min	Max
Respondent Perceived attitude to Sex ^b	626	<i>My close friends believe it is safe to engage in sexual activity in Second Life;</i> <i>My close friends believe it is safe to engage in sexual activity in Second Life with avatars they have just met;</i> <i>My close friends feel being exposed to sexual activity in Second Life is a risk worth taking;</i>	<i>Completely disagree,</i> <i>Disagree, Neither Disagree or Agree, Agree, Strongly Agree</i>	2.63	0.73	0.67	4
Respondent to Friend Trust	2,733	<i>I tend to believe what this person says;</i> <i>I consider this person to be well informed about a wide range of issues;</i> <i>This person is honest;</i> <i>This person and I share similar values and beliefs;</i> <i>I like this person;</i>		3.28	0.65	0.4	4
Respondent to Friend Social Comparison	2,632	<i>If I am the least bit uncertain how to act in a social situation, I look to the behaviour of this person for cues;</i> <i>I find that I tend to pick up slang expressions from this person and use them as part of my vocabulary;</i>		2.23	1.01	0	4
Respondent to Friend Prototypicality	2,632	<i>This person has qualities that are typical of the people in my Second Life Network;</i>		3.01	0.94	0	4

Table 13 (continued)

Descriptive Analysis of the Study 2 Variables

	N	Item(s)	Response options	M	SD	Min	Max
Outcome Variables							
Personal attitude to Sex ^c	621	<i>I believe it is safe to engage in sexual activity in Second Life;</i> <i>I believe it is safe to engage in sexual activity in Second Life with avatars I have just met;</i> <i>I feel being exposed to sexual activity in Second Life is a risk worth taking;</i>	Completely disagree, Disagree, Neither Disagree or Agree, Agree, Strongly Agree	2.44	0.85	0.33	4
Respondent pluralistic ignorance	52			1.85	0.34	1	3.67
Concordance between network attitude to Sex and Respondent attitude to sex	52			1.75	0.64	1	3.67
Respondent-Friend attitude concordance	890			1.92	0.74	1	4.67

Note. ^a See Table 10 for category values; ^b $\alpha = 0.77$; ^c $\alpha = 0.76$

5.6. *Results*

Descriptives

Whole network descriptives

Between April and December 2006, 1,251 people clicked through to the online survey from the Instant Message link or a link at the SSRL. Of these, 1,117 contributed 9,561 names to the name generator question. There were 6,711 unique avatars in this network. The minimum number of Friends listed was 1 ($N = 64$) and the maximum number of Friends listed was 322 ($N = 1$). On average, respondents listed 13.13 Friends each ($SD = 17.79$). 53.2% of respondents claimed between one and eight Friends. There was a small relationship between respondents who reported that they spent more time in Second Life and those who reported having more Friends ($r = 0.24, p < .00$).

All avatars were rated on the network strength predictor variable, which served additionally to sub-select strong and weak ties for further assessment. From a pool of 667 weak relationships and 3,789 strong relationships, 2,733 were rated on the Trust scale and 2,632 were rated on each of the Social Comparison and Prototypicality items. The variation in scale ratings was due to participant dropout. 621 people completed the survey in full³².

Sub-network descriptives

For a summary of the sub-network descriptives, see Table 10.

The percentage of responses on the predictor and outcome variables in each group ranged from 30.8% to 78.6%, reflecting the number of respondents in each sub-network. Across all rating categories, 10 of the 17 groups had an over 50% rating rate.

³² See section 5.7.3 for further discussion of the survey drop-out rates.

Table 14

Demographic and Community Involvement Clustering Between Sub-Networks

	χ^2	df	F	F^2	Cramer's V
Real-life gender	33.25 ^a	16	0.46 ^a	0.21	0.46 ^a
Avatar gender	31.52 ^a	16	0.45 ^a	0.17	0.45 ^a
Length of time in Second Life	126.62 ^b	80	0.92 ^b	0.83	0.92 ^a
Personal experience of sex in Second Life	39.38 ^b	16	0.53 ^b	0.28	0.53 ^b

^a $p < .05$, ^b $p < .00$

There was some evidence of demographic homophily across the sub-networks. Specifically, there were significant associations between networks and the demographic variables, including real-life reported gender, reported avatar gender, length of time spent in Second Life, and residency in the UK (see Table 14).

There were also significant differences between the groups in the means of perceived attitude about sex ($F(212,134) = 2.36, p < .00$) and in their personal experiences of sex ($\chi^2 = 39.38; df = 16; p < .00$). There was no evidence that personal attitudes clustered in the sub-networks.

Structural predictors of attitude to sex in Second Life

There were three structural models tested in this research. They assessed the predictions outlined in Hypotheses 1-3. Although network density, network position and network strength did not have significant relationships with personal attitude, it was anticipated that they would predict Personal-Network attitude concordance (density, position) and Personal-Friend attitude concordance (strength).

Table 15

Simple Regression Analysis for Structural Predictors of Similarity Between Personal Attitude to Sex and the Network Average

Model		β_0	β_1	t
1	Network density	2.27	-0.21	-6.93
2	Network position	1.72	0.20	6.62

 $p < .00$

There were a variety of different types of network structures in the sub-sample, demonstrated by the significant differences between the means of degree centrality between the groups ($F(16, 359) = 4.76, p < .00$). This indicated that the networks had different ratios of high and low degree central actors in them. The average network density was $M = 0.19 (SD = 0.09)$, but this ranged between very low-density networks ($m = 0.04$) to higher density networks ($m = 0.36$).

The results of the analysis demonstrated that, for every one unit increase in density, concordance between personal attitude and network average increased by 0.21 standard deviations³³. Results for Model 1 are detailed in Table 15. The effect was significant ($F(1,1047) = 48.03, p < .00$), with a small effect ($R^2 = 4.3\%$).

The result supported the hypothesis that networks with many interconnections between individuals represented groups of people with similar attitudes to sex. Individuals in networks who had fewer interconnections were more likely to hold different attitudes to the rest of their cohort.

Network density and Personal-Network attitude concordance

The second model tested Hypothesis 2 sought to establish a predictive relationship between network position and the concordance between the personal attitude and the network attitude. Network position demonstrated a moderate relationship with network density ($r = 0.41, p < .01$) and small relationships with offline gender ($r = 0.29, p < .05$) and online gender ($r = 0.28, p < .05$) (see Table 16).

The results of the regression analysis are detailed in Table 15.

In contrast to the outcomes of Model 1, the second model indicated that as centrality increased, similarity between the personal attitude to sex and the average attitude of an individual's Friends decreased.

³³ Lower values of Personal-Network attitude concordance indicated greater similarity between the pair.

Table 16
Correlations Between Study 2 Individual-Level Predictors and Outcome Variables

		Personal attitude to sex	Perceived attitude to sex	Sub-network density	Sub-network position	Sub-network average attitude	Personal attitude-network average attitude similarity	Pluralistic ignorance	Respondent sex experience
Personal attitude to sex	Pearson Correlation	1	.53**	-0.09	0.09	.49**	0.14	0	.37**
	N	621	613	46	46	46	46	46	621
Perceived attitude to sex	Pearson Correlation	.53**	1	-0.17	-0.05	0.29	0.11	0.18	.33**
	N	613	626	46	46	46	46	46	626
Sub-network density	Pearson Correlation	-0.09	-0.17	1	.41**	-0.08	-0.03	-0.2	-0.03
	N	46	46	52	52	52	52	52	46
Sub-network position	Pearson Correlation	0.09	-0.05	.41**	1	0.2	-0.01	0.08	0.19
	N	46	46	52	52	52	52	52	46
Sub-network average attitude	Pearson Correlation	.49**	0.29	-0.08	0.2	1	-.33*	-.38**	0.28
	N	46	46	52	52	52	52	52	46
Personal attitude-network average attitude similarity	Pearson Correlation	0.14	0.11	-0.03	-0.01	-.33*	1	.65**	-0.27
	N	46	46	52	52	52	52	52	46
Pluralistic ignorance	Pearson Correlation	0	0.18	-0.2	0.08	-.37**	.65**	1	-.37*
	N	46	46	52	52	52	52	52	46
Sex experience	Pearson Correlation	.37**	.33**	-0.03	0.19	0.28	-0.27	-.37*	1
	N	621	626	46	46	46	46	46	641

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

The significant model ($F(1,1047) = 43.85, p < .00$) had a small effect size ($R^2 = 3.9\%$), but the standardised beta value of the central variable indicated that for every standard deviation increase in network integration, the difference between the individual's and his/her network's beliefs about sex increased as well. This provided support for the hypothesis that this structural factor predicted an influence outcome, but it was not in the direction that was anticipated.

Network Strength and Personal-Friend attitude concordance

A striking result, and one which supported the idea that exposure was not a significant influencer in this analysis, was that personal attitude was not directly related to the Friend's attitude (see Table 16). Indeed, this variable did not demonstrate any relationships with the predictor or outcome variables in this analysis. However, Hypotheses 3-8 anticipated that the network and psychological strengths of relationship between two Friends would predict the degree of similarity between the personal attitude and the Friend's attitude.

Model 3 tested Hypothesis 3, anticipating that type of communication that two Friends engaged in would predict Personal-Friend attitude concordance, or the amount of agreement between their attitudes to sex in Second Life. The average of Personal-Friend attitude concordance was low ($M = 1.92; SD = 0.74$) suggesting that connection partners shared more similar attitudes on average.

Each respondent rated his/her Friends on the modes of communication they interacted in. An ANOVA demonstrated that there was a significant difference between the communication practices between respondents, $F(1,728) = 7.40, p < .00$; some were more likely than others to use private modes with their Friends. This significant main effect suggested that there was respondent-level variance that needed to be accounted for. To do this, multi-level modelling was used to test Model 3.

The third model was significant based on the difference between the log likelihood values of a fixed effects model and the multi-level model that included the network strength measure. However, network strength was not a significant predictor of the degree of similarity between a respondent's attitude and his/her Friend's

Table 17

Multilevel Model Analysis of Effects of Network Strength on Similarity Between Personal Attitude to Sex and Friend's Attitude to Sex

Model	β	SE	u_{oj}	SE	$e^{ij}o_e^2$	SE	LogL	
-	Constant	1.92	0.03	0.55	0.03	-	-	1994.8
N=890. Model resolved after 1 iteration. $p < .05$								
Network strength NS								
3	Constant	1.95	0.05	0.15	0.03	0.4	0.02	1920
N=890; model resolved after 2 iterations. $p < .05$								

attitude. In other words, the similarity between a respondent's and his/her Friend's attitudes to sex was better explained by the variation in each respondent's scoring than whether they communicated in public in Second Life, in private in Second Life or outside Second Life. This was not the hypothesised result, and suggested that network strength did not contribute any explanation for observed similarities between personal attitudes. The results are detailed in Table 17.

The three structural explanatory variables contributed to an understanding of a contextual aspect of personal attitude: these variables did not have a direct relationship with personal attitude on their own, but they did demonstrate an indirect relationship between a respondent's beliefs and the beliefs of his/her close group of interconnected Friends. This outcome suggested that structural features did bring to bear explanations for attitude, but that they were related to the normative environment instead of a direct exposure effect. Rather than predicting personal attitude, they predicted how similar the individual was to his/her local group and offered network explanations for why.

The next set of models looked at the effects of psychological predictors on personal attitude.

Psychological predictors of attitude to sex in Second Life

It had been hypothesised that interpersonal and normative source attributions, personal experience and the perception that Friends held an attitude about sex would predict an individual's personal attitude. This was outlined in Hypotheses 4-8, which

proposed that these predictors would explain why two Friends' attitudes would be similar and what would inspire its adoption. The results of the models that assessed these hypotheses are outlined in this section.

Interpersonal and normative features of influence and Personal-Friend attitude concordance

Although the network-based strength measure had not been significant, it was hypothesised that psychological features of influence would have an explanatory effect of concordance between the Friend's attitude and the personal attitude.

There were significant differences between the means of respondents' ratings on the items and scales that measured the interpersonal and normative attributions: Trust $F(627, 732) = 7.46, p < .00$; Social Comparison $F(612, 2631) = 4.44, p < .00$; and Prototypicality $F(612, 2631) = 3.94, p < .00$). This result confirmed the need to proceed with multilevel analyses to control for the differences between respondents in their perceptions of the interpersonal and normative features of influence when assessing the effects of these measures on influence.

Model 4 was repeated four times with four different predictor variables: two interpersonal features of influence (Trust, Social Comparison) and two normative feature of influence (Prototypicality and Avatar Gender similarity). It tested the hypotheses that the psychological variables would directly predict an individual's attitude based on the similarity between a Friend's attitude ratings.

The results of the multilevel models are outlined in Table 18.

Each model was significant, demonstrated by the log likelihood changes from the fixed effect model to the models with Trust, Social Comparison, Prototypicality and Avatar Gender similarity. However, the only predictor variable that was significant was Avatar Gender similarity. In other words, the degree to which respondent reported that s/he trusted his/her Friend, viewed him/her as a source of social comparison and considered him/her a prototypical member of the group did not predict the variance in the similarity between a respondent's attitude to sex and his/her Friend's attitude.

Table 18

Multilevel Modelling Analysis of Effects of Interpersonal and Normative Features of Influence on Similarity Between Personal Attitude to Sex and Friend's Attitude to Sex

Model	β	SE	u_{oj}	SE	$e^{ij}o_e^2$	SE	LogL	
	Constant	1.92	0.03	0.551	0.03	-	-	1994.80
-	N = 890. Model resolved after 1 iteration.							
	$p < .05$							
	Trust	NS						
4	Constant	1.72	0.26	0.14	0.06	0.38	0.06	645.20
	N = 293. Model resolved after 7 iterations. NS = Not Significant.							
	$p < .05$							
	Social Comparison	NS						
4	Constant	1.93	0.01	0.12	0.06	0.4	0.06	635.46
	N = 293. Model resolved after 8 iterations. NS = Not Significant.							
	$p < .05$							
	Prototypicality	NS						
4	Constant	2	0.16	0.12	0.06	0.4	0.07	635.08
	N=293. Model resolved after 8 iterations. NS = Not Significant.							
	$p < .05$							
	Respondent-Friend avatar homophily	-0.11	0.05					
4	Constant	2.09	0.08	0.15	0.03	0.4	0.02	1915.17
	N = 890. Model resolved after 2 iterations.							
	$p < .05$							

This was an interesting finding, as it had been anticipated that psychological attributions would affect the intention to adopt a source's attitude. This was not observed in these results. However, the significant relationships between network strength and these psychological variables (Trust: $r = 0.48, p < .00$; Social Comparison: $r = 0.21, p < .00$; Prototypicality $r = 0.21, p < .00$), which themselves demonstrated moderate correlations (Trust and Social Comparison: $r = 0.45, p < .00$; Trust and Prototypicality: $r = 0.42, p < .00$; Social Comparison and Prototypicality: $r = 0.31, p < .00$), suggested that this was a consistent finding for this outcome variable, and that the network and psychological strength measures did not explain exposure-based influence. Although this did not support the hypotheses in this study, the results did support the research that criticised exposure-based influence.

On the other hand, avatar gender similarity, constructed as a normative cue in this analysis, did predict Personal-Friend attitude concordance. This may have been an artefact of the nature of the variable (it was not attributed to a Friend) and gender biases (there was a small negative relationship between offline gender and attitude to

sex ($r = -0.12, p < .01$). As was outlined in the introduction to this chapter, women were less likely to engage in sexual activity online. It can be argued that this may have affected their attitudes to the pastime. This was supported by the strong relationship between online and offline gender ($r = 0.87, p < .00$), which, consistent with the results in Study 1, suggested a very low incidence of gender bending in this online world.

Personal experience, perceived attitude and personal attitude

The next hypotheses assessed the direct relationship between the psychological predictors and the reported personal attitude. These analyses tested Hypotheses 5 and 9, which anticipated that personal experience and perceived attitude would predict personal attitude. Personal attitude to sex did demonstrate a significant correlation with personal experience ($r = 0.37, p < .00$), offering support for the Hypothesis 5. However, the variable with the strongest relationship to personal attitude was perceived attitude ($r = 0.53, p < .00$).

The relationship between perceived attitude and personal experience ($r = 0.33, p < .00$) suggested that there may have been some overlap in the variance in personal attitude score explained by these variables. When these two predictors were included in a multiple regression (method: enter), the significant Model 5 ($F(2,8493) = 2400.63, p < .00$) demonstrated a large effect ($R^2 = 36.1\%$), and the effect of perceived attitude on personal attitude was twice as strong as the effect of personal experience (perceived attitude: $\beta = 0.47, t = 52.54, p < .00$; experience of sex: $\beta = 0.26, t = 28.87, p < .00$). This lent support for Hypothesis 9.

An additional interesting finding was that both personal experience and perceived attitude were related to the number of hours account holders spent in the virtual world. Although the relationships were small (Experience: $r = 0.24, p < .00$; Perceived Attitude: $r = 0.28, p < .00$), and this variable was not directly related to personal attitude, the effect of community involvement may have had an indirect influence on the development of a respondent's attitude to sex.

Structural explanations for psychological predictors

The final set of analyses sought to integrate the structural and psychological predictors, to assess how their effects varied in predicting attitude outcomes.

There were two outcome measures that were assessed in this group. The first was pluralistic ignorance. It was hypothesised that structural measures would predict how accurate an individual was in his/her perceptions of the local group's attitudes. The second outcome variable was the direct measure of personal attitude. This was revisited to assess the variation in the effects of the significant structural and psychological predictors from the models in this study.

Network density, network position and pluralistic ignorance

The first model was aimed at testing Hypotheses 10 and 11, which proposed the indirect relationships between structural factors and personal attitudes. These analyses sought to identify the effects of network density and network position effects on pluralistic ignorance.

There was a significant difference observed between the personal and perceived attitude measures. A related-samples t-test showed significance beyond the 0.05 level ($t(612) = -5.99, p < .00$). The 95% confidence interval was (-0.25, -0.13) which did not include 0. This small effect ($d = 0.24$) suggested a pluralistic ignorance outcome. Most respondents had similar attitudes to their network's averages ($M = 1.75, SD = 0.64$), but were less accurate in their predictions of the average attitude ($M = 1.85, SD = 0.34$). Although this figure was only slightly inflated relative to personal-network average concordance, both measures' ranges were the same, suggesting that pluralistic ignorance did generate more extreme predictions of others' beliefs than reported.

Both density and position demonstrated significant relationships with pluralistic ignorance, lending support to Hypotheses 10 and 11. A significant linear regression coefficient provided evidence that the greater the density in the local network, the more accurate the perception of others' attitudes ($F(1,1047) = 209.29, p$

$< .00$). The fewer interconnections in a network, the less accurate perceptions were. This was a large effect ($R^2 = 16.6\%$) in the anticipated direction of association.

Similarly, greater peripherality increased the accuracy of attitude perceptions by 0.17 standard deviations ($F(1,1047) = 31.64, p < .00$). In other words, more central people were less accurate about their networks' attitudes. People on the outskirts of the network were better able to identify the attitudes of the people in the group than those who were deeply integrated into it. Again, this was evidence that this network measure did have an effect on attitude development, but it was in the opposite direction than anticipated. It was interesting to note the significant relationship between gender and network position again. Although these were weak relationships, they suggested that there may have been a gender effect on the pluralistic ignorance outcome as females were more accurate about their Friends' attitudes than males.

There was a moderate relationship between network position and network density ($r = 0.41, p < .00$) and so both variables were incorporated into Model 6 to assess if the density of the network affected the degree of pluralistic ignorance a central or peripheral actor experienced. The significant model ($F(2,1046), p < .00$) indicated that the more central an actor was in a dense network, the less accurate were the perceptions about others' beliefs (see Table 19). In other words, being at the centre of a tightly knit group increased the likelihood of inaccurately predicting Friends' attitudes to sex in Second Life. Peripheral actors were better able to accurately predict others' attitudes when they belonged to denser networks. This was a large effect ($R^2 = 26.5\%$).

Table 19
Simple Regression Analysis for Structural Predictors of Pluralistic Ignorance

Model		Constant	β	<i>t</i>
6	<i>Network position</i>	2.31	0.33	11.96
	<i>Network density</i>		-0.51	-18.41
<i>p</i> < .00				

Composite model

Finally, Model 7 was designed to assess the relative predictive power of all the significant variables in this analysis on the personal attitude. As a variation in personal attitude was implicated in the dependent variable in all the models in this analysis (Personal-Network attitude concordance; Personal-Friend attitude concordance; and pluralistic ignorance), this model was a composite of the significant predictors on this variable. It was an exploratory analysis.

Because of the variation between respondents, this model was analysed to take into consideration the multiple levels. In fact, it used a fixed intercept and did not vary at the Friend level because the avatar-respondent gender similarity category did not vary between survey participants.

The relationship between the predictors were described previously, but in brief, there was a moderate correlation between network density and network position, and between personal experience and perceived attitude. Avatar gender concordance did not demonstrate any relationships with the other variables, although online and offline network genders were positively related to network position.

Table 20 displays the estimates for the predictors in this multilevel model in the β column.

Only two variables were statistically significant, and these were the psychological factors that had predicted this outcome measure in Model 5. The first was perceived attitude: the more close Friends were perceived to hold an attitude about sex, the more likely the respondent was to hold that attitude him/herself. Personal experience of sex was also found to be significant: respondents who reported that they had engaged in cybersex were more likely to have a positive attitude towards the activity than people who had not had cybersex. Although network density and network position were not significant predictors in this composite model, their relationships with the indirect, contextual measures of personal attitude should not be overlooked, as they demonstrated how structural features contributed to the development of perceived attitudes.

Table 20
Composite Multilevel Model Analysis of Significant Psychological and Network Variables on Personal Attitude to Sex

Model	β	SE	$e^{\beta} \sigma_e^2$	SE	LogL
-	Constant	2.51	0.01	0.77	0.01 21739.02
N=8447. Model resolved after 2 iteration					
7	Respondent-Friend avatar homophily	NS			
	Network density	NS			
	Network position	NS			
	Personal experience of sex	1.19	0.14		
	Perceived attitude	0.68	0.09		
	Constant	0.03	0.38	0.37 0.05	229.18
N = 124. Model resolved after 1 iteration. NS = Not Significant					
$p < .05$ level					

5.7. Discussion

This thesis aimed to examine how the structural features of the social system in Second Life directly and indirectly influenced the development of community members' thoughts, feelings and actions both independently of and in conjunction with theorised psychological predictors. Study 2 aimed to identify what roles network position, network density and network strength played in predicting attitudes to cybersex in this virtual world and how these variables interacted with the effects of personal experience, interpersonal and normative attributes of relationships and perceptions of Friends' attitudes. The analyses were based on a large, interconnected egocentric network.

The results indicated that there was no direct relationship between two Friends' reported attitudes. However, knowing a respondent's personal experience of cybersex and what s/he perceived Friends to feel about it did predict the personal attitude, and it was here that the structural predictors played important roles in social influence.

These outcomes are discussed in the context of literature in section 5.7.1, referring to how both structural and psychological features were affected by the computer-mediated Internet environment in which the research was set. Specifically, it is argued that Second Life challenged the effectiveness of influence predictors

because it offered few channels for participants to directly or indirectly observe Friends' attitudes put into practice, resulting in greater reliance on perceptions of social norms. These theoretical assertions are described in section 5.7.2.

The chapter continues with a detailed look at the methodological challenges in this study (section 5.7.3) and concludes with a summary of the major findings and the questions raised that are considered in Chapter 6 (section 5.8).

Overview of the analysis

Overall, the results of the analysis supported the hypotheses: variations in personal attitude to online sex were predicted by personal experience of cybersex (Hypothesis 4) and close Friends' attitudes to sex (Hypothesis 9). Network structure and network position predicted perceptions of personal attitudes (Hypotheses 1 and 2) and perceptions of close Friends' attitudes (Hypotheses 10 and 11). There were two areas where the hypotheses outlined in this research were not supported: the amount of agreement two Friends shared in their attitudes was not predicted by network strength, based on the type of communication between two Friends (Hypothesis 3), and on ratings of trust, social comparison and prototypicality (Hypotheses 5, 6 and 7). There was, however, one hypothesised normative effect observed on attitude similarity: two avatars who shared the same gender assignment were more likely to also share attitudes to sex in this virtual world (Hypothesis 8).

This section describes the predictors of personal attitude, of personal-network attitude concordance, and of pluralistic ignorance, and proposes why the network strength measure and the psychological attributions did not predict personal attitudes in this study.

Psychological predictors of personal attitude

Perceived attitude and personal experience were the only variables that demonstrated direct predictive effects on personal attitudes to sex in Second Life. Specifically, the belief that Friends held an attitude was a robust predictor, and was twice as effective as the other direct predictor, personal experience.

This outcome provided evidence for Hypotheses 5 and 6, and offered additional support to Acock & Bengtson's (1980) research, which has emphasised the predictive effect of perceptions on attitude. In this study, the relative power of perceived attitude identified subjective views of the group's social norms, and arguably inspired greater conformity to a projected in-group than the actual attitudes reported by participants. Particularly in this online environment, this was an interesting finding that lent support to SIDE (Spears & Lea, 1994). This result was further supported by the effect of avatar gender similarity, which in this study was identified as an observable signifier of a social identity, on the similarity between Friends' attitudes (Hypothesis 8). This outcome was consistent with Westphal & Bednar's (2005) research that found that as demographic homogeneity between two people increased, false attributions of attitudes decreased.

However, there was no significant direct relationship between avatar gender and personal attitude, only the Personal-Friend attitude concordance outcome; this suggested that other factors were involved in the development of similar attitudes between Friends. Network strength based on communication activity did not have a demonstrable effect on attitude (Hypothesis 3), so any indication that greater self-disclosure on the basis of gender similarity would be unfounded (Dindia & Allen, 1992). An explanation may be that certain avatar genders were more likely to have experienced online sexual activity, which contributed to the observed similarity between them (e.g., McCormick & Leonard, 1997; Wohn, 2009; Cooper *et al.*, 2000). However, this was not the case in this research. Indeed, the absence of a relationship between online or offline genders and experience of sex suggested that neither male nor female avatar-account holders were more or less likely to have had sex. Another explanation may be that greater network centrality – a variable that was related to experience of online sex, attitude to sex and the female gender (online and offline) played a role in similarities between participants' attitudes.

Structural and psychological predictors of Personal-Attitude concordance

Network strength, operationalised on a scale of the type of communication two people interacted in, had no effect on attitude. This contradicted Hypothesis 3,

which proposed that the type of communication between two Friends would predict similar attitudes. In fact, no such observation was made: Friends were as likely to share beliefs about sex if they communicated in public in Second Life, via Instant Message in the virtual world or outside its boundaries, as they were likely not to share.

This was an unanticipated finding; the prediction had been based on the premise outlined by communication network analysts Rogers and Kincaid (1981a) who had found significant outcomes supporting their theory in various environments. Although they had not assessed its effectiveness in computer-mediated communication, it had been anticipated that similar outcomes would be observed.

One explanation is that the duality of computer-mediated communication, as an interaction in a non-physical cyber-space between people who are physically sat at individual terminals, disrupts the processes involved in influence. This has been observed in other influence research when the location under observation is mediated; for example, Petty & Cacioppo (1986) observed differences in persuasion processes when the interaction was mediated, specifically when the content of a message was attended to more so than the peripheral cues. The results documented in this research may identify another instance in which attitudes are held locally (i.e. offline) rather than are situated in the group.

The observed position findings may also have been a result of the intention of the individual: in research that has documented attitude change based on online interaction, participants have actively sought to change their beliefs and used the environment to test out new attitudes (e.g., McKenna & Bargh, 1998). Community members in this virtual world may not have been motivated to change their attitudes about cybersex, and so word of mouth behaviours did not affect their personal beliefs (Brown & Reingen, 1987).

Structural social network analysts would support the outcomes of Hypotheses 3-7, as the influence processes they describe in addition to exposure, like structural equivalence (Burt, 1987), have been demonstrated to be effective in predicting influence without network strength considerations. However, the absence of any

relationship between personal attitude and Friend attitude and the strong effects of perceived attitude on personal attitude described by Hypothesis 6 suggest that there were interpersonal processes involved in influence.

