Virtual Mimicry: an exploration of unconscious behaviour change technique in human computer interaction

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Abstract

Mimicry, also known as mirroring, is one of the most common unconscious behaviours in the psychology area. Psychologists believe that people always have an unconscious intend to mimic other postures, mannerisms and facial expression during their interaction to understand others emotion and thinking. Mimicry is a complex unconscious behaviour which consists of four types: behaviour mimicry, facial mimicry, verbal mimicry, emotional mimicry. Previous research indicate that the consequences of mimicry could lead to many positive behaviours and feelings, such as increasing trust, liking, emotional and behaviour convergence and even changing opinion. Moreover, mimicry has been applied as a powerful behaviour change tool in the human and human relationships. Researchers have begun to notice the potential of mimicry in the human computer relationship and established the idea of "Virtual Mimicry". However, due to lack of the adequate research and the limitation of previous technologies, we are still not able to fully understand virtual mimicry. Therefore, it is important for us to continue to explore how virtual mimicry could be applied as an unconscious behaviour change tool in the human computer interaction area.

The purpose of this study is to explore the effect of virtual mimicry to improve unconscious behaviour- change intervention. Baes on previous research, we had two hypotheses: 1. Virtual Agent mimic can increase users positive feeling, including liking, trusting 2. Virtual Agent can use Virtual Mimicry to increase people unconscious tendency to specific conten**t.** To exam our hypotheses, this research had built its own virtual mimicry system by combine different materials and used IAT (Implicit association test) as implicit measure and liking, trust, IOS and Explicit attitude towards food scale as explicit measure. However, due to many factors we did not find any significant difference between Mimicry and Non-Mimicry group in both explicit and implicit measure.

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Chapter 1 Introduction

Technology is changing the way how human interact with their smart devices. With the advance of modern technology, the function of smart devices has been evolved from a simple communication tool to an advanced personal assistant. Therefore, more and more studies start to focus on developing new types of behaviour change techniques based on the internet and mobile device. However, one of the problems of modern behaviour change systems is that conscious interventions have many limitations. Due to the limitation of conscious intervention behaviour-change techniques, scientists begin to pay attention to the role of unconscious intervention in behaviour change techniques.

Mimicry, also known as mirroring, is one of the most common unconscious behaviours in psychology. Psychologist believe that people always have an unconscious intend to mimic other postures, mannerisms and facial expression during their interaction to understand their opponent's emotion and thinking. In the past long history, there are many research related to mimicry. One of the most famous theories is "**The Chameleon effect**"(Chartrand & Bargh, 1999), The Chameleon Effect believes that "one's behaviour always passively and unintentionally changes to match that of others in one's current social environment as a social glue