In this research, these interpersonal processes were expected to be the degrees of trust, social comparison and prototypicality that Friends were attributed with. As outlined in Hypotheses 5-7, psychological relationship strength was anticipated to effect the similarity of attitudes to sex between two Friends as attitudes of Friends who were viewed as more trustworthy, as sources of social comparison and more typical of the in-group would be more persuasive. However this was also not supported by the results: Friends who were rated as more trustworthy, for example, were as likely to have the same attitude to sex as those who were rated less trustworthy. Again, it can be argued that participants were not seeking confirmation for attitudes to sex, and therefore others' beliefs had no effect on their own attitudes.

The ineffectiveness of the network or psychological strength measures instead may have emerged because they sought to explain an exposure outcome – i.e. similarity between reported attitudes - where in fact there was none. It would have been interesting to assess the relationship between these strength variables and respondent's perceptions of each Friend rather than the aggregate perceived measure generated in the survey that was used to generate the personal-network attitude concordance and pluralistic ignorance measures, however it was decided that this would have put too much strain on survey respondents (see section 5.7.3 for more). Indeed, Megas (1977) demonstrated in his research that interpersonal cohesion did have a significant relationship with perceived attitude, with the outcome an increasing in willingness to adopt an innovation. Additionally, assessing the amount of communication rather than generic observation of modes of communication between respondents in addition to the degrees of trust, social comparison and prototypicality may have explained attitude similarity effects.

Yet the significant result of the avatar gender similarity and attitude concordance suggested that this observed social identity cue was effective in the online influence process. This result demoted the psychological cues in this online

environment, suggesting that the content primed the gender identity or that psychological attributions of interpersonal and normative influence fell below the effects of avatar physical representation in a possible peripheral cue hierarchy. This result confirmed the assertions outlined by SIDE, suggesting that even in an environment that was designed to promote the development of social capital, the deindividuation of CMC was in effect. Further research is recommended.

In sum, personal attitude to sex was best predicted by normative attributions of in-group attitudes and personal experience; exposure to an attitude had no effect. Structural features did not directly affect the personal attitude, but as described in the next two sections, network density and network position may have contributed to attitude development by affecting the development of perceptions of social norms.

Structural predictors of personal and network concordance

The structural variables in this study had no direct effect on personal attitude; rather, the results demonstrated that they were involved in developing the perceived attitudes that did have a direct effect on personal attitude. In other words, structural features appeared to predict personal attitude by explaining how perceived attitudes were formed.

As hypothesised in H₁, a sub-network's density described the amount of similarity between the personal attitude and the group's attitude. Networks that were more interconnected generated a closer concordance between the two; in other words, it was possible to predict the attitude of an individual by knowing how dense his/her close network was and the average attitude to cybersex in that network. Conversely, it was possible to predict the average attitude in a group of interconnected Friends by identifying an individual's attitude. It was also observed in the results of the Model 6 analysis that group members in tightly knit groups were similar in their reported experiences and in their beliefs – correct or incorrect – about others' attitudes. Both of these outcomes supported Hypothesis 1, describing the network's effect on influence.

However, the latter result could also be explained psychologically: rather than network structures inspiring attitude and behaviour conformity, group members may

have chosen to be Friends with those who they presumed had similar attitudes and who had similar experiences (Foster, 1996). Yet this explanation does not describe why network density was such a strong predictor of attitude similarity; the structural feature described the most unique variance in the group attitude effects.

While the density findings supported existing research, the outcomes of the effects of network position on predictions of Personal-Network attitude concordance contradicted evidence from the social network paradigm. Central actors, anticipated to be individuals who represented the group's norms because of the amount of information they received and transmitted from their highly connected positions in their networks, were less likely to share attitudes with their local groups. Instead, the more integrated an actor became in a network, the less like his/her Friends she/he was. This outcome would have been expected if the actor had been in a loose network, but this finding was consistent even when density was controlled for, observed in the results of Model 6. Instead, the findings suggested the peripheral actors' attitudes were more representative of the group's overall average. The theoretical implications of this outcome are discussed in greater detail in the section beginning on page 201, but briefly, it suggested that central actors' attitudes were confirmed by their direct contacts who had similar views to sex, but that their views diverged from other network members who they were not directly connected to. In other words, there may have been an attitude "buffer" between central actors and the rest of the network that was created by the people in their immediate social circles. More research is recommended to assess the possible gender effects of these results, based on the significant relationship between femaleness and network position.

Structural predictors of pluralistic ignorance

Network density and structure also predicted how accurately the respondents were in their perceptions of their Friends' attitudes. In other words, the belief that one's Friends were more positive about sex than they actually were occurred more often in loose networks, while the belief that Friends were as positive as they reported occurred more often in networks with many interconnections between group

members. This finding corroborated network analytic research, and supported Hypothesis 10.

Different network structures have been found to affect the amount of pluralistic ignorance perpetuated by members of a community. Lyons, Clark, Kashima and Kurtz (2007) argued that this is the result of stereotyping, perpetuated by both the reassertion of similarity with a relationship partner based on the repeated interaction that is facilitated by the dense structure, and by the motivation that community members have to interact with others who will develop an agreeable shared reality. Indeed, dense online networks have encouraged the development of stereotypes of both in-group and out-group members (Williams, 2007), resulting in cyberbalkanisation and confirmation biases.

This result conflicted with Putnam's (2000) proposal, that that the loose networks in online environments do not generate coherent and enunciated social identity between group members. Instead, this finding suggested that assumptions of attitude similarity served to enhance the connectedness that group members felt with one another, and provided a platform on which personal beliefs could be validated as correct and accurate (Correll, 1995; Wojcieszak, 2008). High-density networks in Second Life reduced the amount of pluralistic ignorance observed in groups and helped to form a cohesive online social identity (Westphal & Bednar, 2005).

Again, the position of the actor in the network demonstrated an opposing effect on pluralistic ignorance than was anticipated in Hypothesis 11; central actors' views of their networks were more likely to misrepresent consensus, particularly if they were in dense networks. This effect was not assessed for the direction of the extremity, although it provided support to Foster's (1996) findings that more extreme attributions would be anticipated of groups of generic 'others'. Daugherty and Burger's (1984) work argued that these outcomes resulted from the demotion of the personal attitude in reference to the generalised other, while Foster's (1996) findings suggest that more accurate attributions are made of close friends and significant others; this is an area for future enquiry.

In this research, it appeared that central actors in loose networks, who were more accurate in predicting their local group's attitude to sex than their central cohorts in dense networks, relied more on their own attitudes to inform their perceptions. The loose networks provided little evidence to corroborate or challenge norms because there was less opportunity to activate connections, and so these central individuals arguably projected similarity onto their local groups based on the scant cues in the online environment (Foster, 1996; Wojcieszak, 2008).

Theoretical contributions

This study described the role of structure in predicting the perceptions of attitudes, which in turn predicted the attitudes themselves. This indirect link offered a new explanation for the reason structural accounts of influence have been successful. This process had not been previously defined; rather, structural explanations were described for their topographical properties - like who linked whom and how the pathways around a social system facilitated or obstructed diffusion - rather than for their psychological properties. Even those researchers who have ascribed attributions of 'closeness' to interpersonal relationships in network analysis propose that the effectiveness of network strength is due to the amount of interaction between two actors in a system, or, drawing on Bandura's (1977) research, exposure to the observed or communicated experiences of network-close actors.

This research had three implications for the relationships between psychological and structural features of influence: first, it extended work that has examined the psychological development of perceived attitudes, both on and off the Internet. In this analysis, perceived attitudes demonstrated strong relationships with personal experience. These variables have been co-predictors of personal attitudes in other studies (e.g., O'Driscoll & Ohsako, 1983), but there has been little analysis that has examined the reasons behind it. An explanation that is situated in the interpersonal setting of computer-mediated communication is that the personal experience was believed to be common amongst in-group members because the individual, who was likely to have experienced sex in this environment based on the

large proportion that reported it, had a tendency to conflate him/herself with the other identification members.

The reverse effect has been observed, but in offline situations: perceived in-group members' experiences have been demonstrated to result in personal attitude change in order to maintain the basis of self-categorisation. For example, (Monin, Norton, Cooper, & Hogg, 2004) found that the belief that an in-group member had performed a behaviour caused individuals to change their personal attitudes, even to counter-normative ones in order to remain similar to their reference group. Amongst adolescents, perceptions of friends' sexual behaviour has been found to be such a strong measure of personal attitude that Wilcox and Udry (1984) have proposed that perceived attitudes about sexual activity were erroneous in comparison. This self-projection was a feature that was expected to create even stronger influence outcomes in virtual environments.

A second area where this research extends existing theory, then, was to offer an additional explanation for the development of perceived attitudes: structure. Specifically, this research offered evidence that the development of inaccurate perceptions of attitudes, or pluralistic ignorance, was structural. The anticipated relationship between network density and pluralistic ignorance, in that looser networks contributed to more false perceptions and that interconnected networks generated more accurate perceptions, offered an additional theoretical explanation for online and offline attitudes based on false projections and rumour (Bordia & DiFonzo, 2002). It also presented a variable that may interact with theories about in-group ignorance (O'Gorman, 1988) and rumour transmission (Bordia & DiFonzo, 2002).

A surprising finding, however, was that the central actors were less accurate about their local network's beliefs, particularly if they were strongly interconnected. It had been anticipated that more central individuals would have better access to the beliefs of everyone in the group. One explanation for the reversal, proposed in Latané & L'Herrou's (1996) Dynamic Social Impact Theory (DSIT), is that the central actor's first-degree connections were like-minded individuals, but that they

acted as filters for content that did not match consistent beliefs. Thus, the discrepancy between what the best integrated group members believed was the average and what was actually observed to be the average was based on his/her ignorance of the different types of attitudes held by the less-integrated members of the community s/he was indirectly connected with. DSIT therefore also offers a theoretical explanation for why peripheral actors may best represent the attitudes of their communities, and why, as Burt (1999) argued, the most central actors in a network may not be opinion leaders.

Another explanation arises from the online literature: the most central actor may have over-represented his or her own beliefs because s/he perceived close Friends as more similar than they actually are. This follows a different process than described above: because the scale in this study sought the aggregated beliefs of the Friends whom the respondent rated as very close, this network member may have attributed similarity because of the virtual context. More central individuals were account holders who spent more time in the virtual world, and so they may have activated the connections with these nominated avatars more frequently. As explored in Chapters 2 and 4, increased interaction in online communities appeared to result in more attributions of similarity, although as evidenced in this study, this did not result in actual attitude concordance.

Indeed, the outcomes of this research further challenged Rogers' and Kincaid's (1981a) communication network analysis. As in Study 1, there was little evidence for the effect of the amount and type of interaction two account holders had in the virtual world on influence. Yet the absence of an effect in this case continued to support the research that disputed exposure theories: amount of communication between two account holders in this virtual world did not predict how similar they were in their beliefs about sexual activity. The attitude that was measured was about an intimate manifestation, and this may have had an effect on how often and in what context interpersonal information was transmitted, but it remained that the other predictors – both psychological and structural - demonstrated much stronger and more significant results than those predicted by basic network analysis.

Methodological considerations

There were several methodological improvements in this study from the research reported in Study 1. First, the trust-credibility attribution scale was developed. These complementary constructs were integrated to enhance the reliability of the measure, to ensure that the same psychological attributions were not conflated, and to reduce the time commitment required of participants.

Second, this study extended the findings of Study 1 by measuring a behavioural network strength attribute, asking participants to identify their actual experiences in communicating with Friends, rather than asking for the reported frequency of interaction or the likelihood it would occur. These improvements ensured that the methodology implemented in Study 2 was robust. However, some considerations remained.

First, the attitudes that were measured were oriented around the intentions to engage with the behaviour. Second, the network, although large, remained egocentric, which had consequences for the connectivity between community members and the amount of data collected about each avatar in the sample. Third, despite the adaptations put in place to the survey, there remained substantial dropout during data collection. These are outlined below.

Measuring attitudes

The attitude measure in this research was a composite of three questions that sought to understand how respondents felt about engaging in online sex. The items were explicitly oriented in a risk ontology because this problematised the behaviour and created a controversial focus around which the attitude was situated. This could have had implications for the findings because it focussed on the intention to engage with sexual activity rather than identifying general affective associations. Although this is often the purpose of attitude measurement (Tanur, 1992), it allied it with experience more than affect. However, instruments that have been designed to measure perceptions of sexual activity have focussed on expectation outcomes (e.g., Goodson, McCormick, & Evans, 2000), and this has even been the case when

seeking attitudes and perceptions of norms from people without direct experience (Toohey, 2007; Daneback, Cooper, & Mansson, 2005).

The explicit association between the behaviour and the attitude measure may have explained the close relationship between attitude and experience. However, the observed association between perceived attitude and the structural variables and the reported attitude variable suggested that this experiential view may not have had as important an effect as may have been implied.

There is evidence from the results that this was the case. The risk-orientation of the measure would have been expected to have the greatest effect with the psychological interpersonal and normative facets of influence had the experience aspect been salient; instead, the absence of any effect indicated that the construction of the attitude variable was an appropriate measure for this study.

In future it would be interesting to test the effects of the structural and psychological variables on a generic affective construct.

Egocentric networks and network measures

The egocentric networks that were described in this study generated a partial representation of the whole social system. Although Granovetter (1976) proposed that this is a consequence of measuring large populations, it nonetheless had implications for the precision of structural descriptives. In this research, corrections were put into place when calculating network position (e.g., using the robust in-degree centrality measure) and network density (e.g., measuring the interconnectedness of sub-networks), yet the absence of links through non-response, participant opt-out or because a survey respondent chose not to identify a Friend still reduced the exactness of these descriptors.

This meant that the structural results of this analysis (specifically, networks density and network position) might have been affected by measurement holes. However, with the exception of the reversal of the expected position effects, the outcomes supported the existing literature, demonstrating that Costenbader's & Valente's (2003) proposed adaptations of existing network measures for low-

response populations were effective. Indeed, the centrality outcomes were unlikely to have been impacted by the partiality of this egocentric network; had the structural variables been compromised, we would have anticipated the predictive quality to be absent, rather than observing consistent trends, albeit in a direction that was not hypothesised.

In contrast, the bi-component subgroups likely excluded some of the avatars who would have been included if the whole network was captured because their links would not have met the criteria for inclusion even if they had been measured. This would have had an impact on the density and makeup of these groups. Yet, this analysis identified clusters relative to the sample collected, seeking to understand the process of influence relative to the links that were observed. Kossinets (2006) argued that implementing boundaries in any network analyses has the effect of discarding the potentially influential connections that fall outside the structures, but this is a feature of the process of network analysis that is consistent across research. Indeed, Robins, Pattison and Woolcock (2004) explained that setting boundaries is a practical and pragmatic solution when dealing with large populations. Analysts must accept that the construction of groups based on links generates results that are unable to fully explain phenomena because of the potential effects of the unmeasured variance from outside the bounded area.

Another issue that arose because of the egocentricity of this research was that only the structural measures could be applied to every individual in the analyses. Each avatar was assigned his/her centrality and density (if included in the sub-network population) because each survey respondent generated the content in his/her responses to the name generator that was used to calculate this information. However, the remaining content, including demographics, community involvement, network strength, the psychological measures of strength, experiences of sex and the attitudes variables, were subjective, from the point of view of the respondent. This affected the development of new variables dependent on the average network attitudes, for example, and the amount of information available in some of the analytic routines. The measure of similarity between the ego's personal attitude and his/her Friend's personal attitude was therefore dependent on the Friend being a

survey respondent as well. Additionally, in some of the sub-networks, there were few respondents, causing the sample sizes in the analyses to fluctuate. To address this issue, routines that would have resulted in very small Ns had they been conducted within the sub-network population were extended to the whole network, where applicable. For example, the analyses that assessed the effects of network and psychological strengths on the similarity of attitudes between a respondent and his/her Friend considered the whole population of Study 2.

A solution would have been to collect more information about Friend connections than was asked for. Asking each respondent to detail the perceptions of each sub-selected avatar's attitude to sex rather than an aggregate measure would have generated the opportunity to examine further questions about the details of what contributed to perceived attitudes (Burt, 1987; Robins, Pattison, & Woolcock, 2004; Frank & Snijders, 1994), but this and similar measurement additions would have added several more questions to the survey that may have resulted in more dropout.

Survey dropout

The final methodological issue that arose was the degree of dropout in the Study 2 survey. Echoing the issues in Study 1, there was a substantial decrease over the length of the survey of complete responses, despite the extensive amendments to that tool. For example, in Study 1, questions defining the nature of each relationship (e.g., the level of Trust, Credibility, Social Comparison and Prototypicality) were asked about every avatar a respondent listed. In Study 2, this process was reduced twofold: first, the social network strength questions, which defined the reported network closeness between pairs based on communication mode interactions, were transformed from Likert scale responses into binary yes/no radio buttons. The question wording was changed from, "How often do you...," or, "How close is ..." to, "Please select those avatars you are likely to...".

This format change streamlined the respondents' answering time, reducing their workload. Further, re-wording the questions situated the network strength measure outside the amount of time a respondent or the avatars on his or her list spent inside Second Life. This may have affected closeness measures in the original

survey, as the Study 1 Likert scale response options required respondents and the avatars on their calling card lists to visit Second Life at least once per week in order for pairs to be graded as ‘close’.

While changing the question format and reducing the number of Friends rated during the bulk of the study resulted in a loss of information about the nature of the relationships in the Second Life social network, the time cost for the respondent was dramatically reduced. The greatest number of Likert scale answers a respondent had to provide in the relationship-based questions of Study 2 was 90 (nine questions x 10 avatars), a reduction of over 500 answers.

Yet, only 17.4% of the sample who were approached for participation, and 58.7% of the 1,251 people who clicked the survey link completed the entire survey. Although Friedkin (1991) argues that this response rate is common when conducting social network sociometric surveys, had the data collection stopped after the network strength section, the completion rate would have been higher.

The substantive effect of this drop out was a reduction in the number of responses for these relationship measures, which was statistically compensated for in the analyses, as described above. The results, however, may have only represented the beliefs of the most persistent participants. A more theoretical concern remained: how to generate online sociometric surveys that captured complete information from as many participants as possible. This issue is discussed in other accounts and is not the subject of this research (cf., Kadushin, 2005; Kadushin, 2003).

Both the structural and the survey dropout issues described in this section could be resolved by using a different technique for data collection. The next chapter details a study that integrated the content generated in Study 2, but with a network map automatically extracted from the servers of Second Life.

5.8. Further Questions and Conclusions

Study 2 identified how interpersonal, normative and structural predictors of influence worked in tandem to influence the development of personal attitudes. Structural descriptives, like network density and network position, offered insight

into why and how perceived attitudes developed among this population. This indirect influence was contextual, situating the development of perceptions of group norms in the interpersonal makeup of interaction clusters. Loosely connected groups were subject to increases in false beliefs about consensus, a process which has implications for virtual communities in general, as they are situated in transient and loose environments. Attributions of attitudes in these spaces implicated the offline personal experience and, in tandem with apparent similarities with other group members, helped to establish the belief that others confirmed one's own ideas.

Additionally, network integration in online environments generated greater inaccuracies about others' actual attitudes: the most popular people were the least representative of their groups and had the greatest disparity between what they thought others believed and what others actually did believe. This inspires research questions outlining the roles of opinion leaders in virtual environments. Indeed, online interaction encourages this outcome because the leanness enforces attributions of similarity when there may not be any basis for this. However, the false normative constructions arguably maintained the community in the face of the challenges to its existence.

This study has proposed that attitude development in the virtual environment was both a psychological and a structural process. It implicated the degree to which the community members negotiated their attitudes depending on the formation of their groups and their positions within them. Importantly and uniquely, it was found that network structures generated normative perceptions that had an influence on attitude outcomes. It also demonstrated that neither psychological nor structural features were more or less important in influence, rather that they worked independently and in tandem in ways that offered insight into the psychological meanings of group formations, and the structural meanings of attitudes.

Accurately measuring attitudes presents challenges to researchers even in offline environments, but in online communities, attitudes are often less evident. In contrast, the study of observable behaviours in online environments generates greater insight into the interactions between the structural and psychological features of

influence because these spaces, in addition to being places where actions are the basis of interaction, allow researchers to accurately capture behaviour information, and information that provides descriptions to explain why these features may vary.

This is basis of the analysis described in Chapter 6.

6. Social Network and Social Psychological Predictors of Innovation Diffusion in Second Life

This thesis has already explored how influence in online communities is both social and networked: Chapter 4 sought to understand the interpersonal and normative features of social influence associated with measures of network strength; Chapter 5 described how network structure affected social perceptions, which affected the development of personal attitudes. The aim in this final empirical chapter was to continue to examine psychological and network theories of social influence in an online community by considering the diffusion of a behavioural innovation - voice communication in Second Life - to understand when and how network and psychological features influenced behaviour over time.

There were two objectives. First, this study sought to assess the pattern of adoption through this online community to compare it with traditional notions of this diffusion offline. The results of the analysis identified periods of rapid acceleration of new voice consumers and rapid deceleration of the rate in adoption, but unlike much of the research on the spread of new behaviours through populations, the diffusion of voice through Second Life demonstrated uncharacteristic acceleration and deceleration patterns.

Second, the study sought to describe the variation in voice adoption as a function of network and psychological predictors. It documented the network and the psychological features that increased the likelihood voice adoption would occur and identified when in the diffusion process each emerged as more important predictors of uptake. The study focussed on personal attitudes, perceptions of behaviour, the strength of the relationship between Friends, exposure to the innovation from a Friend who adopted the month before or at the same time, the relative position in the network of the adopter and his/her Friends, the point at which adoption occurred in the diffusion process and whether adoption in the network at that time was fast or slow.

The results suggested that structural and psychological processes affected influence differently during periods of slow and rapid adoption. It was proposed that these fluctuations were associated with how the content of the innovation was transformed from a new phenomenon with unknown social risks into a legitimate behaviour.

The analysis benefited from one of the unique assets of the Internet for studying social behaviour: it was possible to accurately track the adoption of the voice service through Second Life because the uptake of the innovation was recorded in the database at the time it occurred. Thus actual behaviour was collected that could test theories that have in the past relied on data gathered via self-report or observation.

Further, the adoption behaviour was situated in an accurate representation of the social connections in this virtual community, allowing for robust assessments of the network features theorised to predict influence outcomes. Using information from the Linden Lab servers, a whole network was recorded that described who was a Friend with whom, thus addressing a major methodological shortcoming described in Study 2. In other words, it was possible to accurately identify when a community member first adopted voice, who of the people s/he was s/he was connected with had already adopted and who adopted later, in order to assess the features that predicted the uptake and spread of voice.

This chapter begins by introducing the voice service (section 6.1). Section 6.2 outlines the hypothesised structural and psychological predictors of behaviour adoption in three proposed stages of the innovation's diffusion through Second Life. The hypotheses are presented in section 6.3.

This study assessed the relationships of 47,643 Second Life avatars using an automated data extraction technique. The criteria for selection of this population and details of the method used to acquire voice use information are outlined in section 6.4. This section also describes the development of the instrument that measured the attitudes and perceptions of 1,047 members of this sample. The analytic processes used to test the hypotheses are outlined in section 6.5. Finally, the results are

presented in section 6.6 and are discussed in section 6.7 within the contexts of their theoretical contributions and methodological considerations. Finally, this chapter concludes by presenting further questions for future research (section 6.8).

6.1. Voice in Second Life

The behavioural innovation considered in this study was a new communication option made available to the Second Life community in August 2007³⁴. It was an interesting innovation because it was a new feature that was relevant to the whole community and was part of the integrated toolkit supplied by Linden Lab. It was also an asset for this research, as its use was recorded in a database and represented an outcome measure that reflected actual behaviour rather than self-reported behaviour.

The voice service was an audio speech tool that offered Second Life account holders the opportunity to speak with one another in real-time via the Internet, as when using a telephone or another Voice over Internet Protocol service. It did not replace text-based communication, but was an addition that Linden Lab offered to the existing interaction facilities. It functioned in the same way as text-based communication: account holders were able to interact with other voice users in public in groups, in private with groups, or in private on a one-to-one basis.

Voice was an integrated tool that could only be accessed by community members whilst logged into the application. To use it, participants were required to open an account with the third-party solution provider Vivox using their Second Life avatar names via a sign-up process that took place in the virtual world³⁵. They were

³⁴ Voice communication was not available in every area in Second Life at launch. Linden Lab rolled out the facility over six weeks to ensure that the service did not affect the stability of their virtual world application. Second Life account holders had been able to test the voice facility since June 2007 on the pre-release version of the Second Life client. This ‘Beta Grid’ was a separate version of Second Life on which new features were tried out by a smaller audience within the secured site.

³⁵ When it was officially released, participants were required to opt-in to the voice service: every account holder who logged into Second Life after 2 August 2007 received an automatic notice that the service has been added to the latest release of the Second Life application, including information

also required to purchase a headset with a microphone attachment. Other Residents were alerted that an avatar had installed voice by the presence of a white dot above the voice users' head (see Fig. 11A). When an avatar was engaged in public voice chat, the white dot icon was replaced by an animated green icon, alerting others that s/he was speaking (see Fig. 11B). Account holders' voices were not altered in any way.

The next section outlines the hypothesised pattern that adoption was expected to take as the voice service diffused through the community over a nine-month period.

6.2. *Predictors of Voice*

Adoption in Second Life

In this study, it was anticipated that the voice service would diffuse through the Second Life population as a function of structural and psychological predictors. It was hypothesised that the spread of the innovation would follow periods of slow and rapid uptake, like that described by network researchers, and that psychological and network predictors would contribute more or less explanation for uptake at these times. This section first describes the pattern the voice service diffusion was proposed to take, and then identifies which predictors would plain the variance at each period in the event.

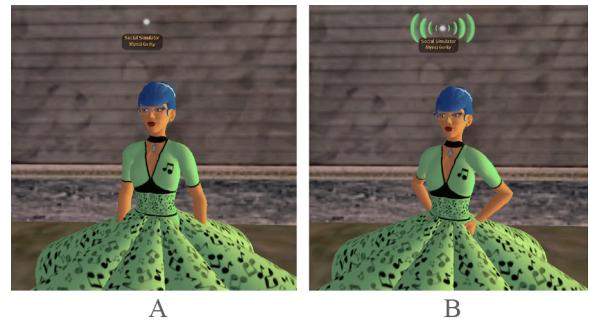


Figure 11. A Second Life avatar with an active voice channel: silent (A) and in speech (B)

The S-curve and diffusions of interdependent innovations

Social network analysts describe the uptake of an innovation over time as a diffusion event. Soule & Strang (1998) defined diffusion as the flow of contagions, mimicry, social learning and other dissemination from source to adopter through communication and influence. This interpersonal process, driven by social

about how to activate it. If users chose not to activate it at that time, they were able to activate it later by editing their account settings.

interaction between ties (Coleman, Katz, & Menzel, 1957; Rogers, 1995) has been used to describe how practices, ideas and innovations spread through social networks. It has been used to explain how phenomena are passed from one person to another through a social system, predicting the anticipated trajectories of commercial products, political participation, international trade, pedagogical practices and the spread of infectious disease.

Innovations that diffuse through networks as a function of social connectivity take a logistic S-shape, which deNooy and his colleagues (2005) describe as characteristic of a chain reaction. Fig. 12 represents a typical diffusion event. Cumulative uptake begins slowly and then increases rapidly after achieving what Valente (1996), Markus (1987) and Oliver and Marwell (2001) describe as critical mass. Critical mass is a point at which innovation adoption becomes self-sustaining and self-perpetuating; the total numbers of people in a system who have already adopted are sufficient to maintain the innovation, even if no one else adopts after. However, it is likely that an innovation will continue to diffuse after critical mass has been achieved, demonstrating rapid uptake for a short time until the population is saturated and the rate of new adoption decelerates.

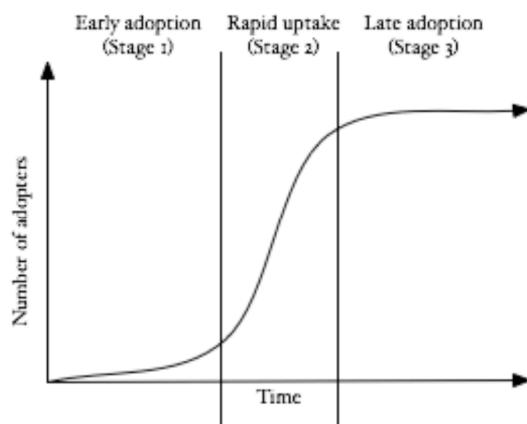


Figure 12. Diffusion curve of cumulative adoption over time with proposed 3-Stage model of early adoption, rapid uptake and late adoption. Adapted from *The Diffusion of Innovations*, by E. M. Rogers (1962). New York: Free Press.

Song (2005) proposed that the relative acceleration of adoption earlier in online diffusion events occurs because there is a

This pattern of adoption has been extensively documented in offline research (Rogers, 1962). Studies that have analysed innovation diffusion in online environments have demonstrated similar patterns, although critical mass appears more likely to occur earlier in a diffusion period, with a longer “tail” of slower diffusion after the critical mass has been achieved (e.g., Song, 2005; Anderson & Emmers-Sommers, 2006).

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greater opportunity to spread information about a new practice to more people online than offline via loose networks; the long tail has been described as a result of the permanence of recorded testimonials that may be accessed by anyone at any time.

Another explanation for early rapid uptake was offered by Batorski and Kucharski (2007), who observed a very steep increase in adoption of a new chat system within a synchronous social network platform. They proposed that individuals' thresholds, or the number of people each individual requires to adopt an innovation before s/he does, are lower in cyberspace because the cost of adoption – in terms of time, effort and consequence – is lower relative to the cost of adoption offline. Thresholds, however, are contested constructs; they are only applicable retrospectively and in relation to the specific innovation and social context under observation.

Another explanation for the speed of uptake in an online innovation like that described by Batorski and Kucharski (2007) is that the innovation diffused quickly because it was intended to enhance the communication options between existing connections, and thus encouraged multiple people to adopt at the same time. This was a feature of the innovation that they observed that was shared with the voice service observed in this analysis, and the pattern of voice uptake in Second Life was expected to result in a similar curve.

Lazarsfeld, Berelson and Gaudet (1948) describe innovations like the new communication system in Batorski *et al*'s research and the Second Life voice service as interdependent: they require other people to adopt in order for the full benefits of the new technology to be felt by everyone in a system. Other examples of interdependent innovations include the fax machine, the telephone, email and the Internet. Analyses of each of these have suggested that they are likely to achieve critical mass more quickly than non-interdependent innovations.

Communication scholars who have followed the pathways of interdependent innovations have focussed on this pattern of early and rapid uptake, arguing that early adopters lay the foundations for subsequent rapid adoption, and that later adoption provides the motivation for earlier adopters to continue to use the service

(Monge *et al.*, 1998). Although these innovations do achieve early critical mass, they are susceptible to rapid drop-out and stagnation (Markus, 1987).

In this research, it was proposed that the voice service would follow the pattern of adoption described by diffusion theorists, and would follow a period of early, rapid uptake.

H1: There will be periods of slow and rapid uptake during the diffusion of the voice service through the Second Life community that will reflect the logistic S-curve.

Proposed stages of adoption and structural and psychological predictors in each

In addition to identifying patterns of uptake by the speed of adoption, diffusion researchers have classified different stages in the S-curve to explain the fluctuations in the speed of uptake, describing the interpersonal processes that occur at different times in an adoption period. There have been many classifications, based on adopter characteristics (Rogers, 1995), cumulative adoption (Katz, 1999) and uptake rates (Valente, 1996). This research followed the stages originally outlined by Ryan and Gross' (1943) research, proposing three periods of adoption characterised by different speeds of uptake: slow at early adoption; rapid uptake; and slow at late adoption (see Fig. 12). It was anticipated that adoption during the different stages would be influenced in different ways by structural and psychological phenomena.

Stage 1: Early adoption

Ryan and Gross (1943) described the first stage in a diffusion event as a time when an innovation was introduced to a community from outside. It was proposed that the slow rate of uptake during this stage reflected the transformation of an innovation's normative content from something that had social risk to something with legitimacy (Strang & Soule, 1998; Nyblom, Borgatti, Roslakka, & Salo, 2003; Lopes, 1999a).

Structural predictors of uptake at Stage 1

Structurally, the speed of adoption early in the diffusion event was expected to be reflected by the positions of people who adopted at this time. Weenig & Midden (1991) emphasised the responsibility of weak ties for bringing an innovation into a group, and the responsibility of strong ties for its diffusion once it was there. The first adopters of the voice innovation were anticipated to be peripheral participants in the Second Life network. These individuals were expected to be the earliest adopters because they have more weak tie relationships and connections with outside networks (Rogers, 1995). Granovetter (1973) theorised that they do not belong to any one group.

Early adopters have also tended to be peripheral community members because adoption of a new innovation has been expected to carry personal structural risk: the individual who adopts early may generate more connections with other members of the group because the innovation is perceived as valuable, resulting in a more central position relative to where s/he was before uptake, or s/he may lose connections because the innovation is considered too radical, resulting in a more peripheral or isolated position relative to where s/he was prior to uptake.

Psychological predictors of uptake at Stage 1

Psychologically, voice was expected to be a welcome addition to many Second Life account holders. Voice communication in online environments has been found to make interaction less ‘lean’ and encourages the development of psychological trust and credibility because participants are better able to identify speakers (Utz, 2000; Williams, Kaplan, & Xiong, 2007). Other reported benefits to the introduction of voice services to online communities include the speed of interaction, more accurate transmission of meanings, increased bridging and bonding social capital through the extension of social interaction, improved sociability and the ability to engage in more complex collaborative tasks (Williams *et al.*, 2007). It was anticipated that adoption would occur in Stage 1 because it would be viewed as useful, a technological advance and a technology that added value (Davis, 1989).

However, it was also expected that for some people, the new innovation would bring social uncertainty, as the implications for the community and for the

individual would be unknown. During these times, Nyblom *et al* (2003) and Deroian (2002) found that interpersonal interaction and social observation increased, as community members sought the opinions of close others to establish an innovation's social legitimacy. Indeed, it was observed that voice inspired substantial discussion on official and unofficial community websites from the time of its initial announcement to after it was launched.

In these debates, participants who expressed positive attitudes about the service argued that voice would make the virtual world platform more user-friendly and accessible to people who did not wish to text-type all communication. However, others expressed concerns about the social implications of the service. For example, several people reported that they were unable to hear or speak, and that their interaction would remain limited to the keyboard. They were apprehensive that they would be excluded from the social communication they had enjoyed when text-based discussion was universal. Additionally, community members with impaired speech, such as people with cerebral palsy, post-stroke or other neurological conditions, expressed concerns that their physical disabilities would become apparent with voice technologies³⁶. It was anticipated that participants with physical, environmental or technological limitations would not adopt voice at this time.

Some community members raised concerns about the effect a new voice channel would have on the division between online and offline identity. Arguably, the voice service challenged the notion of the explicit construction of the online, or mediated, self described in Chapter 2. As a 'rich' resource of information, offline content that was perceived to be under the control of the account holder when communication was text-based – gender, geo-location, age and other demographic features – was automatically disclosed through the microphone³⁷. Text has been

³⁶ The voice service did not have a voice-to-text feature built-in that would facilitate the needs of people who could not communicate via voice.

³⁷ There is evidence from early research into text-based communication that even this lean communication channel exposed demographic attributes (e.g., Yates, 2000). Although voice was perceived as a threat to some Second Life users, the Internet medium is not neutral, and participants

observed to allow for a multiplicity of identity, while face to face and voice to voice communication challenged the presentation of a persistent and consistent constructed identity as it demanded prolonged, continuous social performance (Rettie, 2007). It was anticipated that some Second Life participants would have negative attitudes about the service for this reason and would not adopt voice during this period.

Second Life community members who did not express an attitude at this time were expected to be influenced by Friends whom they regarded as close. Rosnow (1991) and Coleman and his colleagues (1957) found that close contacts were more persuasive during times of social uncertainty than those who were not close. Also, as the voice service was an innovation that demanded participation by at least two people to function, it was anticipated that the communicated and observed experiences of close Friends would be important to the decision to adopt or not.

H2: Second Life community members who adopted the voice service during the early, slow stage of the diffusion would hold more peripheral positions than their Friends. They would have more positive attitudes to the service. It was proposed that they would adopt if close Friends had also adopted or if they believed they had.

Stage 2: Rapid uptake

The second stage described by Ryan and Gross (1943) was characterised by period of rapid uptake. During this time, the majority of community members were expected to adopt the innovation. It was during this stage that critical mass was expected to be achieved (Oliver & Marwell, 2001; Thorn & Connolly, 1987). Adoption was anticipated to be propelled by network effects, particularly by the exposure to the innovation by Friends who had already adopted.

Structural predictors of uptake at Stage 2

Structurally, although exposure had not been included in Study 2 as a predictor, it was anticipated to have a predictive effect in Study 3 and at this time in

were likely giving up more information about themselves than they thought (Postmes & Baym, 2005). The social cues described by SIDE arguably operate on this level (Spears & Lea, 1994).

particular, because voice was an interdependent innovation. Markus (1987) found that the success of these kinds of innovations depended on the perceived amount of uptake, and that as both an observable activity and a communication system that connected people, it was proposed that the more people an individual was connected with who had already adopted the voice service, and the more an individual perceived his/her Friends were voice users, the more likely it would be that s/he would also adopt it.

Adopters at this time were also anticipated to hold more central positions than their Friends. Kerckhoff, Back and Miller (1965) observed that innovation uptake increased rapidly when people who were more central adopted. As briefly outlined in Chapter 5, they argued that this played two social roles: first, it exposed more people to the innovation because of their embedded positions in the network. Indeed, it has been observed that diffusion curves that follow innovations that originate from peripheral and from central sources are different; deNooy and his colleagues (2005) described a steeper, earlier curve when central actors are the sources.

Second, central actors' adoption signalled the acceptability of the innovation to their network of direct contacts. Rogers (1995) identified the central position as one that holds a normative currency; central individuals have been found to be more conservative, but they have been described as opinion leaders (Weiman, 1991). The evidence that they represent the group's norms was challenged in Study 2, but the perceptions of innovation legitimacy by others in the network because a central actor has adopted have been observed in several studies (Freeman, 1978).

Psychological predictors of voice at Stage 2

Psychologically, it was anticipated that Second Life account holders would have more positive attitudes about the innovation as the adoption accelerated. This was expected in part as a result of continued communication with close Friends about their experiences with the innovation. Fuller, Hardin and Scott (2007) described personal positive attitudes as a driver towards adoption of virtual world technologies, but that a group's overall valence towards the technology influenced an individual's willingness to adopt.

Further, the perceived usefulness of the technology was expected to increase as a result of the potential number of people with whom an adopter could connect (Mahler & Rogers, 1999). Specifically, the exposure to the innovation was expected to result in a decrease in the perception of social risk associated with adoption. Arguably, as more people adopted, the social risk emerged not from adopting too early, but adopting too late or not at all (Rogers, 1995). As an interdependent innovation, the social pressure was arguably greater with voice, as participation in the community would be dependent on the use of voice with other in-group members.

In sum, it was proposed that, at times of rapid uptake, an adopter would be a person whose Friends, in general, would have already adopted. S/he would believe they had already adopted, and would be a more peripheral actor than those Friends who had. S/he would have a positive attitude towards the innovation and have a strong relationship with Friends who had adopted. However, it was anticipated that the structural predictors (network position and exposure) would be stronger predictors of uptake during this stage than the psychological variables.

H3: Second Life community members who adopted the voice service during the rapid stage of the diffusion would hold more central positions than their Friends. They would adopt at the same time or soon after their close Friends had adopted, or if they believed they had. They would have positive attitudes to the service.

Stage 3: Late adoption

Ryan and Gross (1943) described the last stage in a diffusion event as a period of deceleration, after the majority had already adopted. Rogers (1962) characterised the adopters during this time as laggards, describing them as resistant to the innovation, but who adopted an innovation on the basis of a trusted advisor or personal friend. This was anticipated to be the strongest predictor at this time.

Structural predictors of uptake at Stage 3

Structurally, new adopters at this time were expected to be peripheral actors. Although the community members who hold these positions in groups may be more cosmopolitan because they may have a variety of connections with people in many different groups, they may also simply be isolated (Rogers, 1995), with few connections, and may have experienced less social risk at not adopting in the rapid uptake stage than others who were better connected in the network.

Psychological predictors of uptake at Stage 3

Psychologically, Nyblom *et al* (2003) observed that actors who adopted latest in diffusion events ascribed a greater cost to adopting. They were aware of the social consequences of the innovation, having observed the experiences of others in the community. In Second Life, it was theorised that these resistant account holders would adopt only because a close Friend adopted at this time or had adopted towards the end of the diffusion period as well.

H4: Second Life community members who adopted the voice service during the final, slow stage of the diffusion event would hold more peripheral positions than their Friends, and would adopt on the basis of the strength of relationship Friends who had already adopted, and at the same time or immediately after a Friend who had already adopted.

6.3. Hypotheses

This review results in the following hypotheses:

H1: There will be periods of slow and rapid uptake during the diffusion of the voice service through the Second Life community that will reflect the logistic S-curve.

H2: Second Life community members who adopted the voice service during the early, slow stage of the diffusion would hold more peripheral positions than their Friends. They would have more positive attitudes to the service. It was proposed that they would adopt if close Friends had also adopted or if they believed they had.

H3: Second Life community members who adopted the voice service during the rapid stage of the diffusion would hold more central positions than their Friends. They would adopt at the same time or soon after their close Friends had adopted, or if they believed they had. They would have positive attitudes to the service.

H4: Second Life community members who adopted the voice service during the final, slow stage of the diffusion event would hold more peripheral positions than their Friends, and would adopt on the basis of the strength of relationship Friends who had already adopted, and at the same time or immediately after a Friend who had already adopted.

6.4. Method

The aim of Study 3 was to explore how psychological and network features contributed to the diffusion of an innovation over time. It addressed this question and the methodological concerns of the partial networks collected in previous studies by following an innovation diffusion process in a 100% whole network and collecting information about personal attitudes, perceived use and exogenous restrictions using an online survey.

The study measured nine time periods of possible adoption (monthly intervals between August 2007 and April 2008), four psychological predictors (personal attitude to the voice service, the perception that Friends used the service, the strength of the relationship between a pair and any reported restriction that compromised an account holder's use of the service) and three network predictors (two levels of network exposure, i.e. adoption by a Friend in the month prior to the one under scrutiny and adoption by a Friend in the same month as the one under scrutiny, and relative network position, i.e. whether or not the adopter was more embedded in the network than the Friend). As was argued in the Introduction to this chapter, these structural, psychological and interpersonal attributes were expected to predict the pathways along which voice spread through the online community over time.

To measure these variables, three separate data collection strategies were devised:

- Voice adoption data was recorded at monthly intervals and captured from the digital servers of Vivox, a third-party solution provider who maintained the Second Life voice service. This information was attained for all actors in the Study 3 sample;
- Network data was extracted from the Second Life database and used to generate a 100% whole network. This technique ensured that no relationships were absent as a function of the snowball sampling techniques used in the previous studies. The result was a complete two-degree network of Study 2's Friends that was used to describe connectivity, strength of relationship, position in the network relative to a Friend and exposure to the innovation;
- An online survey established attitudes towards the voice service, perceptions that Friends used it, and any restrictions that prevented the account holder from using the service. This information was attained for some of the Study 3 sample.

Figure 13 describes the timeline of each collection period for the Study 3 sample.

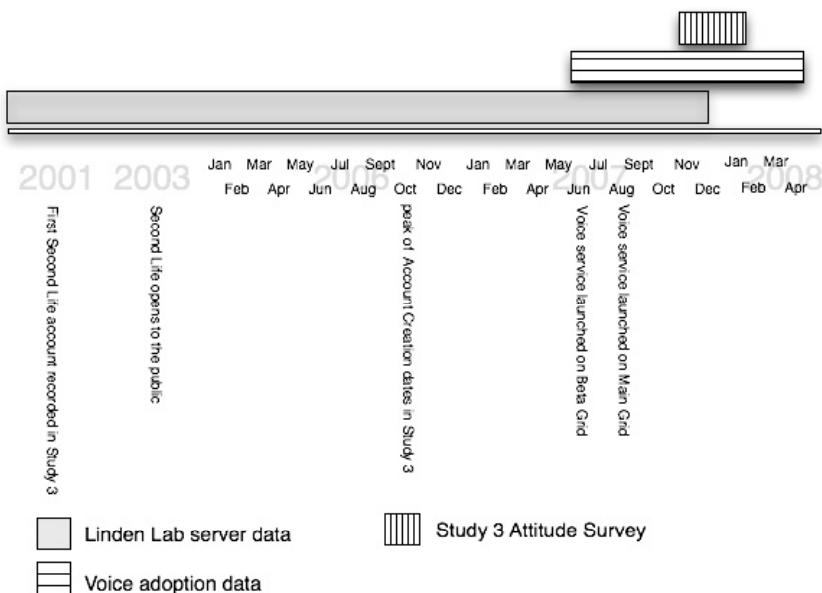


Figure 13. Study 3 data collection timeline by instrument

Participants and procedure

In February 2007, the primary investigator approached Linden Lab with a request to access data collected about their 6,860,473 customers³⁸ from their Second Life servers. Virtual community servers retain information about customer accounts, including demographic and other offline data, in-world activities, movements and self-declared group associations. Such data is guarded by online community companies as it includes sensitive commercial and private content. To protect the company and the research, a Non-Disclosure Agreement was established between the primary researcher and Linden Lab for the duration of this research³⁹. A final dataset was delivered by Linden Lab in December 2007 and included information about all accounts created since 2001⁴⁰.

The Second Life voice service was developed and maintained by Vivox, a third-party commercial company that offered voice solutions to online communities. This research benefited from their relationship with Linden Lab to access instances when new voice accounts were generated from the Vivox database between July 2006-April 2008. This data access fell under the Linden Lab Non-Disclosure Agreement.

³⁸ Taken from <https://blogs.secondlife.com/community/features/blog/2008/02/22/key-economic-metrics-through-january-2008>

³⁹ In return for data, the primary researcher was retained by the company for six months from November 2007-April 2008 to provide network analytic intelligence for their community team. The content of this internal work focussed specifically on the diffusion of the new voice service, a project proposed by the primary investigator in accordance with the PhD thesis. In addition to the analysis that fell within this remit, other reports were developed at the request of the company using the social network connectivity data generated for the PhD that benefited internal and external projects. The content of these other reports is not included in this thesis, but outcomes relevant to the specific PhD research questions are reported in the Results section.

⁴⁰ Although the virtual world was not opened to the public until 2003, Linden Lab employees created their own avatar accounts as early as 2001. The application was released to a limited number of non-employees in 2002 in order to test the platform before its general release.

Study 3 sample

Figure 6 on page 67 depicted how the avatars in the Study 3 sample were identified. There were 47,643 avatars that were included in this sample, who had a total of 86,629 connections. 1,047 avatars provided valid responses to the online survey. As Table 1 in section 3.1.2 outlined, almost 90% of participants from the Study 2 sample were included in Study 3 and 76.0% of actors in Study 1 were included in Study 3. Additionally, the Study 3 sample included the network connections of Study 2 respondents' Friends that had not been listed, plus the full network connections for all Friends of Friends. Avatars that were not included in Study 3 from the previous studies did not meet the criteria established for selection.

Criteria for Selection: Study 3 sample

The Linden Lab data provided information about recorded Friendships between active Second Life account holders, the permissions granted to each Friend⁴¹ and demographic and community involvement attributes⁴² of each avatar in the sample. Active account holders were defined as Residents who had logged into the service at least once within the previous six months and had been in-world for at least 60 minutes over that time. In total, using these initial screening criteria at December 2007, there were over 1.5 million unique avatars and over six million relationships between them.

To ensure the continuity of information between Studies 1, 2 and 3 of this thesis, and to make the resulting dataset computationally manageable within the constraints of current technology and the time frame of this research⁴³, the data was substantially further reduced. Avatar names included in the final Study 3 sample

⁴¹ See page 231 for details of this measure.

⁴² Community involvement variables included the date the actor created his/her account and the number of cumulative minutes s/he had spent in the virtual world since the account was created.

⁴³ Access to this data was in conjunction with a consortium of other social network academics who sought to use it for their own research purposes. These analysts offered technological support for the PhD research using a supercomputer at Northwestern University in the USA, but the complexity of the operating system and the data processing required to compute the social relationships between all Second Life account holders would have taken substantial time and travel even with this facility.

were required to be connected within two degrees to the 750 respondents who nominated Friends in Study 2. In other words, Study 3 avatars had to be Friends of Study 2 respondents or Friends of their Friends. This ensured that Friends who had been nominated in Study 2 were represented in the contexts of their own social networks, and that Study 2 respondents' networks were also complete⁴⁴. The aim was to create a more interconnected system than had been observed in the previous two studies. Further relationship degrees outward from the Study 2 respondents were deemed unnecessary as the size of the dataset would quickly become exponentially unmanageable, and the whole network collection method ensured that there was no missing data in the sample retained.

Attitude survey

Recruitment and Sampling

The attitude survey was built using the Qualtrics online survey software with the support of the Community Initiatives and Voice teams at Linden Lab. Members of these teams contributed several questions that aimed to identify specific attributes of the service which were more or less successful, and which product features would compel current non-users to adopt in future. The Linden Lab results are not included in this analysis as they fell outside the remit of the purpose of this study.

Upon opening the survey tool, respondents were welcomed and informed of their rights and obligations. To continue to the questions, participants were asked to enter their full Second Life account (avatar) name as a unique identifier so the responses could be matched with any data collected about them and their relationships specifically for Study 3 or from earlier, in Study 2. In the body of the survey, there were three sections: characteristics of current and intended use, source of referral, perceived Friend use and attitudes towards the voice service. Only the attitude data was included in this analysis. The full text is in Appendix 3-2.

The survey was integrated into the Second Life login screen and appeared in a pop-up window to one in every 200 Residents who logged into the service between

⁴⁴ This approach included Study 2's Friends whom they had not listed in the Study 2 survey.

21 November 2007 - 4 February 2008. From this screen, participants were invited to complete the survey by clicking a link that took them to a secure server where they were able to submit their responses. Participants were also recruited via the official Linden Lab blog at the beginning of survey data collection and two months later in a follow-up post. In addition to this support from the company, the survey invitation was also distributed to the members of the Second Life Real Life Education listserv. This email communication group was chosen in particular because group members were active in promoting voice use for classroom sessions during classes that took place in Second Life.

Criteria for Selection: Attitude survey

Any active Second Life participant was eligible to take part in the survey. To establish a spectrum of attitudes about the voice service, both current users and current non-users of voice were invited to complete the tool. The only two criteria for their responses to be included in the Study 3 sample was that they completed the survey in full and that they were part of the population extracted from the Linden Lab data that were within the 2-degree Friendship network of the Study 2 sample. The remaining completed surveys were used by the Community and Voice teams internally at Linden Lab.

Materials

Instruments

Demographics and community involvement

Demographic and community involvement information about each avatar included in the Study 3 sample were extracted from the Linden Lab data servers. Demographic variables included country of origin, offline gender, avatar gender and whether s/he was an employee of Linden Lab. Community involvement variables included the date the Second Life account was created and the number of minutes the account holder had spent in the virtual world since account creation.

Outcome measures

Voice adoption

The data that was provided by Vivox included the avatar name of the account holder and the first date on which the voice channel was activated. Account names of Study 3 avatars were replaced by unique identifiers and their names were no longer associated with the data.

Adoption was categorised into nine binary identifiers that listed the earliest date of adoption for each account holder for each month. For example, an avatar that adopted the voice service in September 2007 was identified with a 0 in August 2007, a 1 in September 2007 and a 0 in October 2007, and so on. Friend avatars were also assigned adoption indicators, which were used to identify if they adopted the voice service in the month before or in the same month as the Ego avatar.

Additionally, two generic voice adoption indicators identified the avatars and the Friend avatars that had adopted at any point during the period of observation in this study. Adopters were listed as 1 and non-adopters were listed as 0.

Predictor measures

There were both structural and psychological predictors in this analysis.

Structural predictors

There were two structural predictors measured in this analysis using the network generated from the Friendship information provided by Linden Lab: network position and network exposure. Network density was not analysed in this study because sub-groups were not extracted.

Relative network position

It was hypothesised that the position of a source Friend who had already adopted relative to the target Ego would have a predictive effect on when the Ego adopted in the diffusion process. Actors who were more central and had adopted were expected to inspire others to adopt soon after them. To assess this, each actor's whole network centrality was calculated in the Pajek social network analysis software package using an All-Degree routine. In this process, every Friend link was

implicated in the centrality score, rather than just those that were nominations from other people (in-degree, as used in Study 2) or to other people (out-degree).

This value was applied to all avatars in the sample and the scores between relationship partners were compared. An indicator variable of 1 identified that the Friend was the more central avatar in the relationship.

Exposure: Friend adoption in the previous month or in the same month

The monthly Friend avatar adoption indicators identified each voice user at every period of observation. These were included in the analyses to predict voice adoption of an Ego avatar at a particular month. In addition, the generic Friend adoption indicator was included in the analyses to predict voice at any point in the observation period. During the analytic routines, a high score represented a Friend who had not adopted, contrary to the value attributed to this indicator⁴⁵.

Psychological predictors

There were four psychological predictors measured in this research. Attitude, perceived use and restriction were measured using the attitude surveys and were informed by the Theory of Planned Behaviour (Fishbein & Ajzen, 1975).

Relationship strength was extracted from the Linden Lab database. It was operationalised in this study as the number of permissions granted to Friends, and was identified as a psychological predictor based on the observed outcomes in Study 1 that aligned Modification strongly with interpersonal and normative features of influence.

Relationship strength

The data used to generate the network of the Second Life population included a summary of the permissions granted from the Ego to each Friend avatar. Friend permissions in Second Life were granted from the perspective of each ego account holder. These permissions included: the ability of the Friend avatar to locate the Ego

⁴⁵ The data was analysed using Logistic Regression (see section 6.5), and these predictors received these assignments from SPSS.

avatar anywhere in the virtual world using the Map feature, the ability of the Friend avatar to know when the Ego avatar had logged in to the virtual community and the ability of the Friend avatar to modify the Ego's virtual objects, including his/her avatar's appearance. Because they were selected in confidence for each Friend from the point of view of the account holder, the Friends did not know which permissions they were granted, nor did the Friend's permissions for the Ego necessarily match.

An increase in the number of permissions granted to the Friend was anticipated to represent a closer relationship. The default permission when a Friendship was established was the ability to see when the Ego was logged in to the service. This was expected to represent the most frequent and the least interpersonally valuable option. In contrast, the most interpersonally valuable option was operationalised as granting all of the permissions to the Friend. The categories are outlined in Table 21.

Attitude

Although the notion of generalised attitudes, or dispositions, are poor predictors of behaviour in specific situations (Wicker, 1969), Ajzen (1985) proposed

Table 21
Key for the Study 3 Relationship Strength Measure

Category	Permission
0	No permissions granted
1	Friend can see Ego's online status
2	Friend can see where Ego is on the map
3	Friend can see Ego's online status and where Ego is on the map
4	Friend can modify Ego's objects
5	Friend can see Ego's online status and can modify Ego's objects
6	Friend can see where Ego is on the map and can modify Ego's objects
7	Friend can see ego's online status, can see where Ego is on the map and can modify Ego's objects

that assessing specific, salient attitudes for particular contexts produced a close link with behaviours. In this virtual world, attitudes were expected to be based on the personal perceptions of usefulness outlined in the Technology Acceptance Model (Davis, 1989), which examines the attitude and ability of an individual to use a new technology (i.e. is the network technology useful, and is it easy to use). This approach has been used to track and predict the uptake of the World Wide Web (Moon & Kim, 2001), voice mail (Straub, Keil, & Brenner, 1997), and other interactive innovations.

All survey respondents were asked four questions about their attitudes to the voice service: two questions detailed general affect (positive or negative feelings) and whether the respondent considered voice an innovation, following the attitude measures outlined by Ajzen (1985), and two questions focussed on functional attitudes (did they perceive it as useful and valuable for their in-world experience) to the expected outcomes (did they anticipate any effect – positive or negative – on personal and business relationships).

Participants selected their responses from three options: *Yes*, *No* and *Don't Know*. Only positive and negative responses were retained⁴⁶ and were averaged into a single attitude score for each respondent. A high score represented a positive attitude to the service.

Perceived use

Respondents were asked if they believed their friends already used the service. This question drew on the pluralistic ignorance outcomes of Study 2 and sought to identify the effects of perceived use on personal behaviour. Participants selected their responses from three options: *Yes*, *No* and *Don't Know*. Only positive and negative responses were retained⁴⁷. A high score indicated that respondents did not believe their Friends used the voice service.

⁴⁶ Between 11.0% and 12.9% responses to each question were rated *Don't Know*; these values were identified as missing.

⁴⁷ 22.0% responses to this question were rated *Don't Know*; these values were identified as missing.

Restriction

Finally, to identify potential reasons why non-adopters had not yet used voice, all participants were asked whether there were any exogenous limitations that prevented them from using the service. Specifically, it asked if there were any environmental, technological or physical restrictions that encumbered their participation in the service. This question aimed to identify individuals who were unrestricted and who had not yet adopted.

Participants selected their responses from three options: *Yes*, *No* and *Don't Know*. Only positive and negative responses were retained⁴⁸. A high score indicated that respondents were not restricted from using voice.

6.5. Analytic Overview

Data organisation

Information about each avatar in the Study 3 sample was added to two data tables.

An Actor Attributes table listed the individual-level independent variables for each actor in the Study 3 sample gained from the Linden Lab database, the Voice Attitude and Intentions survey and from Study 2, including:

- Demographics and community involvement
- Attitude
- Perceived use
- Network position
- Voice adoption (overall and at month)

A Network Relationship table paired an account holder with his/her Friends, and described the interpersonal attributes of each relationship based on the Linden Lab data and on the psychological ratings unique to each Friendship pair described in Study 2. These attributes included:

- Relationship strength

⁴⁸ 3.1% responses to this question were rated *Don't Know*; these values were identified as missing.

- Relative position

Additionally, each avatar-Friend pair included the indicators that identified at which month they adopted voice in.

Acceleration analysis

The number of unique voice adopters at every month was subtracted from the number of unique voice adopters at the next month to assess the acceleration of uptake between these two time periods. These values were compared with the cumulative rate of uptake value that was used to define the diffusion curve in order to identify which months were appropriate for analysis of the hypotheses outlined in each of the three stages of voice adoption.

Logistic Regression

This research aimed to describe the variation in adoption/non-adoption and in scores of personal attitude as predicted by multiple variables. Because the behavioural outcome variables and five of the predictors were categorical⁴⁹, a series of logistic regression equations were produced and tested to help identify the indicators of voice adoption in the Second Life sample. Although the data was multilevel, varying at the Friend and the Ego avatar levels, it was not possible to assess the potential variance between the Ego avatars on their relationship ratings because of their extremely large Level 2 (Ego) N , but the high proportion of relationships that were observed to be rated with the default setting (Friend can see the other account holder's online status) (see section 6.6) suggested that any variation would be very small. As this was the only variable that could be constructed as multilevel, a multilevel analysis was not conducted.

In total, ten logistic regressions models were tested. The first tested adoption at any point during the observation period using the generic adoption indicator for each Ego avatar, predicted by his/her attitude to the service, the perception that his/her Friends used the service, the relationship strength recorded by Linden Lab

⁴⁹ Attitude and relationship strength were considered scale items.

with each of his/her Friends, their relative positions in the network and the generic Friend adoption indicator.

The remaining nine models looked at the predictors for the specific months of the observation period. Voice adoption at each month was tested with each of the seven predictors. There was one exception: August 2007 was tested with six predictors, as the service was launched that month and so no account of Friend's adoption in a previous month was available.

Table 22

Descriptive Analysis of the Study 3 Variables

	<i>N</i>	Item(s)	Response options	<i>M</i>	<i>SD</i>	Min	Max
Survey respondents	1,047						
Demographic and Community Involvement							
Account holder gender ^a	734	What is your gender (offline)?	male (<i>N</i> = 348) female (<i>N</i> = 386)				
Avatar gender ^a	734	What is the gender of your avatar?	male (<i>N</i> = 314) female (<i>N</i> = 420)				
Linden Lab employee	47,493		Yes <i>N</i> = 216 (0.5%) No <i>N</i> = 47280 (99.5%)				
Country of origin	47,493		Australia <i>N</i> = 1,143 (2.4%) Canada <i>N</i> = 2,527 (5.3%) France <i>N</i> = 711 (1.5%) German <i>N</i> = 1,541 (3.2%) Netherlands <i>N</i> = 1,138 (2.4%) UK <i>N</i> = 4,174 (8.8%) USA <i>N</i> = 31,051 (65.2%) Other (< 5% each) <i>N</i> = 5,064 (10.7%)				
Date of account creation ^b	47,493						
Number of minutes logged in to Second Life ^c	47,493						

Table 22 (continued)

Descriptive Analysis of the Study 3 Variables

	N	Item(s)	Response options	M	SD	Min	Max
Psychological predictors							
Relationship strength	65,634		No permissions N = 144 (0.2%); Can see online status N = 55,698 (85.2%); Can see online status and can see on the map N = 6,145 (9.4%); Can modify objects N = 78 (0.1%); Can see online status and can modify objects N = 914 (1.4%); Can see online status, can see on the map and can modify objects N = 2,369 (3.6%);				
Personal attitude ^f	1,037	Do you generally feel positively nor negatively about the introduction of Voice communication in Second Life? Do you think Voice is a useful feature for Second Life? Do you think voice communication will add value to Second Life? Do you think Voice communication is a technological advance?	I feel positive about voice I think voice is useful I think voice adds value I think voice is a technological advancement	1.44	0.27	1	2
Perceived use	1,047	Do you think your Friends use voice?	Yes N = 338 (32.3%) No N = 474 (45.3%) Don't Know N = 235 (22.4%)	3.28	0.65	0.4	4
Restriction	1,047	Is there anything technological, physical or environmental which restricts you from using Second Life's Voice service?	Yes N = 204 (19.5%) No N = 811 (77.5%) Don't Know N = 32 (3.1%)	2.23	1.01	0	4
Structural predictors							
Network position	4,599			0.00041	0.0014	0.000022	0.03351

Table 22 (continued)

Descriptive Analysis of the Study 3 Variables

	<i>N</i>	Item(s)	Response options	<i>M</i>	<i>SD</i>	Min	Max
Relative network position	80,016	Account holder more central <i>N</i> = 64,693 (80.9%) Friend more central <i>N</i> = 15,323 (19.1%)					
Friend adoption in current month ^d							
Friend adoption in previous month ^d				0.19	0.09	0.04	0.36
Outcome Variables							
Account holder voice adoption (overall)	47,643	Yes <i>N</i> = 23,205 (48.7%) No <i>N</i> = 24,438 (51.3%)		2.44	0.85	0.33	4
Account holder voice adoption (month) ^e							

^aFrom Study 2. ^bSee Figure 14. ^cSee Figure 15. ^dSee Table 24. ^eSee Table 23. ^f $\alpha = 0.92$

6.6. Results

A summary of the demographic, voice adoption, network and survey variables is listed in Table 22. The results are briefly outlined below.

Descriptives

Linden Lab supplied information that detailed the demographic attributes of its account holders, whom they referred to as “Residents”, including country of residence, date of Second Life account creation, total number of minutes spent logged into the virtual world and whether or not the avatar’s account holder was an employee of Linden Lab. The server logs also provided information about the account holder’s date of birth and offline gender, but these variables were discarded from the analyses⁵⁰.

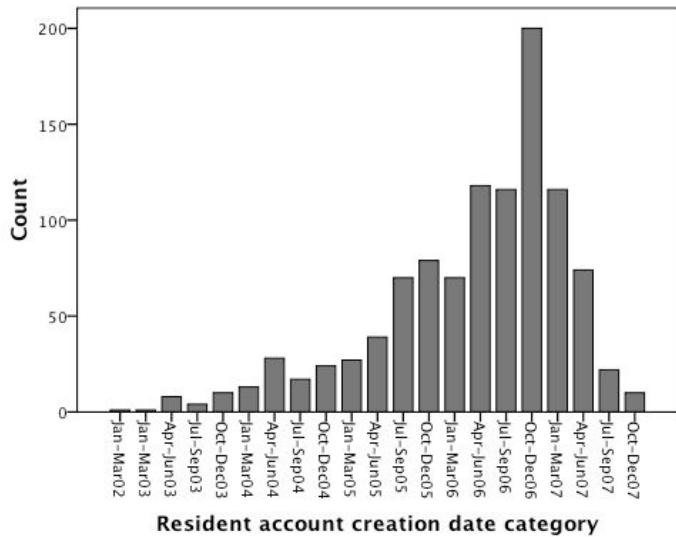


Figure 14. Frequency analysis of the cumulative Second Life “Resident” account holder date of creation in the Study 3 sample

⁵⁰ When signing up for a Second Life account, applicants must provide information about real-life gender and date of birth, however Linden Lab had identified issues with gender and age verification that they had corrected, but which had implications for the validity of these variables.

If new users had signed up on the official Second Life site (<http://www.secondlife.com>) and did not identify themselves as male or female, the system would not allow them to progress until they had selected one. Therefore, any record of gender in these situations was likely to have been recorded correctly, except in instances when participants recorded their genders wrongly.

However, if a new account holder signed up for Second Life using any of Linden Lab’s authorised third-party providers, until October 2007 these third parties were not required to collect gender data. If this variable was not requested during registration, the Linden Lab database recorded a default value ‘male’.

There was a tendency for participants to come from the USA; the USA joined other native English-speaking countries like the United Kingdom, Canada and Australia in accounting for 81.9% of the nationalities in this sample.

The span of dates over which avatars in this sample were created ranged from early 2002 (before the virtual world was released to the public)⁵¹ to December 2007 (the month Linden Lab's databases were accessed). The overall distribution described in Figure 14 reflected the surge of accounts that were opened in late 2006 inspired by the increased media interest in the virtual world, but it also indicated that most of the people in this network were virtual world age cohorts.

The lifetime usage distribution described in Figure 15 suggested that most people in this sample were regularly logged into Second Life. 26.4% of actors in this network had used more than 110,860 minutes to the date of data collection, the equivalent of 77.0 24-hour days. The most frequent number of minutes used by this population was between 46.7 and 77.0 days over the space of their Second Life account lifetime. This was not a factor of how long the account had been established; rather, there was a low, negative relationship between these two variables ($r = -0.25, p < .00$), suggesting that newer account

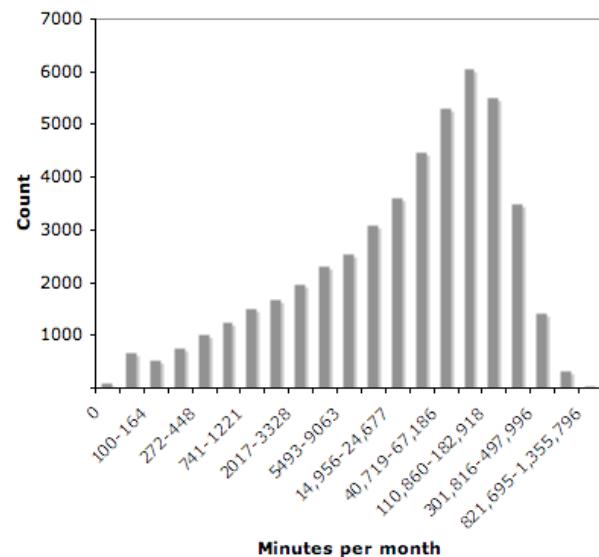


Figure 15. Frequency analysis of the cumulative number of minutes spent logged into Second Life since account creation

In addition, as Second Life's Main Grid is an 18+ service, Linden Lab recorded the year of the new registrant's birth to establish his/her adult status. However, this field was free-response, allowing new applicants to fill in their year of birth themselves. This resulted in a wide range of impossible dates, from 1000 to 9999.

⁵¹ The very early account holders were part of the 0.5% of the sample that was employed by Linden Lab.

holders registered more hours than long-term account holders.

There was a tendency for participants to report that they used the virtual world for both business and pleasure (59.9%), although 36.5% reported that they used the service for social purposes only. A chi square test rejected the hypothesis that there was a difference in voice use between the Second Life activities.

Voice adoption

The information released by Vivox for this study listed the date that Second Life account holders established a voice channel for the first time on the full-release version of the software⁵² between August 2007 and April 2008. It was imported into a database and content relevant to the Study 3 sample was extracted to SPSS. 23,205 (47.8%) actors in the Study 3 network opened voice accounts during the period of data collection (see Table 23 for breakdown by month). In this population, 80.9% of survey respondents reported that they had no environmental, technological or physical restriction to using the service.

Network position

Network position was operationalised in this Study as degree centrality. Degree centrality was calculated for each actor using the Pajek software package (M

Table 23
Sample Voice Adoption by Month

Month	Frequency	%	Cumulative %
Aug-07	12,422	53.5	53.5
Sep-07	3,224	13.9	67.4
Oct-07	2,116	9.1	76.5
Nov-07	1,442	6.2	82.8
Dec-07	751	3.2	86.0
Jan-08	695	3.0	89.0
Feb-08	1,460	6.3	95.3
Mar-08	899	3.9	99.2
Apr-08	196	0.8	100.0
Total	23,205	100	

⁵² Not the ‘Beta Grid’, pre-release server, which allowed Second Life account holders to test the voice service between June 2007-August 2007.

$= 0.00041$, $SD = 0.001$). The individual with 1,584 connections was considered the most embedded person in the network. There was a good spread of participants in positions located throughout the network who had adopted the voice service, and there was no indication that it was an innovation used by people who were any more or less integrated into the network. Only 19.1% of avatars held more peripheral positions than their Friends. The relative position variable was not significantly related to any of the demographic, survey or other network measures.

Attitude

Responses to the four attitude items were averaged for each respondent, generating an overall attitude score ($M = 1.44$, $SD = 0.27$; min. = 1, max = 2). This variable demonstrated significant and strong relationships with the belief that a Friend used the voice service ($r = 0.56$, $p < .00$), supporting the results observed in Chapter 5.

Perceived Friend use

In total, 55.8% of respondents believed their Friends were current users of the voice service, but of the 42,252 avatars nominated, 48.8% adopted the service between August 2007 and April 2008 (see Table 24 for breakdown by month), suggesting a tendency of Second Life participants to overestimate their Friends' use of voice.

Table 24
Study 3 Sample Voice Adoption Frequencies by Month for 'Ego' Actor and Friend Actor

Month	Frequency of 'Ego' adoption	Frequency of Friend adoption
Aug-07	33,019	24,452
Sep-07	2,820	5,252
Oct-07	3,663	3,448
Nov-07	1,034	2,140
Dec-07	1,323	1,291
Jan-08	1,632	1,155
Feb-08	2,812	2,698
Mar-08	383	1,488
Apr-08	41	328
Total	46,727	42,252

Relationship strength

There was a strong tendency amongst this sample to grant Friends the system default permissions, representing the weak relationship category in this analysis (see Fig. 16). Of the remaining relationships, account holders most often allowed their Friends to see where they were located on the Second Life map system (9.4%) and, in addition to the other permissions, offered them modification rights (3.6%).

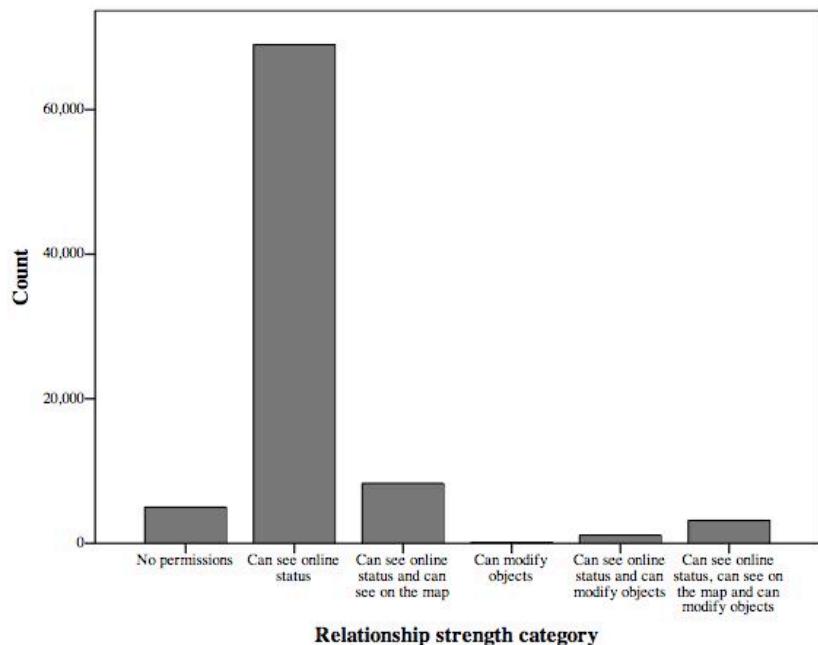


Figure 16. Frequency of Second Life account holder relationship strength permissions granted to each Friend in the Study 3 sample

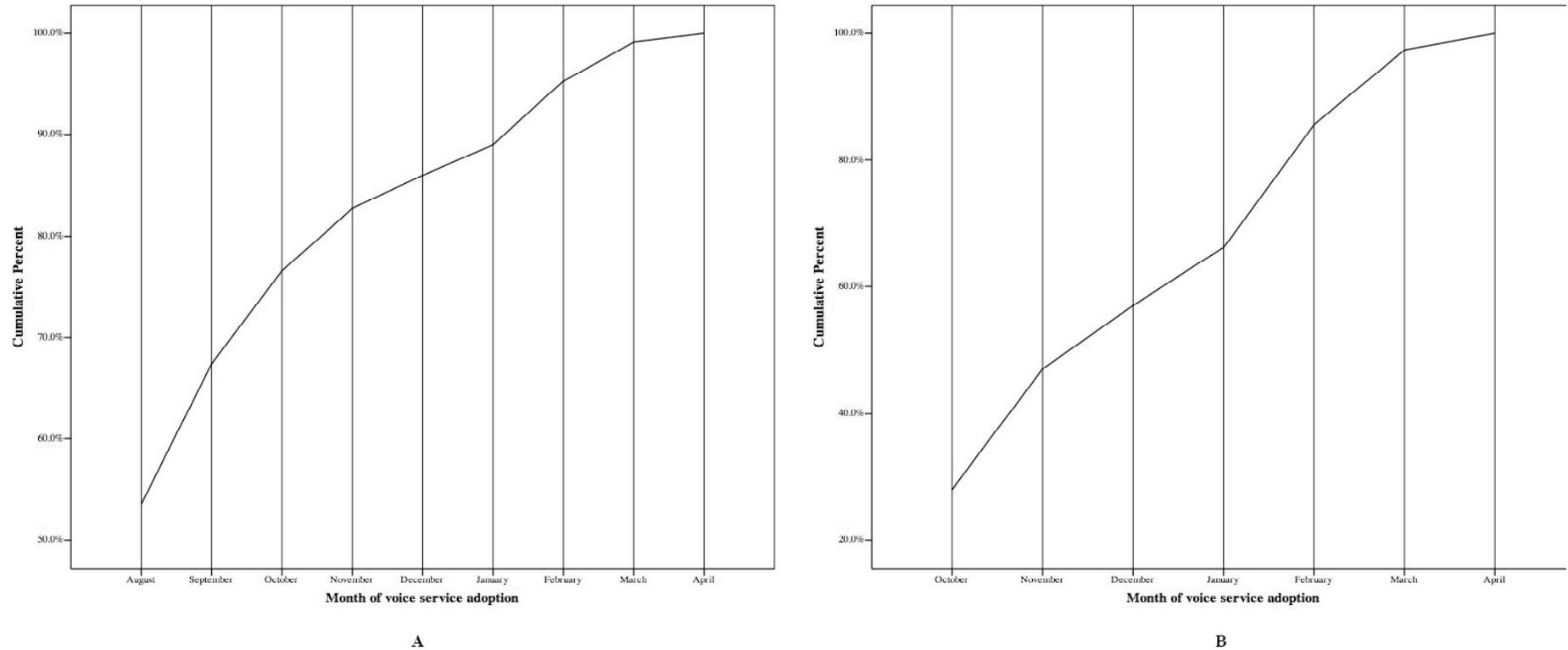


Figure 17. Cumulative voice adoption over the entire observation period (A) and detail of adoption at October 2007 – April 2008 (B), highlighting the period of rapid uptake at January 2008 – February 2008

Stage assignment to each month of adoption

Table 25 lists a breakdown of adoption at every month, the cumulative percent of adoption at every point in time, and details the innovation's acceleration throughout the diffusion event. Cumulative adoption rates were graphed and the result, in Figure 17 (A), verified that the innovation spread via network connections, indicated by the gradual S-curve that increased between January and February 2008 (Fig. 17B) after a sharp increase after the service's launch.

To identify the periods of time in the diffusion that aligned with the three stages outlined on pages 217-223, a plot of the acceleration rates listed in Table 25 was generated (see Fig. 18). As expected, there was evidence of a rapid increase in adoption in the month immediately after the service launched and the deceleration between August and September was unmatched at any other point in the observation period. Although the cumulative adoption described by Figure 17 continued to rise in September and October in a manner that appeared to be a similar rate as in August,

Table 25
Voice Adoption Rates and Acceleration of Voice Diffusion in Second Life

Month	Total diffusion period			
	Cumulative N Adopters	Cumulative %	Adoption Rate ^a	Acceleration
Aug-07		53.5	12422	-9198
Sep-07	15646	67.4	3224	-1108
Oct-07	17762	76.5	2116	-674
Nov-07	19204	82.8	1442	-691
Dec-07	19955	86.0	751	-56
Jan-08	20650	89.0	695	765
Feb-08	22110	95.3	1460	-561
Mar-08	23009	99.2	899	-703
Apr-08	23205	100.0	196	

^aNumber of new adopters

these months demonstrated a reduction in the speed with which Second Life account holders adopted the voice innovation. There was further evidence between November and December, and January to April that the speed of uptake continued to decelerate in each successive month. However, there was another period of rapid uptake in February 2008. These results offered evidence in support of Hypothesis 1.

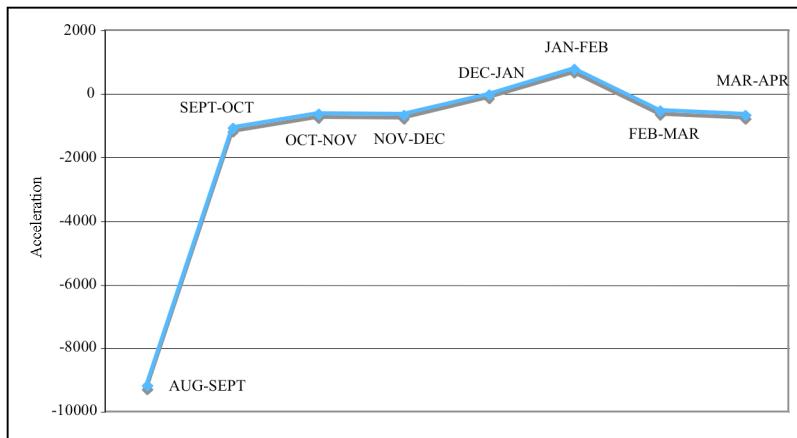


Figure 18. Voice adoption uptake plotted to identify periods of acceleration and deceleration as they occurred throughout the observation period

The acceleration graph was used to identify the months of slow and rapid uptake over the course of the observation period that matched the three stages outlined on page 217. Stage 1 was proposed to be characterised by a steady but slow increase in the cumulative number of adopters. The months selected for closer inspection of the network and psychological predictors of adoption during this phase were October, November, December and January.

Although the acceleration data suggested the speed of uptake at this time decelerated, overall this slow-down became less pronounced and became steadier between October – November ($a = -674$) and November – December ($a = -691$). Finally, in December and January, the acceleration data decreased the least of the observed period ($a = -56$), maintaining a near steady rate of adoption.

Adoption in February was classed as Stage 2, as it was in this month that a peak in acceleration was observed. August was also included as an outcome variable in assessing the hypothesis outlined in this stage, as the rapid adoption rate at the outset

was expected to be propelled by a relative importance of network ties due to the interdependence of the innovation.

September, March and April were identified as Stage 3, the period at the end of a rapid increase characterised by a continued increase in adoption, but a general decline in the rate of acceleration.

Predictors of voice adoption

An overview of the significant predictors in each model is listed in Figure 19.

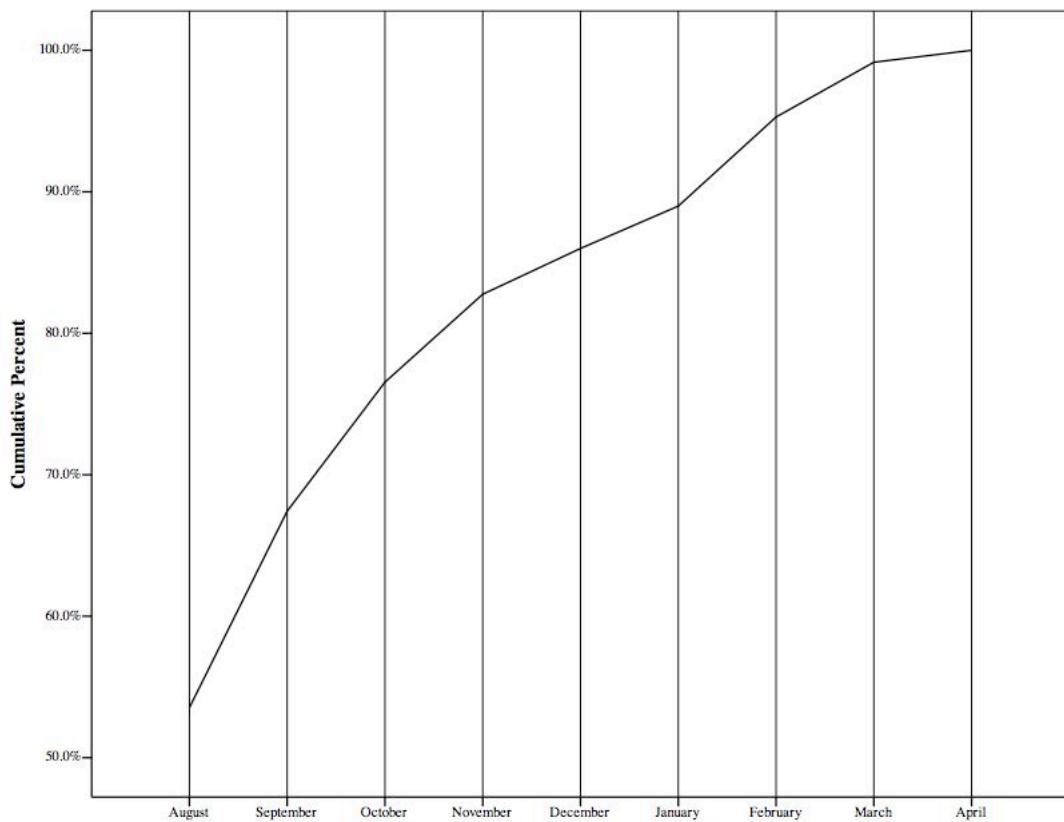
General adoption trends

A direct logistic regression analysis was performed on adoption at any point in the nine-month diffusion period as outcome and six network and psychological predictors: adoption at any point by a Friend, the relative centrality of the Ego to his/her Friends, average attitude towards the service, perceived use of the service by Friends, the strength of the relationship between two Friends, and whether the survey respondent reported that s/he was restricted in any way from using the service.

Analysis was performed using SPSS.

8,182 pairs of Friends were available for analysis: 2,398 instances of adoption and 5,244 instances of non-adoption.

A test of the full model with all six predictors against a constant-only model was statistically significant, $\chi^2(6, 8182) = 709.09, p < .00$, indicating that the predictors, together, reliably distinguished between voice adopters at any point in the observation period and non-adopters at any point in the observation period. The variance in adoption status was small, however, with Nagelkerke's $R^2 = 0.11$. Prediction success was unimpressive, with 100.0% of adopters correctly predicted, but 0% of non-adopters correctly predicted, with an overall success rate of 64.1%.



Attitude ^a	-	NS	+	NS	NS	NS	+	NS	NS
Relationship strength ^b	-	NS	+	+	-	NS	+	NS	NS
Perceived Friend use ^c	+	NS	+	NS	NS	NS	NS	NS	NS
Restriction ^d	+	NS							
Relative centrality ^e	+	+	-	-	NS	-	-	-	NS
Friend adopted prev. month ^f	[Redacted]	+	NS	NS	NS	NS	-	-	NS
Friend adopted same month ^f	NS	NS	NS	NS	NS	NS	-	NS	-

^aHigh attitude score indicates positive attitude; ^bHigh relationship strength score indicates stronger relationship; ^cHigh Perceived Friend Use score indicates the belief that a Friend had used the service; ^dHigh Restriction score indicates an environmental, physical or technological restriction; ^eHigh relative centrality score indicates the avatar held a more peripheral position than his/her Friend; ^fHigh Friend Adoption score (same month/previous month) indicates that the Friend did not adopt.

Figure 19. Cumulative adoption graph with valence of significant Study 3 psychological and network predictors of voice uptake at every month

Table 26 shows the regression coefficients, Wald statistics, odds ratios and 95% confidence intervals for each of the predictors. Based on the Wald criterion, all of the variables reliably predicted adoption at any point in the observation period. All significant Wald statistics were $p < .00$.

Overall, the odds an individual would adopt at any point in the diffusion event were increased if a Friend adopted as well, if the Friend was more central, if the adopter perceived his/her Friends had adopted, if the account holder had a positive attitude about the innovation and if s/he was not environmentally, technologically or physically restricted. An odds ratio of 3.85 showed the strongest change in the likelihood of adopting based on one unit of increase in how positive a respondent's attitudes were towards the service. The odds ratio of 2.67 for restriction showed a good change in the likelihood that an individual would not use voice if s/he did demonstrate some restriction, as did the odds ratio of 2.61 for perceived use, which indicated that there was a strong likelihood that participants would adopt if Friends were believed to have adopted. The odds ratio of 0.91 showed little change in the likelihood of adopting when a Friend also adopted. In contrast, the odds that an account holder would use voice if an adopting Friend was better embedded in the Second Life network were increased by 1.82.

There was one predictor that decreased the likelihood that an account holder

Table 26
*Logistic Regression Analysis of Network and Psychological Predictors of Voice Adoption
 between August 2007 - April 2008*

Predictor Variable	β	Wald test (z-ratio)	95% confidence interval for odds ratio		
			Odds ratio	Lower	Upper
Friend adopt at any point ^a	-0.10	4.26	0.91	0.82	1.00
Relative centrality ^b	0.60	63.46	1.82	1.57	2.10
Attitude ^c	1.35	81.94	3.85	2.87	5.15
Relationship strength ^d	-0.10	34.66	0.91	0.88	0.94
Perceived use ^e	0.96	136.61	2.61	2.23	3.07
Restricted ^f	0.98	262.74	2.67	2.37	3.01
Constant	-2.55	112.06	0.08		

Note. ^aHigh score = Friend did not adopt. ^bHigh score = Friend more central. ^cHigh score = positive attitude. ^dHigh score = strong relationship. ^eHigh score = Friends perceived to use. ^fHigh score = not restricted

$p < .05$

would adopt the voice service between August 2007 and April 2008: the strength of the relationship between an adopting Friend and the account holder. However, the odds ratio of 0.91 showed little change in the likelihood of rejecting the innovation on the basis of one unit increase in relationship strength.

The significant aggregated Friend adoption variable was divided into its component month parts. These were tested as predictors with the psychological and network variables included in the previous model. The outcome remained the generic adoption at any point in the diffusion period. Friend adoption in November and February were observed to be reliable predictors of an individual's likelihood to adopt at any point in the innovation's diffusion, in addition to the significant predictors already described. This model was significantly different from a constant-only model, $\chi^2(14, 8182) = 721.20, p < .00$, although the variance in adoption accounted for was still small, with Nagelkerke's $R^2 = 0.12$. However, the odds ratios for the two months that were significant showed little change in the likelihood of adopting based on Friends' adoptions in November (.72) or February (0.66).

The other variables included in the model (relative centrality, attitude to the innovation, Friends' perceived use, strength of relationship and restriction) demonstrated comparable results to the model that included an overall indicator of Friend adoption.

Stage 1: Structural and psychological predictors of early adoption

Five logistic regression analyses were performed on adoption to test the hypotheses based on the predictions outlined in Stage 1. The outcome months were assigned on the basis of the acceleration analyses, which suggested that adoption in October, November, December and January represented the slow uptake period that would lead to the rapid adoption period observed in February.

The first model examined voice adoption in October as outcome and seven network and psychological predictors: a Friend's adoption in September, a Friend's adoption in October, the relative centrality of the account holder to his/her Friends, his/her average attitude towards the service, perceived use of the service by Friends,

the strength of the relationship between the account holder and his/her Friends, and whether the survey respondent reported that s/he was restricted in any way from using the service. Analysis was performed using SPSS.

There were 8,700 pairs identified in October and September in which at least one person had adopted the innovation during that month. After deletion of cases with missing values, data from 7893 people who didn't adopt in October and 289 people who did adopt in October were available for analysis.

A test of the full model with all seven predictors against a constant-only model demonstrated a reliable difference, $\chi^2(6, 8182) = 37.79, p < .00$, indicating that the predictors, as a set, reliably distinguished between people who adopted in October and people who did not adopt in October. The variance was small, however, with Nagelkerke's $R^2 = 0.11$. Prediction, while 96.5% correct overall, was unimpressive: 0.0% of adopters were successfully identified, while 100.0% of non-adopters were successfully identified.

Table 27 shows the regression coefficients, Wald statistics, odds ratios and 95% confidence intervals for odds ratios for each of the seven predictors. According to the Wald criterion, a Friend's adoption in September, a Friend's adoption in October and a reported restriction did not reliably predict adoption in October. Four predictors did, however, predict adoption. Adoption was more likely to occur in this month when the adopter was more central than his/her Friends, when s/he reported a more positive attitude, when his/her relationship with Friends was stronger and when s/he thought his/her Friends used the service. All significant Wald statistics were $p < .00$.

A model run with the significant variables not included was reliably different from a constant-only model, but none of the network predictors included reliably predicted adoption in October. This confirmed the finding that relative position, personal attitude, relationship strength and perceived use were reliable predictors of adoption at this time in the diffusion event.

The strongest odds that adoption would occur were found with the psychological variables. In particular, the attitude variable, which demonstrated an

Table 27

Logistic Regression Analysis of Network and Psychological Predictors of Voice Adoption in October 2007

Predictor Variable	β	Wald test (z-ratio)	95% confidence interval for odds ratio		
			Odds ratio	Lower	Upper
Friend adopt Sept 07 ^a	NS				
Relative centrality ^b	-2.89	50.59	0.60	0.30	0.12
Attitude ^c	4.36	28.39	78.00	15.70	387.22
Relationship strength ^d	0.11	9.29	1.12	1.04	1.21
Perceived use ^e	1.36	13.13	3.90	1.87	8.15
Restriction ^f	NS				
Constant	-11.53	1.27	82.07		

Note. ^aHigh score = Friend did not adopt. ^bHigh score = Friend more central. ^cHigh score = positive attitude. ^dHigh score = Friends perceived to use ^eHigh score = strong relationship.

^fHigh score = not restricted

$p < .00$

odds ratio of 78.00 indicated that likelihood an individual would adopt in October would be strongly changed by a one unit change in attitude towards voice. In contrast, the only significant network predictor, relative centrality, had an odds ratio of 0.60, suggesting little change in the likelihood of adopting in October based on the position of the Friend in relation to the individual. These results offered support for Hypothesis 2.

The second model tested was performed on adoption in November as an outcome and the seven psychological and network predictors. This did not demonstrate a reliable test; indeed, when the model was divided into its constituent network and psychological groups and tested again, only the model including the three network predictors (Friend adoption in October, Friend adoption in November and relative position in the network) was statistically reliable as a set, $\chi^2 (3, 86627) = 10.00, p < .05$. It included all possible pairs, in which 1,034 people adopted and the remaining 85,593 cases did not⁵³. The variance accounted for was very small, however, with a Nagelkerke's R^2 less than 0.01. This outcome did not support Hypothesis 2.

However, what this model cautiously suggested was that the relative network position was the only reliable predictor of adoption at this time. Table 28 shows the

⁵³ This number represented the possible number of pairs of actors, rather than each individual case.

regression coefficients, Wald statistics, odds ratios and 95% confidence intervals for the odds ratios for each of the three predictors. According to the Wald criterion, neither a Friend's adoption in the previous month nor a Friend's adoption at the same time reliably predicted voice uptake. Further, the odds ratio for the relative centrality predictor of 0.81 was small, and showed little change in the likelihood of adoption on the basis of a Friend being more or less central.

Finally, one other variable that emerged as statistically reliable in predicting uptake in November was the relationship strength observed between an adopter and his/her Friend. This model included a total of 10,821 Friend pairs of which 1034 people adopted at this time. The variance in adoption was small (Nagelkerke's R^2 was less than 0.01) and prediction was unimpressive, with 0% of adopting actors correctly identified, but the re-emergence of this psychological predictor at this time did lend support to Hypothesis 2.

However, what this model cautiously suggested was that with one unit change in the strength of the relationship between an actor and his/her friend, the odds that adoption was likely was 1.14. The Wald criterion indicated that relationship strength reliably predicted adoption in November, $z = 47.57$, $p < .00$, and the model was reliably different from the constant-only model, $\chi^2(1, 10821) = 40.89$, $p < .00$. As higher scores on the relationship variable indicated a stronger relationship, the stronger the relationship, the more likely an individual was to adopt.

Table 28

Logistic Regression Analysis of Network and Psychological Predictors of Voice Adoption in November 2007

Predictor Variable	β	Wald test (z -ratio)	95% confidence interval for odds ratio		
			Odds ratio	Lower	Upper
Friend adopt Oct 07 ^a	-0.15	0.94	0.86	0.64	1.16
Friend adopt Nov 07 ^a	-0.24	1.78	0.79	0.55	1.12
Relative centrality ^b	-0.21	7.23	0.81	0.70	0.95
Constant	-3.99	292.09	0.02		

Note. ^aHigh score = Friend did not adopt. ^bHigh score = Friend more central.

* $p < .00$

The results of the next two models suggested that December and January were the months represented a period of transformation of the voice innovation from an uncertain, novel phenomenon to one that reflected the majority group norms. This occurred in the period immediately before the rapid increase in voice adopters observed in February, and which itself demonstrated acceleration in voice adoption.

A logistic regression analysis was performed on adoption at December 2007 as outcome and all seven predictor variables: a Friend's adoption in November, a Friend's adoption in December, the relative centrality of an account holder to his/her Friends, average attitude towards the service, perceived use of the service by Friends, the strength of the relationship between two Friends, and whether the survey respondent reported that s/he was restricted in any way from using the service were analysed. At least one person in 2,357 pairs adopted in December. Analysis was performed using SPSS.

The model that included the network and psychological predictors as a set was not reliable; when the model was divided into its constituent network and psychological groups and tested again, only the model including relationship strength was significant, $\chi^2(1, 86627) = 17.46, p < .00$. Although this indicated that the relationship strength variable distinguished between adoption and non-adoption at this time ($z = 15.363, p < .00$), the variance in adoption accounted for was less than 0.01 (Nagelkerke's R^2). Further, prediction success was similarly unimpressive, with 0.0% of the 1,323 people who adopted in December correctly predicted, but an overall success rate of 98.5% of the 6,859 who did not adopt in December were correctly predicted.

What this model cautiously suggested, however, was that because higher scores on relationship strength indicated a stronger relationship, the negative regression coefficient demonstrated that a weaker relationship between a potential adopter and his/her Friend resulted in adoption. The odds ratio of 0.03 indicated that a change in relationship strength would have demonstrated little change in an adoption outcome. This outcome did not support the proposal made in Hypothesis 2.

The next logistic regression performed to test the hypothesised results in Stage 1 resulted in a more robust model, and one that lent support to Hypothesis 2. The model tested adoption in January 2008, a month in which 232 new people adopted the voice innovation, in 1,632 pairs of people, with all seven network and psychological predictor variables: a Friend's adoption in December, a Friend's adoption in January, the relative centrality of an account holder to his/her Friends, average attitude towards the service, perceived use of the service by Friends, the strength of the relationship between two Friends, and whether the survey respondent reported that s/he was restricted in any way from using the service. This model was statistically reliable, $\chi^2 (6, 8182) = 1961.51, p < .00$, indicating that the predictors, as a set, reliably distinguished between people who adopted in December and people who did not adopt in December. The variance it accounted for was large, with Nagelkerke's $R^2 = .71$, and prediction success impressive: there was an overall success rate of 97.5% adopters (65.9%) and non-adopters (98.9%) correctly predicted.

Table 29 shows the regression coefficients, Wald statistics, odds ratios and 95% confidence intervals for odds ratios for each of the seven predictors. Based on

Table 29
Logistic Regression Analysis of Network and Psychological Predictors of Voice Adoption in January 2008

Predictor Variable	β	(z-ratio)	Odds ratio	95% confidence interval for odds ratio	
				Wald test	
Friend adopt Jan 08 ^{a, 1}					
Friend adopt Dec 07 ^a	-0.48	0.26	0.62	0.10	3.95
Relative centrality ^{*b}	-2.43	22.01	0.09	0.03	0.24
Attitude ^c	124.38	0.01	1.05E+54	0	.
Relationship strength ^d	-0.05	0.89	0.95	0.85	1.06
Perceived use ^e	47.78	0.01	5.61E+20	0	.
Restriction ^f	-43.15	0.01	0	0	.
Constant	-218.30	0.01	0		

Note. ^aHigh score = Friend did not adopt. ^bHigh score = Friend more central. ^cHigh score = positive attitude. ^dHigh score = Friends perceived to use ^eHigh score = strong relationship. ^fHigh score = not restricted

¹ Variable was not included in final model

* $p < .05$

the Wald criterion, only the relative position of an individual and his/her Friend reliably predicted adoption, $z = 22.01, p < .00$. A model run with relative position omitted was not reliably different from this model, however it was reliably different from a constant-only model. This confirmed that relative position was the only reliable predictor of adoption in December among the psychological and network variables. Because a high score indicated that a potential adopter was less central than his/her Friend, a person who was better embedded in the network than a Friend would have been more likely to adopt in December. This lent support to Hypothesis 2. However, the odds ratio of 0.09 showed little change in the likelihood of adoption on the basis of this predictor.

Stage 2: Structural and psychological predictors of rapid adoption

The acceleration and cumulative adoption analyses identified two months of rapid uptake: August and February. August was the first month voice was available to the Second Life public, and for this reason, it was expected that the results would be different from those observed in analyses of the February adoption outcome. February was anticipated to adhere to the proposal outlined in Hypothesis 3. However, to test this, two logistic regression models were run.

The first was performed on adoption in August as outcome and six psychological and network predictors: a Friend's adoption in August, the relative centrality of the Ego to his/her Friends, average attitude towards the service, perceived use of the service by Friends, the strength of the relationship between two Friends, and whether the survey respondent reported that s/he was restricted in any way from using the service. Analysis was performed using SPSS.

There were a total of 24,452 pairs with at least one adopter recorded in August. After removing cases with missing values, data from 8,182 Second Life account holders were available for analysis: 4,244 adopters and 3,938 non-adopters. A test of the full model with all predictors against a constant-only model was statistically significant, $\chi^2 (6, 8,182) = 1030.38, p < .00$, indicating that the predictors, all together, reliably distinguished between voice service adopters and non-adopters during the service's first month after it was released. The variance in

adoption accounted for was small, with Nagelkerke's $R^2 = .16$. Prediction success was robust, with 79.2% of adopters and 60.4% of non-adopters correctly predicted, with an overall success rate of 70.1%.

Table 30 shows regression coefficients, Wald statistics, odds ratios and 95% confidence intervals for each of the six predictors. According to the Wald criteria, only a Friend's concurrent adoption in August, did not reliably predict adoption. This result did not support the proposal outlined in Hypothesis 3. A model run with only this variable demonstrated a significant difference from the constant-only model but not from the full model, confirming the finding that relative position in the network, attitude to the innovation, the strength of the relationship between an individual and his/her Friend, the perception that Friends used voice and whether or not a restriction was reported were the reliable predictors of voice adoption.

The odds ratio of 0.43 showed that there would be little change in the likelihood of adopting based on a change in attitude to voice; similarly the odds ratio of 0.88 showed that there would be little change in the likelihood of adoption based on a change in the strength of the relationship between two Friends. However, the odds ratio of 5.03 for restriction indicated that a reported restriction would change the likelihood of adoption in August.

Table 30
Logistic Regression Analysis of Network and Psychological Predictors of Voice Adoption in August 2007

Predictor Variable	β	(z-ratio)	Odds ratio	95% confidence interval for odds ratio	
				Wald test	Lower
Friend adopt Aug 07 ^a	-0.08	2.55	0.92	0.83	1.02
Relative centrality ^b	0.47	44.24	1.593	1.39	1.83
Attitude ^c	-0.84	32.80	0.432	0.32	0.58
Relationship strength ^d	-0.13	52.96	0.88	0.85	0.91
Perceived use ^e	0.50	44.31	1.645	1.42	1.90
Restriction ^f	1.62	530.47	5.028	4.38	5.77
Constant	-0.23	0.98	0.797		

Note. ^aHigh score = Friend did not adopt. ^bHigh score = Friend more central. ^cHigh score = positive attitude. ^dHigh score = Friends perceived to use ^eHigh score = strong relationship. ^fHigh score = not restricted

* $p < .00$

As a high score represented no restriction, an absence of environmental, technological or physical impediments indicated that an individual would be more likely to adopt in August. Also at this time, if a Friend was more central, the individual was more likely to adopt. The odds ratio of 1.59 demonstrated that there would be some change in the likelihood of voice uptake if relative position changed. This supported the proposal outlined in Hypothesis 3. In addition, the belief that Friends used voice increased the likelihood that voice was adopted at this time.

The second model was performed on voice adoption in February as the outcome variable with seven psychological and network predictors: a Friend's adoption in January, a Friend's adoption in February, the relative centrality of the account holder to his/her Friends, average attitude towards the service, perceived use of the service by Friends, the strength of the relationship between two Friends, and whether the survey respondent reported that s/he was restricted in any way from using the service. Analyses were performed using SPSS. A total of 4,444 relationship pairs included at least one individual who adopted in February 2008. After removing missing cases, data from 8,182 cases were included in the model: 272 Second Life account holders were recorded as adopters and 7,910 were recorded as non-adopters.

A test of the model with all seven predictors against a constant-only model was significant, $\chi^2 (7, 8182) = 673.86, p < .00$. The variance in adoption accounted for was moderate, with Nagelkerke's $R^2 = .31$. Prediction success was 96.7%, although 0.0% of adopters and 100.0% non-adopters correctly predicted.

Table 31 shows regression coefficients, Wald statistics, odds ratios and 95% confidence intervals for odds ratios for each of the seven predictors. Two of the psychological variables, perceived use and restriction, were not reliable predictors of adoption in February, but a model with only these two variables included was significantly different from the full model. It was not significantly different from a constant-only model, which confirmed that a Friend's adoption in January, a Friend's adoption in February, the relative centrality between the relationship pair, the strength of the relationship between the pair and personal attitude to voice reliably predicted adoption outcomes at this time. The odds ratios of adoption in January

Table 31

Logistic Regression Analysis of Network and Psychological Predictors of Voice Adoption in February 2008

Predictor Variable	β	(z-ratio)	Odds ratio	95% confidence interval for odds ratio	
				Wald test	Lower
Friend adopt Jan 08 ^a	-1.32	10.72	0.27	0.12	0.59
Friend adopt Feb 08 ^a	-0.85	12.69	0.43	0.27	0.68
Relative centrality ^b	-1.51	54.43	0.22	0.15	0.33
Attitude ^c	1.73	13.98	5.62	2.27	13.90
Relationship strength ^d	0.12	11.59	1.13	1.05	1.22
Perceived use ^e	-18.31	0.00	0.00	0.00	.
Restriction ^f	0.10	0.46	1.11	0.83	1.48
Constant	-3.11	11.74	0.05		

Note. ^aHigh score = Friend did not adopt. ^bHigh score = Friend more central. ^cHigh score = positive attitude. ^dHigh score = Friends perceived to use ^eHigh score = strong relationship. ^fHigh score = not restricted

* $p < .00$

(0.27), adoption in February (0.43) and relative centrality (0.22) showed little change in the likelihood of adoption on the basis of one unit change in either variable.

However, as a lower score on Friend adoption indicated that the Friend had adopted in that month, the regression coefficients suggested that network exposure effects based on a Friend's adoption in either January or February increased the likelihood of adoption. This supported the proposal in Hypothesis 5. However, an individual's position as more central than his/her Friend increased the likelihood that s/he would adopt.

The odds ratio of 5.62 showed some change in the likelihood of adoption for a unit change in personal attitude to voice, and the odds ratio of 1.13 showed some change in the likelihood of adoption for a unit change in the strength of the relationship between a pair. In the case of attitude, because a higher score represented a more positive attitude, adoption was more likely as the attitude increased. In the case of the latter, because a higher relationship rating indicated a stronger relationship, a weaker relationship increased the likelihood of adoption.

Stage 3: Structural and psychological predictors of late adoption

The two months of rapid uptake were followed by periods of a relative decrease in acceleration. Although the cumulative number of voice adopters increased, September, March and April were representative of the months described

by Stage 3 and were anticipated to be characterised by a decrease in adopters' centrality in the network an increase in the expectation that Friends had already adopted, and an increase in the importance of relationship strength. This was outlined in Hypothesis 4.

The first logistic regression analysis was performed on adoption in September. There were seven psychological and network predictors: a Friend's adoption in August, a Friend's adoption in September, the relative centrality of an account holder to his/her Friends, average attitude towards the service, perceived use of the service by Friends, the strength of the relationship between two Friends, and whether the survey respondent reported that s/he was restricted in any way from using the service. Analysis was performed in SPSS. 29,704 relationship pairs had at least one individual who adopted in August or September. The model that was analysed included 510 people who adopted and 7,672 who did not adopt.

A test of the full model with all seven predictors against a constant-only model was not significant, and when the model was divided into its constituent parts, only the model that included the network predictors, Friend adoption in August, Friend adoption in September and relative position, was significant, $\chi^2 (3, 8182) = 848.95, p < .00$. None of the other variables reliably distinguished adopters from non-adopters in September.

The variance in adoption accounted for in the significant network predictor model was small, with Nagelkerke's $R^2 = .04$. Further, although 96.7% of the

Table 32
Logistic Regression Analysis of Network and Psychological Predictors of Voice Adoption in September 2007

Predictor Variable	β	Wald test		95% confidence interval for odds ratio	
		(z-ratio)	Odds ratio	Lower	Upper
Friend adopt Aug 07 ^a	0.13	8.30	1.14	1.04	1.24
Friend adopt Sept 07 ^a	0.00	0.00	1.00	0.85	1.17
Ego more central ^{*b}	1.15	886.27	3.15	2.92	3.40
Constant*	-3.90	1846.12	0.02		

Note. ^aHigh score = Friend did not adopt. ^bHigh score = Friend more central.

* $p < .01$

prediction was successful, 0.0% of this correctly predicted adopters. 100.0% of non-adopters were correctly predicted.

Table 32 shows regression coefficients, Wald statistics, odds ratios and 95% confidence intervals for odds ratios for each of the three predictors. According to the Wald criterion, the only predictor that did not reliably predict adoption in September was Friend adoption in September. The other two variables significantly predicted the outcome variable. A model with the significant predictors removed was not reliably different from the constant-only model, but it was different from the full model, confirming the finding that Friend adoption in August and relative network position were the only reliable network variables. The odds ratios of 3.15 (relative position) and 1.14 (Friend adoption in August) suggested that there was some change in the likelihood of adoption in September of the basis of a change in these variables. As a Friend's greater centrality was identified with a high score, an individual was more likely to adopt if a Friend was more central. This did not support H₄.

However, as ratings on Friend adoption that were high indicated that a Friend had not adopted, it was more likely that an individual would adopt if a Friend did not. This lent some support to the proposals in H₄.

As the diffusion curve was different than anticipated, it was expected that the results of the decline in acceleration in September would be different from those outlined in Hypothesis 4. However, March represented a month at the end of what was proposed to be a more typical diffusion event. A logistic regression was performed on adoption of voice in March and the seven network and psychological predictors: a Friend's adoption in February, a Friend's adoption in March, the relative centrality of an account holder to his/her Friends, average attitude towards the service, perceived use of the service by Friends, the strength of the relationship between two Friends, and whether the survey respondent reported that s/he was restricted in any way from using the service. Analysis was performed in SPSS. The test of the full model was not significant.

Table 33

Logistic Regression Analysis of Network and Psychological Predictors of Voice Adoption in March 2008

Predictor Variable	Wald test			95% confidence interval for odds ratio	
	β	(z-ratio)	Odds ratio	Lower	Upper
Friend adopt Mar 08 ^a	-0.55	3.17	0.58	0.32	1.06
Friend adopt Feb 08 ^a	-0.51	4.61	0.60	0.38	0.96
Ego more central ^b	-0.31	5.76	0.73	0.57	0.95

Note. ^aHigh score = Friend did not adopt. ^bHigh score = Friend more central.

* $p < .05$

When the model was broken into its component network and psychological parts, only the model that included all of the network predictors was significant, $\chi^2(3, 86627) = 12.53, p < .00$. This indicated that the predictors as a set reliably distinguished between adopters and non-adopters of the voice service at this time. There were 3,195 pairs in which at least one individual adopted in February or March, but in this model, all possible pairs were included. There were 383 instances of adoption identified and analysed, and successful classification of adopters (0.0%) and non-adopters (100.0%) was 99.6%. The variance in adoption accounted for was less than 0.01 (Nagelkerke's R^2).

Table 33 shows regression coefficients, Wald statistics, odds ratios and 95% confidence intervals for odds ratios for each of the three predictors. According to the Wald criterion, the only predictor that did not reliably predict adoption in March was Friend adoption in March. The other two variables significantly predicted the outcome variable. A model with the significant predictors removed was not reliably different from the constant-only model, but it was different from the full model, confirming the finding that Friend adoption in February and relative network position were the only reliable network variables.

The odds ratios of 0.6 (Friend adoption in February) and 0.73 (relative network position) showed little change in the likelihood of adoption or not adopting based on a change in these variables. In addition, the results only partly supported to the ideas proposed by Hypothesis 4, as an individual who was more central than a Friend was more likely to adopt but an individual with a Friend who had adopted in February was also more likely to adopt.

Finally, the last month under scrutiny was April 2008. A logistic regression analysis was performed on adoption of the voice service in April 2008. There were seven predictors: a Friend's adoption in March, a Friend's adoption in April, the relative centrality of the Ego to his/her Friends, average attitude towards the service, perceived use of the service by Friends, the strength of the relationship between two Friends, and whether the survey respondent reported that s/he was restricted in any way from using the service. When the analysis was conducted in SPSS, the full model was not significant. Further, when it was dismantled into its component network and psychological parts, only the network variables resulted in a model that significantly different from the contact-only model, $\chi^2(3, 86627) = 117.37, p < .00$, indicating that as a set they distinguished between adoption and non-adoption. In this analysis, all possible relationships were included, although only 383 relationship pairs had at least one individual who adopted in either March or April. In total, there were 41 people who adopted in April and 342 who did not adopt. The variance accounted for was small, Nagelkerke's $R^2 = 0.17$. Prediction success was strong, although 0.0% of adopters correctly accounted for and 100.0% of non-adopters correctly accounted for, with an overall success rate of 100.0%.

None of the predictors was significant, although a Friend who had adopted in April was just insignificant (0.06). This suggested that there might have been a trend during this final month that supported Hypothesis 4, as people who adopted voice did so if their Friends adopted it concurrently. The odds ratio of 0.15 showed very little change in the likelihood of this, however.

6.7. *Discussion*

The results of the current study indicated that voice adoption among account holders of the Second Life virtual community accelerated and decelerated at different times in its diffusion. After an initial period of very rapid uptake, immediately following the launch of the service, voice adoption decelerated for six months, and then rapidly accelerated again. This did not follow a typical diffusion S-curve pattern; rather, there was evidence for two diffusion phenomena: the first occurring between August and September that was likely inspired by the interest generated

around its release, and the second occurring between October and April that reflected a social diffusion pattern similar to that observed in most research in this field.

Voice adoption varied as a function of the time in the diffusion process when it occurred, the speed of the acceleration or deceleration and psychological and network predictors. There was a general trend that suggested that earlier adoption and adoption during periods of rapid uptake occurred because of psychological predictors, and adoption immediately following periods of rapid uptake and later in the diffusion event occurred because of network phenomena.

Overview of the analysis

Adoption patterns of voice adoption

The first objective of the research was to assess the pattern of uptake of the voice innovation through the community of Second Life. Diffusion diverged from the anticipated trajectory of the offline S-curve. The S-curve observed had an earlier critical mass slope, with voice use surging upon its release into the community, when the majority of the adopters in the sample opened the new communication channel. Rapid acceleration had been expected to occur early because of the interdependent nature of the innovation, but the immediacy of the critical mass suggested that it occurred because of the public attention paid to it in the run-up to launch.

Of interest, however, was that the rate of acceleration plummeted in September. Although there were twice as many people who adopted in September than in each of the remaining months in the observation period, this correction was dramatic, and there followed six months of a steady decline in the number of new users per month before adoption rates appeared to recover.

However, the pattern that emerged from October to April did suggest the S-curve of diffusion: there was a steady rate of cumulative uptake from October to December, followed by an increase in the number of new users in January, leading to a strong spike of new adopters in February. After this short acceleration period, adoption rates decelerated, and the number of new users decreased. So, rather than a slow acceleration of usage leading to a critical mass event, followed by a period of

deceleration, the diffusion of this innovation was characterised by two spikes of adoption

Overall, the process of diffusion in this community with this innovation was more complex than what had been predicted in the first hypothesis. There was evidence for both slow and rapid periods of uptake, but the pattern that was presented was not consistent with the prevailing theory: the tendency for deceleration rather than acceleration contradicted diffusion research in a way that enforced attention to less rapid deceleration rather than less rapid acceleration in the lead to the period of rapid uptake in February 2008.

Variations of adoption as a function of the predictors

The second objective of the research was to identify how patterns of voice adoption varied as a function of when in the diffusion curve it occurred, whether it was adopted during a period of acceleration or deceleration, and how the psychological and network predictors affected uptake. The data allowed for the exploration of the effects of each of these predictors at monthly intervals, which offered a complete picture of the uptake over time.

The hypothesised predictors that were anticipated to increase the likelihood of uptake during the diffusion event - specifically that adoption during a slow period at the outset would be characterised by psychological phenomena, adoption during a rapid period would be characterised by network phenomena and adoption during a slow period at the end of the diffusion would be characterised by both network and psychological predictors – were generally supported, but the pattern obtained was more complex than had been proposed. In part, this may be explained by the two diffusion phenomena, the first in August and September characterised by the first spike in uptake and subsequent recovery, and the second between October and April that followed a more anticipated pattern. Another explanation may be that psychological factors emerged as the stronger predictors for adoption, which has not been emphasised in previous diffusion research.

In August, when voice was launched and uptake was rapid, both psychological and network predictors increased the likelihood an avatar would adopt.

There was a trend for peripheral account holders to sign up for the service, a feature of this diffusion that was consistent with Diffusion Theory (Rogers, 1995), but surprising given the proportion of new accounts created at this time.

These first voice users tended to believe that their Friends also used the service, a trend that supported the outcomes of critical mass analyses that have focussed on interdependent innovations. As Markus (1987) observed, the perceived usefulness of a new communication service was tied to the belief that it would connect new users with other people to whom they wished to be connected to. There was no trend identified by the exposure data to suggest that this was the case, rather, the perceived belief that Friends used the service appeared to be sufficient to encourage adoption. This supported the results observed in Study 2 that demonstrated the effect of perceptions on an influence outcome.

The self-reported negative attitude among adopters towards the voice service that was observed at this time may have been a result of the time-lag between adoption and when the respondent completed the survey; as Markus (1987) described, an innovation's early adopters will only continue using an interdependent service if it continues to appear useful. As there was a sharp decline in uptake in September, continuing through January, the voice channel may not have offered the services that these early adopters had anticipated, and their initial attitudes to voice may have changed over that period.

The innovation's success depended on the people who adopted at every successive month to create a sense of usefulness that would maintain the interest of the previous cohort of adopters and to encourage future adoption. A persistent negative attitude might have threatened the success of this innovation in the long term despite the number of initial adopters, as it could have discouraged later uptake of the service. This may have undermined the perceived usefulness of the innovation for the early adopters, and they may have discontinued their use. This scenario has been observed in research into online interdependent innovations particularly in the critical mass research, which as Markus (1987) argues, are susceptible to stagnation.

However, adoption in September arguably laid the foundations for the beginning of the second diffusion event. There was a dramatic rate of deceleration at this time, and the results suggested that the people who adopted during this month did so independently of any Friends who adopted in August. It seemed that they were the first among their contacts to use the service, and their peripheral positions suggested that they would be responsible for bringing voice to their local groups. There were no psychological predictors at this time; adoption appeared to be driven by the position the new adopter held in the community. It is possible that they were exposed to voice by a weak tie (Granovetter, 1973).

The results indicated that the months of October to January represented the slow uptake phase in the second period of diffusion, the stage described in Hypothesis 2. The increasingly steady rate of new adopters at each month interval reflected this stage in the interpersonal diffusion process. Although the number of new users per month was still in decline, the rapid deceleration observed between August and September and September and October decreased.

Adoption during the months of October to December appeared to be propelled by the interpersonal communication between peers. This supported Hypothesis 2, and to some extent classified it as part of the “persuasion” stage of diffusion (Ryan & Gross, 1943). Indeed, the trend towards psychological predictors during this time, particularly the strength of the relationship between a new adopter and his/her Friend, suggested that this was a period when the innovation was propelled by interpersonal interaction, which served to legitimise it for later adopters who were more cautious in their use of the service.

Success of this innovation during this period reflected the social processes described by Coleman and his colleagues (1957); in this research, the successive uptake over the months leading to the rapid acceleration in February could be explained by the communicated experiences of people who had adopted before. There was an emphasis in both October and November on the strong relationships between new voice users and their Friends. October adopters had tendencies to hold positive attitudes about the service and it is possible that this inspired adoption in

November. The observed experiences of Friends who adopted in November may have inspired adoption in December. Although in December, weaker relationships were more likely to inspire adoption, it is worth noting here that a “weak” relationship in this study represented the default category of relationship strength, suggesting that the innovation had developed a public representation at that time that inspired adoption based on a generic Friendship connection, rather than one that had interpersonal significance. This result may offer support for why, between December and January, the adoption rate was the steadiest of any point in the observed period, despite the lack of evidence for the effect of relationship strength at this time, and why adoption at any time in the nine-month observation period was more likely if a Friend had adopted in November.

Network features were also observed to have an effect on adoption in Stage 1. From October, the trend was for adopting avatars to hold more central positions than their Friends. As these individuals have been observed to be important for legitimising the innovation as appropriate for the rest of the community (Lopes, 1999), the more central positions of adopters at each successive month may explain how the innovation achieved the rapid acceleration in February.

The types of adoption predictors observed in February were similar to adoption in August, except that there was more evidence for the effects of network exposure during February than during August. An avatar was more likely at this time to use the voice service if his/her Friends had adopted during January or February. S/he was also more likely to hold a more central position in the network, which suggested that this innovation had achieved critical mass. More than in August, these outcomes offered evidence for Hypothesis 3, that the network predictors – position and exposure – contributed significantly to the adoption at this time.

Further, it was possible that the acceleration that was observed in February encouraged legitimisation of the innovation by the interpersonal interaction that occurred between October to January. Although no data was collected to directly test this hypothesis, results from this study indicated that a person who had a positive attitude about the innovation and strong relationships with Friends adopted in this

month. They did not adopt in August; rather, they waited for six months before converting. Additionally, the likelihood an individual would adopt at any point increased if a Friend adopted in February; this was despite the relatively lower total number of people who adopted in this month compared to August, which suggested that the innovation had transformed into a phenomenon that was considered acceptable by the entire network. Future research examining the effects of the slow period of adoption on the normative construction of the innovation is encouraged.

The pattern of variables that predicted adoption in March was identical to September, the other month that followed a period of rapid adoption, yet the results were strongly suggestive that the people who used the service for the first time in these two months held different roles in diffusion. Both months were characterised by a sharp deceleration in adoption rates and both groups of avatars were more likely to adopt because of network predictors. However, whereas September was characterised by new voice users that emerged from the periphery of the Study 3 social network and who had no connections with previous voice users, March was characterised by new voice users who held more central positions than their Friends and who adopted because a Friend had adopted in the previous month.

These different effects for these two months, which were matched in their positions immediately following rapid uptake, may be explained by their temporal position in the diffusion event. September was early in the voice lifecycle and the diffusion may not have permeated all local networks at that time. It is possible that by March voice had diffused to such an extent that most local networks would have had at least one person who had adopted. Whereas it was argued that September's new voice users were early adopters who had direct contact with multiple sources of information and interacted with other innovators, the new voice users who adopted in March were Late Majority adopters (Rogers, 1962) who relied on a trusted adviser to help them make sense of the technology. This supported Hypothesis 4, which stated that late adopters would adopt on the basis of exposure.

This argument may suffer from a simplistic, top-down approach, overlooking the local wisdom and norms of the community; it is possible, for example, that the

innovation may not have been adopted until later because the perceived costs were greater than the perceived benefits for the individual. As outlined in the Introduction to this chapter, voice may have challenged the perceived control an individual felt s/he had over what was disclosed about his/her offline identity to his/her online network, and the Friends who had adopted in February who inspired adoption in March may have been sources of interpersonal or normative reference. This proposal is further supported by the tentative results of April adoption, which, at that time, was inspired by a Friend's concurrent uptake.

Theoretical contributions

The results of this study extended two areas of the literature. First, the outcomes of the analysis described how the network and psychological variables worked independently and in tandem to predict voice uptake, and described the pattern of adoption. Second, the results also extended the online influence literature by highlighting the interpersonal and normative characteristics of the psychological predictors of behaviour uptake, and alluded to the negotiations that virtual community members may make when deciding to adopt an innovation.

Relationships between psychological and network predictors

The results of this analysis demonstrated that the psychological predictors under scrutiny explained the likelihood that the voice innovation would be adopted consistently more than the network predictors did, but that, over time they worked in tandem to produce adoption outcomes.

Psychological predictors were more effective at predicting whether adoption would take place overall, and in predicting the time of adoption. These outcomes supported the processes described by psychological influence theories like the ELM (Petty & Cacioppo, 1986), the TPB (Ajzen, 1985) and the TAM (Davis, 1989), and extended them by situating interpersonal and normative features of influence, personal attitudes and perceptions of norms in the online context. The results also demonstrated that personal positive attitudes drove uptake amongst early adopters, and that the re-emergence of positive attitudes amongst later adopters signalled the

beginning of another phase of rapid uptake. Although the literature had linked attitude with behaviour (e.g., Ajzen, 1985), by documenting when during a diffusion event attitudes became important predictors, this research offered a more nuanced understanding of the role it plays in online behaviour change.

The results of Study 3 also extended the body of research that has examined the role of perceived norms in behaviour uptake. The outcomes also addressed timing by showing when the perception that a Friend used the service emerged as an important predictor. This supported the extensive research that has linked normative influences with behaviour change by demonstrating that an online Friend's perceived use was a significant predictor when adoption of the voice service was considered overall. In addition, because perceived use was not a significant driver of uptake at all of the time points during the diffusion event, it offered an opportunity to examine its effect in more detail. Perceived use was only a significant predictor during the launch month and in October, the month that, this research proposed, began the second diffusion event. This suggested that the belief that direct contacts had already adopted was only relevant at the beginning of an innovation's lifecycle. Instead, the network variables and the other psychological predictors appeared to propel the adoption at other times.

The months during which relationship strength demonstrated a significant effect, particularly between October and February, supported the network theories that have proposed a legitimisation process that an innovation goes through before it is considered acceptable for adoption by the majority of the network (e.g., Lopes, 1999; Soule, 1999). The stronger relationships that were activated during the period of slow uptake reflected the inward-looking, persuasion phase described by Ryan and Gross (1943) and supported the arguments made by Rogers (1995) in Diffusion Theory in which he described the effect that the content of the innovation had on the pattern and speed of its uptake. This research outlined the processes in more detail, identifying these psychological processes that occurred during these time periods.

The outcomes also extended network approaches to diffusion by emphasising that network descriptors did not adequately explain uptake in an online diffusion

event on their own; indeed, the only months when they significantly increased or decreased the likelihood of adoption on their own was during times of rapid deceleration. Rather, personal attitudes, relationship strength and perceptions of norms were responsible for more of the variance in uptake in the time building up to critical mass and during rapid adoption. This was consistent with the diffusion literature, but these patterns had not been examined for their psychological properties.

It also appeared that the network predictors maintained the diffusion of voice when psychological predictors could not explain adoption. This was observed to be the case after the second period of rapid uptake in February, during which time exposure to the innovation was the sole predictor. At this time, the structural features of network theories, like threshold (Valente, 1996) and structural equivalence (DiMaggio & Powell, 1983), may have been the drivers.

In sum, the results suggested that there was an interplay between the psychological and the network predictors over the lifecycle of the voice diffusion event that lent support to network theories that emphasised the psychological processes for influence, like innovation legitimisation and network strength. In this way, they also provided support for psychological theories that emphasise interpersonal and normative features of influence. In addition, by assessing the effects over time, the results contributed to the literature by identifying when psychological attributes were more or less important in online attitude and behaviour change.

Features of online diffusion

The results of this study provided evidence that the interpersonal and normative features of influence described by social psychologists in theories like the ELM (Petty & Cacioppo, 1986), SIT (Tajfel & Turner, 1979) and C-ET (Perez & Mugny, 1996) are relevant to interaction in online communities. Personal attitudes, perceived norms and relationship strength were all significant and strong predictors of voice adoption; indeed, their relative strengths compared with the network

predictors lent support to Haythornthwaite's (2007) argument that it is possible to identify meaningful communities in CMC.

Of particular interest to this thesis, and the area that is arguably extended by the outcomes observed in Study 3, was that community members appeared to develop social norms about the innovation. This was evident in two ways. First, the pattern of voice uptake in Second Life reflected the social adoption patterns described by offline diffusion theorists: although there was a surge in adoption at the outset that may have been described by mass media effects (Katz & Lazarsfeld, 1955) or the interdependence of the innovation (Markus, 1987), the secondary diffusion event that occurred between October and April followed the S-curve that Ryan and Gross (1943) maintained was due to interaction between social ties.

Second, the pattern of the relationship strength variable suggested that the online community created a normative representation of voice. Although this was not directly assessed in this research, it is argued that the importance of the strength of the connection between an adopter and his/her Friend early in the period of slow uptake reflected interpersonal social influence processes.

The diffusion process may have reflected an offline S-curve pattern because of the nature of the voice innovation. It is proposed that the legitimatisation process may have occurred because of potential online-offline identity conflicts associated with voice use. Voice adoption offered a similar kind of self-disclosure that was described for Modification and non-Second Life communication, two of the network strength variables assessed in Study 1: voice conveyed offline content – gender, nationality, age – to the virtual public. This may have affected the timing of the decision to adopt the voice service for some participants because personal offline information may have been perceived to be in conflict with an online self that an account holder had constructed, and might have impacted on the social capital s/he had developed over time in the virtual world.

For example, Guadagno & Cialdini (2005) observed that offline status is less salient online as both authority figures and people low in social status have the opportunity to communicate at the same time, and on the same level. The

introduction of voice may have re-introduced offline power structures, or may have disrupted them. In other words, the voice innovation may have undermined the control some Second Life users may have wished to maintain over their online personae, and this may have been a factor in later adoption and the legitimisation process. Further research is recommended to assess the effect that a service like voice, which discloses offline identity information to the online community, might have on influence and the patterns of virtual innovation diffusion.

In sum, this research extended the online community literature that has described the development of significant relationships in cyberspace in the face of the limitations of the medium that McKenna and Bargh (2000) outlined, and supported the proposals set forward by Guadagno & Cialdini (2005), who hypothesised that influence processes in online communities would reflect the processes described in the offline psychological literature.

Methodological considerations

This research was designed to address many of the methodological criticisms levied against diffusion research methodologies presented by Rogers and Kincaid (1981). First, it addressed the inadequate attention given to the consequences of technological innovations by explicitly setting out to examine the diffusion of a communication innovation in a computer-mediated environment.

Second, it examined an integrated diffusion model that looked at network features, personal attributes and interpersonal influences. The multiple method design of this research measured an accurate whole network of the Second Life population and the strengths of relationships between account holders based on the information retained on Linden Lab's computer servers, plus personal attitudes and perceived behaviours using a self-report survey. Both sets of data, when considered together, allowed for analyses based on the value of local expertise, rather than focussing on diffusion as a product of individual decision-making, and provided scope for assessing the spread of innovation in a way that offered insight into both network relationships and psychological phenomena.

Third, the diffusion information was based on observed behavioural data, rather than retrospective self-report. The data was split into monthly intervals, but because it was accessed from the computer, the behaviour outcomes could have been divided into smaller time periods. Indeed, the opportunities that automated data extraction afforded this research and offer social science research in general are exciting. For example, future research could look at the uptake during the first diffusion event in August and September to examine the patterns at every hour or minute in order to extend understandings of the interpersonal phenomena that occur during the process of achieving critical mass. The content available allow for insight into behavioural phenomena in social settings that have meaning for the people invested in them (Shadbolt & Berners-Lee, 2008).

However, although there were several methodological strengths, there were also some areas for consideration.

Attitude survey

First, the voice service was officially launched in Second Life in August 2007. The survey was launched in November 2007, four months later, and five months before the observation period ended. Although this time period was chosen in order to gauge both adopters' and non-adopters' attitudes towards the service, and to assess whether non-users' attitudes predicted uptake in the months after responding, this may have affected the outcomes. Participants were asked about their attitudes and perceptions at the time they took the survey, but these were considered predictors at the time of adoption. The retrospective attributions may not have represented the feelings or perceptions at the time of voice uptake. The effects of this may have been most acute in cases when participants adopted voice in August, but responded to the survey in January. In future, it is recommended that self-report measures be captured at the time of adoption.

Additionally, the data that was collected in the attitude survey that was not used may have explained additional variance, and as such provides an opportunity for more detailed analyses of the psychological predictors of voice adopters' decisions to use the service. For example, the Theory of Planned Behaviour

(Fishbein & Ajzen, 1975b) argues that attitudes and norms are only two aspects of the process involved in uptake: the researchers also emphasised individuals' intentions to adopt an innovation as a predictor of behaviour.

The questions in the survey that asked about sources of references for the voice service arguably could offer an opportunity to examine greater interpersonal detail about the effect of the source of the innovation. The different categories included could arguably be examined for effects of sources perceived for their expertise, for media effects and for personal recommendations at each point in the diffusion event. Particularly with the observed early uptake of voice in August, it would have been interesting to consider what role blogs and other online and offline news sources had on the individual critical mass, compared with the personal sources, who were proposed in this research to be active during slow periods of uptake.

Finally, how account holders used Second Life, whether for business or pleasure, may have also played a role in the decision to adopt, and the data gathered from the survey question addressing this could have been used to consider the effect these different approaches to virtual community involvement may have had on uptake. Reactions to a rich channel of communication like voice for interaction in an online community may have depended upon the rationale for using it. Account holders who used this virtual world exclusively for business purposes may have had a different relationship with the voice service than account holders who used it solely for social aims. These communities likely used Second Life for different reasons; the former had clear objectives (meetings, classes, projects), while the latter used the virtual world to explore other account holders' creations or to 'hang out' and chat. Participants who engaged in undirected social play - activities that were not tied to offline identity – may have found the introduction of the voice service more problematic than business users as their online identities were less likely to be tied with their offline selves.

The survey offered a richness of data that fell outside the present analysis, but offered an opportunity for further, more nuanced analyses in the future.

Time-series analysis

Second, the time limit of the observation period, which ended in early April 2008, set an artificial boundary on the diffusion. The analyses in this study were limited by the temporal boundaries placed on the research and, as this analysis focussed on the diffusion of the innovation from its launch, greater emphasis in the results may have been placed on the effects of the uptake upon its release.

This may have affected how the diffusion curve was identified and what patterns were observed. Indeed, this study relied on ‘less deceleration’ rather than ‘less acceleration’ to identify rapid and slow periods because of the launch’s accelerating effect on uptake. A longer period of observation may have resulted in a normal curve of adoption that would have more closely reflected the stages outlined in the Introduction.

Network measures considerations

A third potential weakness in this study was how the network predictor exposure was measured. In this study, it was operationalised as a Friend’s adoption in the same month or the month prior to the one under observation. This effect only sought to identify the immediate effects of uptake on an individual’s behaviour, and for this reason it was not surprising that critical mass effects were observed. Another approach would have been to calculate the cumulative number of people who had used the voice service before the target had adopted. However, as this measure of exposure is a contested predictor variable because it is conflated with the outcome variable, it was decided that the criteria for network exposure used in this study was appropriate to assess the phenomena under scrutiny.

Further, the relationship strength measure applied in this research was designed with the automated data extraction method in mind more than the account holder’s experience. This decision was made in part to rely as little on self-report as possible while retaining as much consistency with the results of Study 1 as the data allowed, but the operationalisation of weak and strong relationships used in this research may not have measured the phenomenological experience that had been assessed in that study. The effect of the measure used was that the relationships that

were classified as “weak” represented the default value attributed to Friends in the virtual world. As described in the overview of the analysis, a “weak” relationship, therefore, may have been an imprecise measure of the affective strength of interpersonal relationships, which arguably offered meaning to the outcomes observed.

Finally, network density was not calculated in this study because sub-groups were not extracted. Their exclusion offers another avenue for future research that the data afforded. It would be interesting to assess this network variable’s effect, in addition to network exposure in identifying the effect of the number of friends from local groups of varying density who adopted in each month to assess that the role of structure had on the time of adoption relative to the rest of the network and relative to the whole diffusion event.

Extracting sub networks would also offer the opportunity to identify more localised measures of position rather than the aggregated variable used in this study. This could be used to replicate the Study 2 results with behaviour, and to observe the diffusion rates within the communities to test the effect of peripheral or central positions on the uptake of interdependent innovations online.

6.8. Further Questions and Conclusions

Despite the weaknesses in the design of the study, this research has extended the literature in diffusion research, influence research and social network analysis. It described the roles of structure and psychology in predicting the adoption of an innovation over time as complimentary, identifying the pattern of voice adoption in the online community and the variation in adoption as a function of attitudes, perceptions of Friends’ use, position in the social network relative to previous adopters and Friends’ prior or concurrent uptake. These network features, personal attributes and facets of interpersonal influence have not been previously examined in this context; rather network theories have tended to focus only on network features, and psychological theories have tended to focus only on uptake based on personal attributes or interpersonal influences.

There were two distinct diffusion phenomena that occurred in this analysis, and network and psychological attributes were complimentary predictors in both. In the first, actors who were on the periphery of their networks enthusiastically adopted the innovation and were responsible for seeding the interdependent innovation into the rest of the social network of the virtual world. The second diffusion event perpetuated the diffusion by establishing the interpersonal milieu in which the innovation could be passed on to the key individuals in local networks who would encourage its uptake on a wider scale. In each case, psychological predictors encouraged both slow and rapid adoption, and the network structures ensured that the innovation continued to diffuse.

Several lines of enquiry were raised that were not addressed in this research but would provide complimentary analyses to some of the questions raised here. First, research questions that consider the metamorphosis of an innovation during the transformation process during the early, slower stages of adoption is recommended and can be approached in various ways. For example, it was proposed that the content of the voice innovation may have had contradictory implications for its adoption by local groups: as an interdependent innovation, it encouraged people who were connected in the network to change their communication behaviour together, but doing so may have disclosed counter-normative identity content to the online community about the account holder. A question might examine innovations that implicate disclosure of offline identity, and how this may be challenged in environments that encourage the development of a new online identity.

It was also proposed that innovations have a normative currency for the local groups that may affect community members' decisions to adopt. What happens to a counter-normative innovation after it enters the group to transform it into a legitimate behaviour? In the case of an innovation like voice, it would be interesting to examine how the construction of such an innovation is transformed within the community and for the individuals using it.

A second area for future research is recommended to examine the processes that perpetuate diffusion beyond an accelerated period after a product launch, for

example. Closer attention to diffusion events with multiple rapid periods could examine the causes of acceleration at different time in diffusions. This would extend critical mass theories, and explore the reasons why some services belatedly achieve critical mass after the initial surge of interest.

Third, analysis of non-interdependent innovations in online environments is encouraged to assess if the multiple-peak model described in this study is replicated for other types of content, and if this is a phenomenon that is relevant for online innovation developers.

Finally, as the Second Life voice service was an official Linden Lab product, the service was likely to succeed because of the interest paid to it by the community owners and the community members. It would be interesting to follow another innovation as it diffused from different kinds of sources with varying degrees of status in the virtual community.

This study has offered insight into the spread of a technological innovation through a virtual community and has described the uptake as both psychologically and network-driven. As ideas, behaviours, attitudes and innovations increasingly are distributed through online channels, greater attention should be paid to the processes that facilitate how the spread. This study offers one step in that direction.

7. Discussion

This research was carried out to gain insight into the unique contribution social network analytic concepts offer to the prediction of influence in addition to the predictors that have been observed in the social psychological literature. The results of three studies confirmed that network strength, network density, network position and network exposure predicted attitudes and behaviours in the online community Second Life, and that they explained the variance in these outcomes in different ways and at different times than the psychological predictors assessed in this research.

This thesis focussed on three component parts of the research question: why network strength features have been effective at predicting influence, why the density of a network and the positions of individuals within a network have predicted personal attitudes and why an individual's position in a network relative to his/her Friend and the amount of exposure s/he has to an innovation via his/her direct contacts has predicted when an individual adopts an innovation as it diffuses through the online community.

To address these questions, this research tested the relationships between network strength and measures of interpersonal trust, credibility, social comparison and prototypicality, it identified how network density and network position affected perceived attitudes, and it followed the slow and rapid uptake of an innovation along a virtual world's interpersonal pathways over a nine month period. Constructions of personal attitudes, perceived source characteristics and interpersonal relationship strength were examined because the literature suggests these constructions are pertinent to social influence offline (Davis, 1989; Hovland, Janis & Kelly, 1953; Bandura, 1977).

From these analyses, two themes emerged. The first dealt with how social network attributes related to psychological predictors, including the features of network analysis that were proxies for psychological measures. It also identified how they are complimentary. It explored the reasons why influence occurred when a social system's structure did not support influence, and when interpersonal and normative features of influence did not predict it. It described how network measures

established the foundations for psychological influence and the implications for network measures on the development of the perception of norms.

The second theme that emerged was how the online attributes – of the context, of relationships and of individuals – affected influence in ways that were defined by network and psychological predictors. For example, a major contention of this thesis was that an online identity and online relationship attributes were relevant to influence processes across the loose and transient online social environment. Indeed, the looseness and transience of virtual social networks affected the perceptions of community norms and practices.

Throughout the thesis, special attention has been paid to the context of the analysis. The literature has argued that the unique interpersonal and structural features of online communities challenge many of the assumptions of offline social psychological theories, which has led to the emergence of influence models that have focussed on the impact of the leanness of cyberspace on group processes (Spears & Lea, 1992). Although this research found that there were some contextual differences, in general, the psychological processes of social influence appeared to function in the same ways as offline. It is argued that researchers should adapt their tools and practices to consider the online context, but that the interpersonal and normative experiences in online communities, on the whole, remain the same as those offline.

7.1. *Overview of the Analysis*

This research set out to examine what social network analysis offered to the study of social influence, in addition to the features that have already been described by social psychological theory. It sought to identify why social network features like network strength, network exposure, network position and network density have been effective predictors of attitude and behaviour change, and what they might contribute to the understanding of influence in an online community.

Second Life was chosen as the domain of study because it was an example of an online community that was increasingly of interest to human scientists for its

emergent interpersonal and normative properties. Second Life additionally offered an opportunity to observe social structures and behaviours that were captured from the computer servers, allowing for a large-scale analysis of the processes at work.

The results of the three studies in this thesis presented several interesting findings. These are summarised and discussed below, followed by several directions for future research.

Relationships between social psychological and social network features

First, this research demonstrated that social network analysts measure proxies for social psychological attributes associated with influence when they seek to define relationships based on network strength. It was argued that many social network outcomes have observed influence on the basis of psychological attributions of interpersonal and normative features associated with influence outcomes.

Study 1 demonstrated that there was a close relationship between the phenomenological measures of network strength and psychological attributes that contributed to social influence. This contradicted the evidence from the network analytic literature regarding the structural explanations for influence such as structural equivalence (Burt, 1987), exposure (Granovetter, 1973) and threshold (Valente, 1996) which emphasise the topographical construction of networks over the strength of a relationship.

However, the literature does account for the possibility of network strength as a predictor of influence, effective at identifying the uptake of new innovations, like documenting birth control practices in villages in South Korea (Rogers & Kincaid, 1981b), new prescription drugs (Coleman, Katz, & Menzel, 1957), new farming practices (Ryan & Gross, 1943) and voting behaviours (Weenig, 1993). Indeed, relationship strength based on Second Life ‘permissions’ was a significant predictor of the uptake of the voice service in Study 3; however, relationship strength was not a predictor in Study 2, which measured attitudes about online sexual behaviour, when the variable was operationalised as communication mode closeness.

As was argued in Chapter 5, the absence of an effect of the communication measure of network strength was unanticipated, standing in contrast with the theorised predictions of researchers like Garton *et al* (1997) and Rogers and Kincaid (1981) and observed by ethnographers like Correll (1995) who proposed that the different modes of communication would indicate stronger or weaker relationships. In the Second Life community, this contradictory finding may have been observed because the outcome was developed to examine network-based exposure, on the similarity between two people's reported attitudes. This outcome does not suggest that network strength has not been effective in predicting attitudes; rather it is proposed that network strength criteria are contextual, and that their relationship with psychological features of influence varies.

There have been many conceptualisations of strength devised by network researchers seeking to identify the most effective measure to predict attitudes and behaviours. The tendency in studies of interpersonal influence towards implementing network strength criteria associated with friendship suggests an implicit or explicit methodological bias towards psychological measures, but other researchers who have sought to operationalise strength based on observational attributes like communication patterns (e.g., Rogers & Kincaid, 1981a) or physical proximity (e.g., contagion; Kerckhoff, Back, & Miller, 1965; Festinger, Schachter, & Back, 1950; McCarty, 2003) have demonstrated that different ways of measuring network strength are still effective depending on the outcome that is under scrutiny and the context the analysis is set in. For example, DiMaggio and Powell (1983) defined network strength as the number of common affiliations held by corporate board members of business executives to assess the homophily across organisational culture while Dingley (2002) identified network strength by the frequency of utterances between people in a CMC listserv to assess its effects on decision-making. In all of these situations, the strength of the relationship between network actors predicted the outcomes better than the structural measures on their own.

Indeed, the results from this research provided evidence for the relative contributions of different types of measures in Second Life towards attributions of trust, credibility, social comparison and prototypicality; in Study 1, interpersonal

attributions were more likely associated with network strength measures like the likelihood of granting Modification rights to a Friend and the tendency to communicate with a Second Life Friend outside the virtual world that implicated more disclosure about the offline identity. In contrast, greater normative attributions were associated with network strength measures that implicated public performances, like public chat.

This offered support for the emphasis that analysts like McCarty (2003), Kirke (1996) and Fischer (1982) have placed on identifying the best criterion for network strength, and reflected the attentions paid to measures of interpersonal and normative attributes by psychologists (e.g., Earle & Cvetkovich, 1995; Renn & Levine, 1991; Poortinga & Pidgeon, 2003).

Compliments between social psychological and social network features

The research also demonstrated that network and psychological measures complimented one another when predicting influence outcomes. For example, it was argued that knowing a network's density would allow psychologists to predict clusters of behaviour and to identify group norms. The results of Study 2 demonstrated that people who reported experiences of sexual activity in Second Life were more likely to cluster into interconnected groups. This replicated the findings of Whyte, Jr. (1954), whose analysis of purchasing behaviours in large cities identified such neighbourhood effects, and in doing so, contradicted the evidence that the Internet does not support social groupings (Kraut *et al.*, 1998). The literature has identified a tendency for groups of cyber-citizens to gather around common ideas and practices (Wellman & Gulia, 1999), at times to their detriment (Van Alstyne & Brynjolfsson, 1996).

Additionally, this research supported the evidence that the depersonalised online environment encouraged groups to form on the basis of perceived attitudes that were developed through the scant cues that were available. This supported the psychological perspective that groups formed because of commonalities as individuals seek one another out in order to confirm existing beliefs. The attitude similarity in Study 2 was more likely to be associated with social affinity (Lewis,

Kaufman, Gonzales, Wimmer, & Christakis, 2008) because Second Life did not enforce relationships based on proximity. In this space, ties were likely based on common attitudes, rather than the attitude based on the ties. It was also observed that, in general, the Second Life neighbourhoods were common in their behaviours.

Clusters of Second Life account holders held common perceptions of their fellow group members' attitudes; there was a tendency for a united pluralistic ignorance (i.e. the degree to which the perceived attitude agreed with the group's average attitude). Participants in Study 2 believed that their local groups had more positive attitudes towards sexual activity than was reported. This effect decreased as density increased, replicating the findings of Latkin, Forman, Knowlton & Sherman (2003). These outcomes suggested that density measures might be useful variables for psychologists to implement to identify group norms. In addition, the perceptions of attitudes predicted the personal attitude, suggesting that the degree of network density in a group may offer psychologists a complimentary explanation for influence.

The research also demonstrated that knowing an individual's position in the network would allow psychologists to predict how accurate or inaccurate the individual's perceptions of the norms would be. There was a tendency for actors on the periphery of networks to experience less pluralistic ignorance. The results of Study 2 also offered evidence that it was possible to predict the attitude of an individual by identifying where s/he was located in the network. People who were more embedded in their local groups, i.e. held more central positions, had attitudes that were less representative of group norms, particularly when they belonged to dense networks. In doing so, this contradicted the literature that suggests that the most central people in a network have the greatest influence because they represent the groups' norms.

Instead, it appeared that others' perceptions of what a more central community member believed had a greater influence on an individual's personal attitude. The literature does account for this misperception; Latané's (2001) Dynamic Social Impact Theory suggested that the most central people in the network are the

most protected from contradictory opinions by the affirmation of their most proximate neighbours. This finding offers psychologists three opportunities: first, to identify which individuals hold a particular belief based on where they are in the network; second, to assess the degree of accuracy between an individual's perceptions about group norms an the groups' norms; and third, to identify to what degree an individual will be influenced by the group's norms.

The research demonstrated that an innovation could be identified as more or less normative depending on where the adopter was in the network. There was a tendency for early adopters to hold more peripheral positions than later adopters, who held more central positions than their Friends. This replicated the findings of Rogers (1964), Soule (1999) and Granovetter (1973) that focussed on the path than an innovation takes from its introduction into a network to its eventual saturation of that community. They proposed two reasons for the efficacy of network position in the acceleration of diffusion.

The first focuses on the number of ties an actor in a central or peripheral position has. The Strength of Weak Ties hypothesis (Granovetter, 1973) argues that new information is introduced to relatively closed systems when a peripheral player, with ties outside the cohesive group, delivers it, and that central actors are responsible for its quick diffusion because they are better embedded in the social group and can expose or "contaminate" (deNooy, Mrvar, & Batagelj, 2005) more people to the innovation. The results of Study 3 demonstrated such network exposure effects both during and after a period of rapid uptake, but individuals who adopted at these times were more central than their Friends, rather than adopting based on the exposure of more central Friends. This trend continued even beyond the critical mass and into the period anticipated to be dominated by a return to less-central adopters. In doing so, these results contradicted the research on exposure, which has focussed on uptake based on the number of people an individual is connected with who have already adopted.

However, the literature does account for adoption from less-embedded sources on the basis of the innovation's normative currency. Rogers (1964), Freeman

(1978) and Friedkin (1991) found that peripheral members were less conservative than their more central cohorts and are willing to adopt a less normative innovation. Indeed, in Study 3, during the months before the second acceleration period, there was a period of slow uptake that was predicted best by psychological variables. It was proposed that at this time the innovation was in the process of transformation from a phenomenon with uncertain social risk into a legitimate tool that was acceptable for people who were more embedded in the network to adopt and to support, facilitated by the psychological variables that encouraged social sense-making. The network measures were no longer significant, except for the relative centrality variable, which represented a consistent increase in the centrality of an individual as the acceleration period grew closer. Relationship strength was also a strong predictor at this time, suggesting greater social interaction around the social construction of the voice innovation for the community.

Although the density of individuals' local networks was not assessed in Study 3, it is tentatively proposed based on the results of Study 2 that the development of a norm around the voice innovation was informed by the density of the network. Indeed, at the outset of early adoption, perceived Friend use was a strong predictor, even though exposure to the innovation by Friends who had adopted in the previous month or at the same time was not. At this time in the diffusion event, it is suggested that the development of personal attitudes to the voice innovation was influenced by the projected opinions of others.

These findings offered opportunities to attend to the shortcomings of social psychological theories that have only focussed on the effects of interpersonal and normative influences on the individual in uptake of innovative attitudes or behaviours; such theories do not describe what happens after the individual adopts. Theories like Social Representations (Moscovici, 1984) and minority influence paradigms, that describe the transformation of message content towards the norms of a community (Moscovici, Lage, & Naffrenchoux, 1969), go some way in explaining social transformations of influential attributes, but they do not describe the speed with which an innovation spreads through a community, why it may not spread, or the effects that an individual's integration into a population has on uptake. Although

some theories have been developed to describe social change based on some of these aspects within the psychological fields (e.g., Latané, 1981), they do not offer explanations for why an innovative attitude or behaviour that supports the norms of a group is not successful, or why one that does not support group norms is.

In sum, it is proposed that the measures described by network analysts and social psychologists are related, and that they offer complimentary measures that can be used to predict the likelihood individuals will be influenced by attitudes or will adopt behaviours. It has been argued that network density allows psychologists to predict the social norms of groups, and that variation in network density allows them to identify how accurate or inaccurate the people in local networks are about the group's norms. In addition, measures of network position allow psychologists to identify how accurate about the group's norms an individual is likely to be, and to predict when an individual will adopt a behaviour, and what role s/he will play in the speed with which it will spread through a community.

Online influence

Second Life was identified as the domain of analysis because it was an example of a type of online medium that is growing in popularity, and because there is evidence that sources of reference for attitudes and behaviour have emerged from virtual environments. This raised questions about how the processes of social influence are affected by the interactions in these computer-mediated spaces.

Indeed, it was anticipated that virtual world participants in Second Life managed cross-media matters that may have affected online influence outcomes. For example, they were observed to attribute more or less trust, credibility, social comparison and prototypicality to online Friends based on the virtual selves other Second Life community members presented. They also negotiated the amount of control they had over a pseudonymous online identity using the features of the virtual world to both develop the avatar-self and to determine which online Friends had access to more or less information about the account holder-self. Finally, they navigated social norms in a computer-mediated environment despite the

shortcomings described by McKenna & Bargh (2000). These are the issues considered in this section.

It is important to note that this research did not set out to test the differences between online and offline as a source of influence, yet the results of the three studies were, on the whole, consistent with results of research that has described processes of interpersonal and normative influence in the psychological literature, and network structures described as influential in the network literature in offline contexts. McKenna & Bargh (2000) proposed several ways in which CMC affected influence, but this research offered evidence that the processes proposed by social psychologists were not as affected as the literature might suggest.

Online attributions

First, McKenna & Bargh suggested that the absence of physical cues in Second Life reduced the emphasis on status, expertise and liking. The results of Study 1 contradicted this, describing virtual behaviours in the online community that identified how interpersonal attributions of trust, credibility and social comparison were realised in this context. This finding confirmed the outcomes of Guadagno & Cialdini's (2005) analysis of online influence who argued that offline status may not have relevance in generic online spaces, but that this attribution did emerge in online community.

McKenna & Bargh also highlighted that there was an increase in the emphasis on the time and place of online co-presence for relationship partners because of the lack of a physical proximity to define influential interpersonal relationships. This research extended this by suggesting how the online presentation of self implicated interpersonal and normative processes.

Online identity

It appeared that the degree to which an online participant disclosed content about details of his/her offline identity to other community members described the degree to which the Friend received attributions of trust, credibility, prototypicality and social comparison. This extended Goffman's (1959) theory on the expressions

and ownership of the self into the online realm. By offering, for example, modification rights to other online participants, the account holder offered the control the ‘face-work’, or the ongoing presentation and re-presentation of a self to the interpersonal environment.

Following this theme, others have described the construction of online identity as a process towards developing avatar agency away from, but in keeping with, the offline self (Kafai, Fields, & Cook, 2007), and by offering, for example, modification rights to a Friend, participants offered control of the self-presentation to another person, putting their virtual social capital at risk. Only people who were trusted, considered credible, sources of social comparison or prototypical were allowed this permission, offering insight into what these constructs meant to community members in this virtual space.

Online norms

Guadagno & Cialdini (2005) observed that anonymity encouraged non-normative behaviour, but it was proposed by the analyses in Study 3 that online community members developed norms that were relevant to their online contexts. This replicated the findings of Correll (1995) who described the emergence of group norms in long-term online environments.

Indeed, a central finding in this research was the effect the loose online social network had on community members’ perceptions of dominant and local system-wide social norms. Overall, participants who expected that their friends held a belief or used a service were more likely to hold that belief or participate in the service as well. The interesting finding, however, was not how this expectation affected innovation adoption or attitude influence, as these are well-reported processes in offline psychological research (e.g., Katz & Rice, 2002), but rather that the diffuse online network contributed to inaccurate understanding of others’ attitudes and behaviours.

What this research found was a pluralistic ignorance effect: the perceived online group prototype was a strong indicator of influence, yet this group prototype did not reflect the reality of the virtual community members.

The scant research into pluralistic ignorance online has focussed on the relationships between false consensus, confirmation bias and the development of extremism, although these studies tend to be situated in small, single-topic asynchronous media (Wojcieszak, 2008). The analyses in this thesis uniquely showed personal attitudes and behaviours in a generic cyberspace, where a plethora of conversation themes was possible, were influenced by the beliefs that others held them or performed them. This had implications for the potential for disinformation to spread around the Web.

The synchronous, distributed feature of the Second Life design meant that avatars were likely to be in close virtual proximity when exchanging informal normative information about beliefs and practices. The relevance of observed or explicitly communicated experiences to convey social norms shed light on the relevance of Bandura's (2001) theories of online socio-cognition. He proposed that influence is both structurally and socio-cognitively diffused through mediated social systems: connectedness offers the pathways, while the interpersonal interaction supports what influence is diffused. Indeed, the co-proximity requirement, coupled with the absence of the persistent record of activity present in other online interactions, may have contributed at least in part to pluralistic ignorance in this population because these pathways were mediated by personal experiences and the communicated experiences of others. The belief that 'everyone else is doing it' was arguably inferred from beliefs about others' actions and attitudes, based from the individual's (mis)understanding of the virtual environment and the structures within it, and these rumours perpetuated through the online space. This research introduced a structural element to misperception, important for diffusion analyses and rumour studies that seek to follow pathways of information online.

Other online effects

There were other differences between online and offline environments observed than those proposed by McKenna & Bargh that may have had implications for social influence. First, the size of an individual's social network was larger than most offline research has observed. This confirmed Wellman and colleagues' (2002)

description of the size of online social networks, and in doing so supported the criticisms levied against Internet relationships outlined by Kraut and his colleagues (1998), Sigman (2009) and others. However, it was expected that by identifying the Second Life-specific network strength measures in Study 1 that identified interpersonal and normative attributions, this research was able to extract the most relevant contacts for that person.

Second, the cumulative adoption patterns during the diffusion event observed in Study 3 suggested a difference between the network and psychological processes online and offline, but these results were consistent with interdependent and highly publicised offline innovations (e.g., Gort & Klepper, 1982). Indeed, results obtained from this research more closely replicated previous research on uptake than other online innovation studies (e.g., Batorski & Kucharski, 2007). The second period of rapid uptake followed a more consistent pattern of diffusion than online innovations that have demonstrated early critical mass (e.g., Markus, 1987) or long tails (e.g., Anderson, 2006). Additionally, the first rapid uptake phase described was in keeping with other high profile diffusions.

There were also some results that were not observed that had been expected based on the literature, like the relationship between interpersonal and normative source attitudes and similarity of attitudes between two Friends in Study 2. While it may be argued that this result suggested that online relationships demonstrated inadequate source attributes to generate an effect on attitudes, the significant results from Study 1 suggested instead that trust, credibility, social comparison and prototypicality did exist, and that they worked in ways that were anticipated by the literature (e.g., Green, 2007).

The implications of these findings are that careful attention should be paid to the tools and criteria for measuring constructs in online spaces when researchers intend to measure interpersonal phenomena. This is in keeping with the literature on online data collection strategies and instrument development (e.g., Reips, 2000; Williams, 2006).

7.2. Methodological Issues and Theoretical Contributions

This study raised two overarching methodological issues, including how to conduct and maintain online research and how best to coordinate inter-related samples across three studies. These issues are discussed in turn before returning to the substantive findings of this research and concluding with a brief note on the how the results of these findings might be generalised across new media and offline theoretical paradigms.

Conducting online research

First, as outlined in Chapters 4 and 5, a snowball sampling method was employed for the sociometric surveys. This was used to capture as much participation as possible from the large Second Life population. In practice this meant that, in addition to the amount of time required to contact avatars named in each round of the research, there was substantial time spent fielding questions about the research from potential participants who were approached for their input.

Specifically, as with other pervasive online communities, many account holders viewed the purpose of Second Life as an escape from the offline world. This research breached that cultural approach of the online community; participants reported their dislike for ‘spam’ from social scientists and other researchers. Community members viewed Second Life as a private public space, in which the conceptual boundaries of the virtual world were sacrosanct, and critical and analytic observation of the activities that people engaged in were breaches of an unwritten social contract. Although there were many people who used Second Life for their own cross-media businesses (e.g., design, simulation), in general, the reaction to requests for participation was that avatars sought to keep the activities in this virtual world private. Hence, it was critical to present as an in-group member of this community, sensitive to the concerns of potential participants, in order to gain as large a sample as possible (Kendall, 1999).

In addition to establishing the Social Simulation Research Lab as a resource for potential participants, it was necessary to maintain consistency across all web

media; the Net is a resource that allows rapid information-gathering with a simple web search, and clear links between the Second Life-based research (e.g., image of the research avatar, links to the in-world research location, schedules for virtual world events) served to establish credibility in this space (Hine, 2000). All Internet communication about the research, including calls for participants and subsequent discussions with curious potential survey respondents, included links to the website. Similarly, interviews with Second Life media were arranged as opportunities to publicise the surveys, to explain the purpose of the study and the rationale for the research, and web links were included alongside these⁵⁴.

Calls for participation on online forums and weblogs offered potential participants the opportunity to ask questions, debate the research questions and to critique the method; it is recommended that researchers attend to any dialogue that occurs around content that was found to be publicly available. It was found to be important to respond clearly and fully, in a timely fashion, as the diffusion of negative information can disrupt data collection efficacy and/or schedules at times, requiring additional work by the investigator.

To counteract any negative effects of misunderstandings, clear responses were drafted and distributed: longer essays of up to four pages were sent via email, while abridged versions were posted to the forums where the debates were held. However, it was necessary to stop dialogues continuing beyond reason as this might have compromised the impartiality of participants' contributions. In this research, a maximum of two response posts to queries explaining the research and offering an overview of the rationale were considered sufficient; if potential respondents wished to continue the debate, links to the website and other supporting materials were posted.

Another result of participant apprehension was that many community members were already aware of the surveys in Studies 1 and 2 before they were contacted because previous respondents had informed them of the research. In practice, it was observed that the people approached for participation sought the

⁵⁴ See <http://bit.ly/28AbOn> for an example.

study's credibility, either by visiting the Social Simulation Research Lab in Second Life to assess the intentions of the research, or requesting more information in the form of asynchronous and synchronous conversations with potential participants who were considering involvement.

Finally, the pseudonymous participants were wary of what their involvement in the research meant for the avatars-friends whom they had nominated as contacts. They were protective of their online personal identities and those of their Friends, and some brought to attention their disquiet about being associated with Second Life sub-cultures. Their apprehensions were likely to have been aimed at protecting their online selves from the online social implications of their involvement in this research among the virtual sub-groups whom they identified within the community.

Inter-relatedness of the sample

A second set of sampling issues involved the inter-relatedness of the populations in each study. Although the format of the relationship strength ratings were different for each study, the actors who contributed to the first analysis provided demographic information that could be used for the other two studies. Any connectivity information gained by Study 1 was therefore unique to that analysis, but the other data was transferable.

Additionally, the avatars nominated by Study 1 participants offered a starting pool for Study 2, as they were part of the global Second Life population and their removal from the analysis could have disrupted the connectedness of the network. Many Study 1 survey respondents were nominated as contacts in that analysis, and thus were the recipients of relationship strength ratings, or were identified as Friends by the data provided by Linden Lab in Study 3. In practice, this meant that at least one piece of information (connectivity) about all actors in the sample was accounted for that could be used for analysis.

However, retaining information about each participant and their networks across studies meant that it was necessary to hold on to identifying data about each avatar throughout the research period. Second Life names were assigned unique user IDs for analysis, but the complexity of the three samples' datasets at the individual

and the relational levels required a master crib sheet for all avatars implicated in this research. This was used to build a series of Study-specific data tables with each survey respondent's individual-level data (attitudes, demographics, voice adoption date) and to match the nominated network neighbours with their own individual-level data (if applicable), their nominating survey respondent, and their unique ratings per relationship pair. It is recommended that research with such complex designs store any required identifying information in an encrypted format on a password-protected machine, and that no soft copies are made.

In sum, the complexity of the sampling and data management involved in this research required extra consideration in the design of the studies, researcher participation and data security. The methodology used sought to gather data that adequately described the experiences of this population.

Generalisability

Challenges of anonymous computer-mediated communication to influence theories like SIT have resulted in specialist theories like SIDE to overcome the deindividuation phenomena described by Spears & Lea (1992). This research sought to attend to many of the criticisms levied against the generalisability of online work in pervasive digital environments.

The influence processes observed in this online community were particularly relevant to the expanding social virtual world application markets, but also had bearing on influence processes for other computer-mediated media like asynchronous social networks, blogger networks and other online environments that trade in social capital based on persistent personal identity.

7.3. *Further Questions and Future Research*

The results of the analysis provided evidence that similar processes guided the influence outcomes predicted by social psychologists and network analysts in online research, but that they were complimentary. In this thesis, online influence analyses drew on processes from both disciplines, but there were several questions that arose that were outside the study design.

Negotiations between online and offline identity

Scholars with an interest in online influence tend to focus on the transitions between offline identity to online influence (e.g., Spears & Lea, 1994) or online identity to offline identity (Turkle, 1995) seeing them as separate phenomena that act upon one another rather than as a continuum. Although this was not the focus of this research, the results of the analyses in each of the studies suggested that there may have been an interaction between online and offline identity in the influence processes that took place in the Second Life online community. These follow the negotiations described by Conflict Elaboration Theory (Perez & Mugny, 1996): the decision to adopt an innovation may have been elaborated upon based on the personal and social implications of its content. However, where future work is welcomed is in examining how the elaboration is relevant to the identity both online and offline.

Online participants may be influenced in several ways by the normative constructions of innovations based on their offline social identities. SIDE proposes that participants conform to attitudes and behaviour choices of those whom they perceived to be similar to themselves offline, based on the explicit (e.g., professional associations) or implicit (offline gender, offline nationality) cues that are divulged through online interaction. Hence, offline norms – although perhaps not immediately apparent in an online environment – may contribute towards online conformity to the attitudes and behaviours of members of these identification groups.

However this approach does not consider that a space like Second Life may have the richness to support a virtual social identity that may be negotiated within the process of conflict elaboration. In this research, active, re-individuated, co-located account holders arguably negotiated their own online selves by choosing whom to disclose more or less information about themselves through the permissions they granted to them (Study 1) and the channels of communication they engaged in (Studies 1-3).

It may be that the offline social identities that would have an effect on influence are those that span the online-offline divide. For example, the use of

Second Life for online business may support the construction of the perceived usefulness of the voice service for business users of the social virtual world that becomes more important in the decision to adopt the channel than the consistency of an online identity that may be challenged by incongruous disclosure from offline.

The online and offline identity may also be made salient in adoption decisions when the deindividuation of the online medium is expected to be breached either through an existing practice or because of the content of an innovative belief or action. Although online community participants develop online selves, it has been argued that these are very personal constructions used to reflect the aspects of the self desired online (Goffman, 1959; Turkle, 1995) and may be closely intertwined with virtual community-based interpersonal relationships.

For example, in this research, control over created objects in Second Life, including the avatar and any other assets built in the virtual world, was devolved only to those people who were viewed as trustworthy, credible and viewed as sources of social comparison. A question that arises is what effect might an innovation that automatically discloses offline information about the account holder have on elaboration based on the perceived effects the offline self? Further, what effects might it have on the online social identity, based on the offline identity cues that would assign the adopter to a determined group or social category which could potentially instigate online normative conflicts (Chryssochou, 2004)? The decision to adopt in this case may be dependent on how a virtual source of social comparison or the online group prototype are expected to respond to the contents of the offline self. It may be that the second diffusion event in Study 3 was a result of the social risk that was perceived by members of the community who viewed such disclosure as a conflict. In similar cases, it may be that the adoptions of online innovations that implicate degrees of disclosure create perceived inter-group conflicts based on a duality of identity. More research on this area is recommended.

The causal relationship between offline and online has been explicitly formalised in deindividuation models such as SIDE. They argue that the negotiation of influence is informed by a primed offline identity made salient in virtuality

through cues wittingly or unwittingly revealed. This may be particularly relevant to Second Life and other social virtual worlds in which a new, online personal identity is explicitly constructed through the experiences of a characterisation that has a different name and, potentially, a different physicality⁵⁵ (Taylor, 2001; Turkle, 1995). Biocca (1997) described how offline community participants make sense of the physical, the virtual and the phenomenal bodies; it may be that the phenomenal, or unstable, body is implicated in the elaboration of influence when confronted with cross-media aspects of computer-mediated communication that implicated both the online and the offline selves. Taylor (2001) theorised that the degree to which the conflict arises is based on the amount an individual engages with the space and role-plays a new identity within it.

The negotiation of tools may also be part of the identity development process in which personal offline identity is activated in the active construction of the virtual self. To what extent is the offline identity a resource to draw on in online in social influence processes? Such identity orientations may inform online community members' decisions to develop an attitude or to engage in behaviour.

A final question demanded by this research that may implicate the negotiation between the online and offline contexts, and the focus of interest to information scientists, marketers and practitioners who wish to use online networks to engender offline social change, is how the online influence effects the offline person. There is evidence that online information campaigns do result in offline behaviour change, with the greatest public concern over the potential for extremism fostered by cyberbalkanisation (Williams, 2007). One explanation may be that the degree to which the online relationships are viewed as significant to the account holder may lead to offline influence. Further research in this area is recommended.

⁵⁵ As Turkle (1995) describes, such social virtual worlds encourage participants to play with their conventions of self, adopting identities that are largely divergent from those possible offline. This has led some researchers to call virtual communities like Second Life 'identity laboratories' in which participants actively separate their offline from their online completely and are emphatic about maintaining the division between the two.

Finally, a related question called for by the results of this research is what effect online pluralistic ignorance has on offline attitudes and behaviours.

Wojcieszak's (2008) study found that offline attitudes became more extreme; the pluralistic ignorance findings of Study 2 provoke further questions about this process.

Structure, psychology and influence

First, this research suggested a tentative relationship between network position and psychological interpersonal and normative features of influence. However, this was not directly assessed. It is recommended that future research seek to identify the psychological attributions of network position.

One explanation proposed by structural network analysts is that the processes that contribute to influence are based on structural equivalence, i.e. actors in similar positions around the network are subject to equivalent influence – resulting in similar times of adoption – because they have access to the same kind of information. The limitation to this theory is that it relies on the subjects of influence to have a macro understanding of their network. However, it is a purely structural conceit that has demonstrated significant predictions that may go some way in explaining why centrality offers explanatory power over and above psychological attributes (Burt, 1987).

Second, it was proposed in Study 3 that the voice innovation transformed from a socially risky phenomenon adopted by peripheral actors to a more legitimate prospect adopted by central actors after a period of sense-making through discussion with or observation of close Friends. This had not been observed or examined in online situations, but on the basis of the outcomes described in Study 2, it is proposed that the norms of the online social group would evolve over time. It would be valuable to follow the shifts in attitude as an online diffusion event occurred to assess how norms are established in the computer-mediated medium.

Finally, the types of innovations examined in this research also offered insights that may be useful for future research. The implications of the content have been described with respect to the potential normative negotiation of online/offline

identity previously in this chapter. Markus (1987) might argue the voice innovation observed in Study 3 fell into a particular category: the interdependent nature required participation by all parties if it was to succeed. This brings questions to bear about the speed with which it was adopted and the motivations for adopting. Other types of innovations, with respect to content, efficacy and demands for reciprocation have diffused through offline populations in different ways; they are also expected to disseminate through online populations differently. It therefore would be interesting to examine the interpersonal features of a diffusion that does not implicate a system-wide adoption in order to identify whether the early critical mass effect observed in the Study 3 cycle or the experiential clustering effects observed in Study 2 are still apparent, and what effect the new innovation might have on the negotiation of the online and offline personal and social identities.

Online influence in different online contexts

It has been suggested in the Internet research literature that online identity is not consistent across virtual contexts (e.g., Turkle, 1995). Talamo and Ligorio (2001) proposed that identity was a strategic construction across cyberspace, while Turkle (1995) described similar multiplicity across different online contexts, and how many multiple identities were active at once.

The Web arguably offers many simultaneous interactive opportunities, from e-commerce sites to communities of practice. Research has suggested that online participants represent themselves in as many ways as the offline space affords. Arguably, there may be an effect of different cross-media identities that might have affect attitudes and behaviours, for example, in the diffusion of beliefs and actions that are not tied to one Web context.

Salient or persistent personae may be transferred from one environment to the next, with participants maintaining an avatar name in different online spaces used to signal self to others who have made transitions between communities or have similar cross-media interests. It is proposed that the persistence of virtual identity across different web environments may contribute to understanding the rapid spread of memes and other information. Further research in this area is recommended.

Affordances of the Internet medium for influence research

Finally, the automated data extraction method used in this research represented a unique opportunity to test existing theories of influence using behavioural data in naturalistic settings, rather than in self-reported constructs. Although there are limitations to the findings that can be made using computer-generated data sets, with well-designed analyses, the benefits of behavioural data mean that insights can be gained and knowledge extended (Shadbolt & Berners-Lee, 2008).

7.4. *Conclusion*

This research set out to understand what social network analysis could offer, in addition to social psychological theories, to the prediction of influence in an online community. It identified the relationships between network and psychological features, and their complimentary roles in predicting attitudes and behaviour. In addition, this work contributed to the theoretical dialogue about the meanings of online interactions for influence.

It identified the structural and normative effects which pluralistic ignorance in the loosely connected online network had on virtual community members, and proposed that these perceptions may engender cultures of extremes. Additionally, this research identified the unique processes in network and psychological descriptions of social systems and relationships that warranted further scrutiny. That they are not full proxies for one another raised questions about what structural, positional and interpersonal uniquely contribute to influence.

It also offered support for research that has placed emphasis on network strength. It argued that structural paradigms that have sought only to measure connectivity rather than taking into consideration interpersonal and normative attributions have not fully explained the processes of diffusion.

Finally, this work supported the outcomes of online communications research by describing the processes that contributed to attitude and behaviours in the loose and transient Internet environment.

These phenomena were described using behavioural observations and self-reported experience in an active virtual community. The processes by which human behaviour was captured and documented reflected an exciting multi-method opportunity for psychologists to generate theories of a massive scale. This research provided support for the richness of behavioural data in online environments and the richness of interpersonal connections in Internet communities. As people increasingly integrate their online and offline selves, sharing experiences and influence in virtual environments, researchers will be able to observe new, emergent phenomena through the patterns of observed in these behaviours.

Yet online influence is arguably unique because the virtual environment allows people from around the world to connect with one another and to be co-present with people similar to themselves. The influence they have is disengaged from the physical reality, but the people behind the avatars make social connections that influence one another and their physical and conceptual worlds.

8. References

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9. Appendices

9.1. Appendix A. Study 1 Survey

Thank you for coming to the Social Simulation Research survey site. This page contains information about the survey we would like to invite you to take. This study, designed toward research towards a PhD at the [University of Surrey](#), examines social communication patterns in online spaces. It has five sections.

The first three sections explore how networks of friends work, including who's connected to whom and how contacts relate to one another. The last two sections deal with how the Second Life community understands public health risks. It should take approximately 30 minutes to complete the full survey.

You will be typing in names of friends and acquaintances into the survey and selecting from menus or choosing from lists. Please ensure that you can have access to the names on your Calling Card list while completing it.

All responses will be kept confidential, and pseudonyms will be used when appropriate. Your participation is voluntary. If you decide not to participate or choose to discontinue your participation at any time during the course of the survey, there will be no penalties or loss of benefits.

If you would like to find out more about this research, please visit the [research website](#). More information is also available in Second Life at the in-world Social Simulation Research Lab located [here](#).

This research has the full support of Second Life developers [Linden Lab](#), and is conducted in accordance with the Second Life Research Agreement.

Please click "Agree" to confirm that you understand the information above and that you are ready to begin the survey. Thank you.

Demographic Information

1. What is your main alt's Avatar name? (*free-response field*)
2. How old are you (offline)? (*drop-down menu*)
3. Where do you live (offline)? (*drop-down menu with countries*)
4. What is your gender (offline)? (*drop-down menu: male-female*)
5. What is the gender of your avatar? (*drop-down menu: male-female*)
6. How long have you been a resident in Second Life? (*drop-down menu: less than 3 months, 3-6 months, 6-9 months, 9 months - 1 year, 1 year - 1 ½ years, 1 ½ - 2 years, 2+ years*)
7. On average, how many hours are you in Second Life per week? (*drop-down menu: 1-5, 5-10, 10-15, 15-20, 20+*)

Section 1. Your personal social network: Who's in your social network?

In the space provided, please list all of the avatars on your Friends list. Please include the avatars' first and last names. If multiple avatars relate to the same person offline, please list only the avatar that you are in contact with most regularly.

Click "Submit Avatar" when you have finished adding that name are ready to add another. After completing your list, please continue to the next page.

Avatar Name

Section 1. Your personal social network: Who's in your social network?

Looking at the list you have created, are there any avatars you are likely to put on your Friends list soon? Please include the avatars' first and last names. If multiple avatars relate to the same person offline, **please list only the avatar that you are in contact with most regularly.**

After completing your list, please continue to the next section. Click "Submit Avatar" when you have finished adding that name are ready to add another. After completing your list, please continue to the next section. *Free-response*

Avatar Name

Section 2. Your personal social network: Your relationship with your social network.

This section is about your relationships with the avatars on your Friends list. We want to know a little bit more. How close is the person represented by each avatar to you as a friend? *Drop-down menu: Very close, Close, Neither close nor distant, Distant, Merely an acquaintance – not close at all.*

- Please respond thinking about your relationship with the person who is represented by the avatar.

Avatar Name	8. How close is this person to you as a friend?

Section 2. Your personal social network: Your relationship with your social network.

Based upon your responses to the previous questions, we have narrowed down your list to those people who you are in touch with regularly. This is your Second Life Network. We'd like to know more information about your interaction patterns with these people. Please respond to the following questions. *Drop-down menu: Once a day to several times a day; Once a week to several times a week (but not every day); Once a month to more than once a month (but not every week); Less than once a month; I do not speak with this person in this context at all nowadays.*

- Please respond thinking about your relationship with the person who is represented by the avatar.

<i>REDUCED LIST (excludes all avatar names marked as "I don't speak with this person at all nowadays")</i>	9. How often do you speak with this person in public in Second Life?	10. How often do you speak with this person via IM in Second Life?	11. How often are you in contact with this person outside of Second Life
Avatar Name			

Section 2. Your personal social network: Your relationship with your social network.

The next questions are about your relationships with each of the avatars you consider close friends. We want to know a little bit more. How much do you agree or disagree with each statement? *Drop-down menu: Completely disagree, Disagree, Neither Disagree or Agree, Agree, Strongly Agree*

- Please respond thinking about your relationship with the person who is represented by the avatar.

<i>REDUCED LIST Avatar Name</i>	12. I would feel comfortable giving modification rights of my avatar to this resident.	13. I would feel comfortable being in-world partners with this avatar.

Section 3. Your personal social network: Your relationship with your social network.

Please answer the following questions about your relationships with each of the avatars in your Second Life Network. How much do you agree or disagree with each statement? *Drop-down menu: Completely disagree, Disagree, Neither Disagree or Agree, Agree, Strongly Agree*

- Please respond thinking about your relationship with the person who is represented by the avatar.

<i>REDUCED LIST Avatar Name</i>	14. This person is reliable.	15. I consider this person to be well informed about a wide range of issues.	16. I like this person.	17. I tend to believe what this person says.

Section 3. Your personal social network: Your relationship with your social network.

These questions are about your relationships with each of the avatars in your Second Life Network". How much do you agree or disagree with each statement? *Drop-down menu: Completely disagree, Disagree, Neither Disagree or Agree, Agree, Strongly Agree*

- Please respond thinking about your relationship with the person who is represented by the avatar.

<i>REDUCED LIST Avatar Name</i>	18. If I am the least bit uncertain how to act in a social situation, I look to the behaviour of this person for cues.	19. I find that I tend to pick up slang expressions from this person and use them as part of my vocabulary.	20. This person has qualities that are typical of the people in my Second Life Network.

Section 3. Your personal social network: Your relationship with your social network.

These questions are about your relationships with each of the avatars in your Second Life Network". How much do you agree or disagree with each statement? *Drop-down menu: Completely disagree, Disagree, Neither Disagree or Agree, Agree, Strongly Agree*

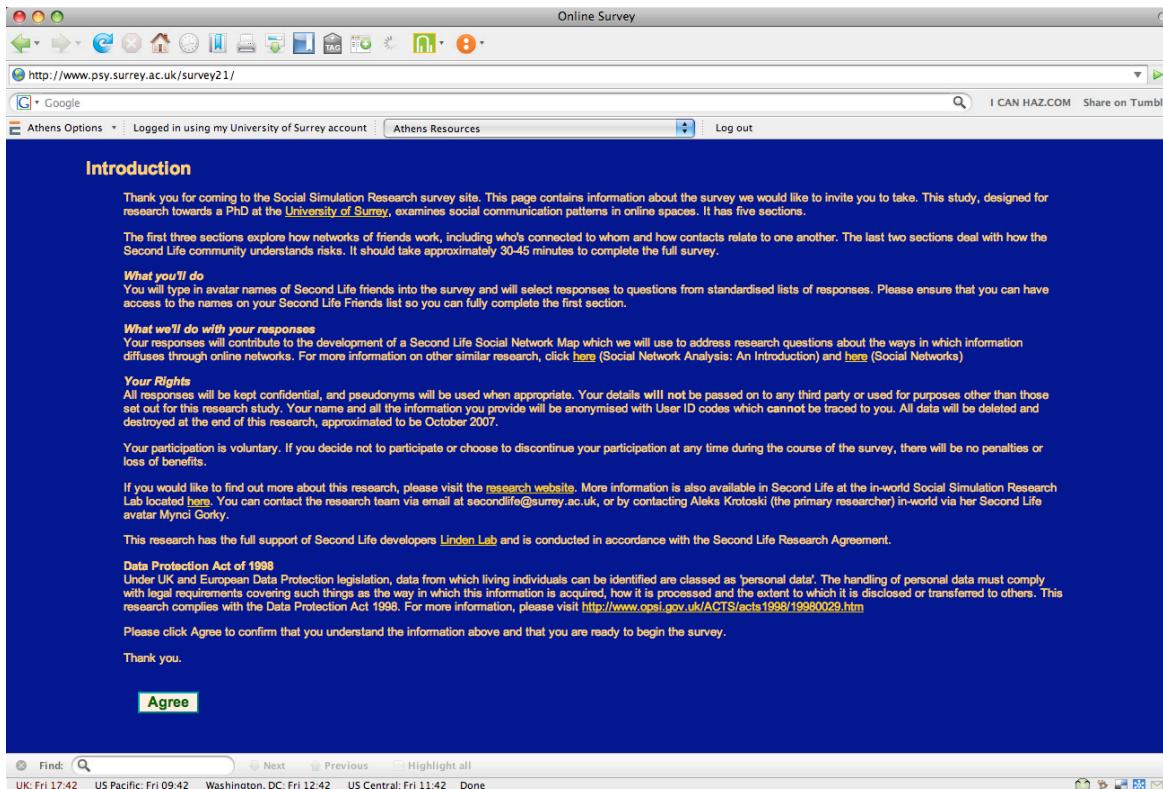
- Please respond thinking about your relationship with the person who is represented by the avatar.

<i>REDUCED LIST Avatar Name</i>	21. This person is honest	22. This person cares about me.	23. This person and I share similar values and beliefs.	24. This person is trustworthy.

--	--	--	--	--

Thank you for taking part in this research. If you wish to find out more information, please feel free to find Mynci Gorky in-world, see the [research website](#) or contact the researchers by email outside of Second Life (secondlife@surrey.ac.uk).

9.2. Appendix B. Study 2 Survey⁵⁶



⁵⁶ This survey is located at <http://www.psy.surrey.ac.uk/survey21/>.

Demographic Information

8. What is your main alt's Avatar name? (*free-response field*)
9. How old are you (offline)? (*drop-down menu*)
10. Where do you live (offline)? (*drop-down menu with countries*)
11. What is your gender (offline)? (*drop-down menu: male-female*)
12. What is the gender of your avatar? (*drop-down menu: male-female*)
13. How long have you been a resident in Second Life? (*drop-down menu: less than 3 months, 3-6 months, 6-9 months, 9 months - 1 year, 1 year - 1 ½ years, 1 ½ - 2 years, 2+ years*)
14. On average, how many hours are you in Second Life per week? (*drop-down menu: 1-5, 5-10, 10-15, 15-20, 20+*)

Section 1. Your personal social network: Who's in your social network?

In this section, you will generate the names of those people whom you are most regularly in contact with in Second Life in order to form your personal social network. In the space provided, please list each of the avatars on your friends list with whom you have communicated SOCIALLY (i.e. your interaction must have been primarily social, rather than primarily business-centred).

Please include the avatars' first and last names. Click "Submit Avatar" when you have finished adding that name and are ready to add another. If multiple avatars relate to the same person offline, please list only the avatar that you are in contact with most regularly. If you have more than 50 avatars on your Friends List who fit this criteria, please email secondlife@surrey.ac.uk and list ONLY those avatars whom you are still in contact with below.

After completing your list, please continue to the next page. *Free-response*

Avatar Name

Section 1. Your personal social network: Who's in your social network?

Looking at the list you have created, are there any avatars you would like to add who are currently not on your Friends List, but who you feel are friends? Please include the avatars' first and last names. Click "Submit Avatar" when you have finished adding that name and are ready to add another.

If multiple avatars relate to the same person offline, please list only the alt that you are in contact with most regularly. After completing your list, please continue to the next section. *Free-response*

Avatar Name

Section 2. Your personal social network: Your relationship with your social network

This section will help us narrow down your social network.

* Please respond thinking about your relationship with the person who is represented by the avatar.

15. Please select those avatars you are NOT in contact with at all nowadays.

Section 2. Your personal social network: Your relationship with your social network.

Based upon your responses to the previous questions, we have narrowed down your list to those people who you are in touch with regularly. This is your Second Life Network. The relationships you have with each person are likely to be different. Some are expected to be closer to you than others.

In order to determine where each avatar is positioned in relation to you, we need more information about your interaction patterns with these people.

- * Please respond thinking about your relationship with the person who is represented by the avatar.
- * Please tick as many times as is relevant, but each avatar MUST be selected at least once across the four statements.

16. Please select those avatars you are likely to speak with in public in Second Life.
17. Please select those avatars you are likely to speak with via IM in Second Life.
18. Please select those avatars you are likely to speak with outside of Second Life.
19. Please select those avatars whom you consider to be a close friend.

Section 3. Your personal social network: Your relationship with your social network.

From the responses you selected in the previous section, we have identified those people you consider to be your closest and most distant friends. Your responses to the questions in this section will help to pinpoint exactly where each person lies in relation to you and to the other people in your social network. Please answer the following questions about your relationships with each of the avatars.

How much do you agree or disagree with each statement?

- * Please respond thinking about your relationship with the person who is represented by the avatar.
- (Drop-down menu: Completely disagree, Disagree, Neither Disagree or Agree, Agree, Strongly Agree)

20. I tend to believe what this person says.
21. I consider this person to be well-informed about a wide range of issues.
22. This person is honest.
23. This person and I share similar values and beliefs.
24. I like this person.
25. If I am the least bit uncertain how to act in a social situation, I look to the behaviour of this person for cues.
26. I find that I tend to pick up slang expressions from this person and use them as part of my vocabulary.
27. This person has qualities that are typical of the people in my Second Life Network.

Section 5. Your attitudes

In this final section of the survey, we'd like to know how you and your closest friends feel sexual activity in Second Life. This will help us to understand what role this activity plays in your Second Life.

28. I have experienced sexual activity in Second Life (Yes, No, Don't Know)
29. I believe it is safe to engage in sexual activity in Second Life. (Drop-down menu: Completely disagree, Disagree, Neither Disagree or Agree, Agree, Strongly Agree)
30. I believe it is safe to engage in sexual activity in Second Life with avatars I have just met. (Drop-down menu: Completely disagree, Disagree, Neither Disagree or Agree, Agree, Strongly Agree)
31. I feel being exposed to sexual activity in Second Life is a risk worth taking. Drop-down menu: Completely disagree, Disagree, Neither Disagree or Agree, Agree, Strongly Agree

Thank you for giving us your ratings. Now, we'd like to know what you think the people you are closest to in Second Life think about sex in this virtual world. What do you think are their experiences?

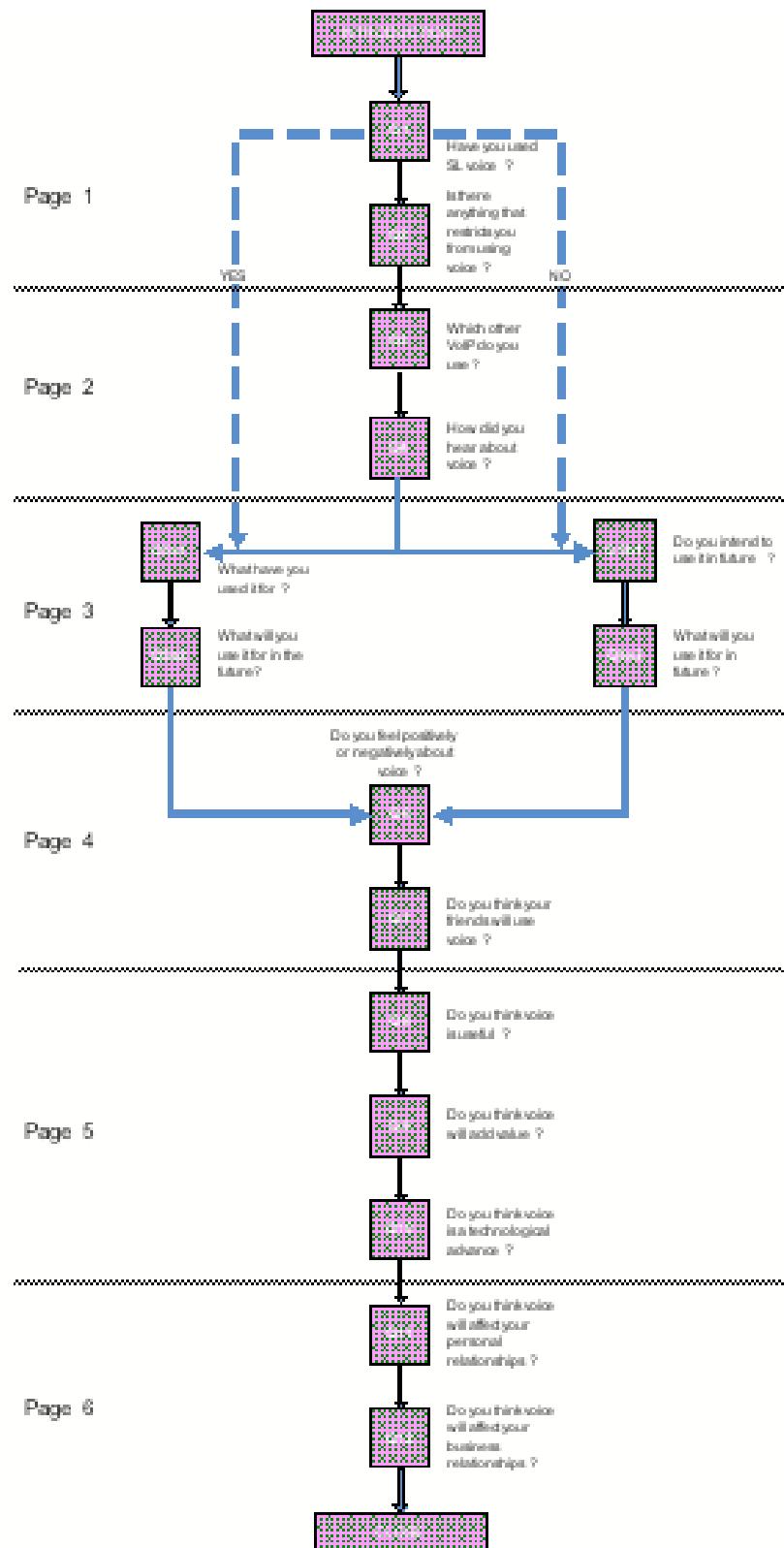
32. One or some of my close friends have experienced sexual contact in Second Life.
33. My close friends believe it is safe to engage in sexual activity in Second Life. Drop-down menu: Completely disagree, Disagree, Neither Disagree or Agree, Agree, Strongly Agree
34. My close friends believe it is safe to engage in sexual activity in Second Life with avatars they have just met. Drop-down menu: Completely disagree, Disagree, Neither Disagree or Agree, Agree, Strongly Agree

35. My close friends feel being exposed to sexual activity in Second Life is a risk worth taking.
Drop-down menu: Completely disagree, Disagree, Neither Disagree or Agree, Agree, Strongly Agree

End of Survey

Thank you for taking part in this research. If you wish to find out more information, please feel free to find Myncei Gorky in-world, see the research website or contact Aleks Krotoski by email outside of Second Life (secondlife@surrey.ac.uk).

9.3. Appendix C. Study 3 Survey



Introduction

Voice communication has arrived in Second Life! We want to make sure the technology suits your needs, so please take 5 minutes to let us know how you feel about and intend to use it. There are 12 multiple choice questions on the next few pages. Questions? Contact aleks@lindenlab.com.

To Participate, please enter your Second Life name below:

- Your SL name is used as a unique identifier and to validate that you are a "real" member of Second Life.
- Your SL name will only be used as a unique identifier for Linden Lab, the makers of Second Life. Third parties who are not part of Linden Lab will NOT see or receive your SL name in any form.
- All data will be destroyed at the end of the survey period.

Non-PC users, please click here to complete the survey.

Page 1

1) Have you already used Voice in Second Life (on either the Beta Grid or on the Main Grid)?

- Yes
No
Not Sure

2) Is there anything technological, physical or environmental which restricts you from using Second Life's Voice service?

- Yes, I am restricted
No, I am not restricted
Not Sure
-

Page 2

3) Which other Voice over Internet Protocol (VoIP) services do you use to communicate with other Residents when logged on to Second Life?

- Skype
Google Talk
MSN
Yahoo
Gizmo
Landline telephone provider
Other
None

4) How did you hear about Second Life's Voice communication? (Please tick all that apply)

- Friend
Business colleague
Overheard someone talking about it in public
Overheard someone talking about it during a group IM
Official Linden Blog
Second Life Resident Blog
Other online source (e.g., webpage or blog)
Offline publication
This is the first time I've heard about Voice
-

Page 3 (see diagram on Page 1 of this document)

Respondents who answer YES to Q4 answer Q5a1 and Q5a2.

5) What have you used it for? (Please tick all that apply)

- Public chat with one other person
- Private IMs with one other person
- Public chat with many people
- Private IMs with many people

6) What do you think you'll use it for in the future? Please select all that apply

- To chat with Friends in public
- To chat with Friends in private
- To chat with colleagues in public
- To chat with colleagues in private
- To send voice messages to friends
- To send voice messages to groups
- For Second Life business
- For RL business
- To meet new people
- To organise group activities/events
- To make presentations
- For in-world performances
- Other
- I don't intend to use voice

Respondents who answer NO to Q4 should answer Q5b1 and Q5b2.

5) Do you intend to use it in the future?

Yes No Not Sure

6) What do you think you'll use it for in the future? Please select all that apply

- To chat with Friends in public
- To chat with Friends in private
- To chat with colleagues in public
- To chat with colleagues in private
- To send voice messages to friends [?is this applicable?]
- To send voice messages to groups [?is this applicable?]
- For Second Life business
- For RL business
- To meet new people
- To organise group activities/events
- To make presentations
- For in-world performances
- Other
- I don't intend to use voice

Page 4

7) Do you generally feel positively nor negatively about the introduction of Voice communication in Second Life?

- I feel positive
- I feel negative

Not Sure

8) Do you think your friends will use Voice?

Yes

No

Not Sure

Page 5

9) Do you think Voice is a useful feature for Second Life?

Yes

No

Not Sure

10) Do you think voice communication will add value to Second Life?

Yes

No

Not Sure

Page 6

11) Do you think Voice communication is a technological advance?

Yes

No

Not Sure

12) Do you think Voice communication will have an effect on your personal relationships?

Yes, in a positive way

Yes, in a negative way

No, it won't affect my relationships

Not Sure

13) Do you think Voice communication will have an effect on your business relationships?

Yes, in a positive way

Yes, in a negative way

No, it won't affect my relationships

Not Sure

Thank you for your responses! We may contact you again in the future for more of your thoughts on this issue. If you would like to be included, please indicate.

I would like to be contacted in the future No thank you

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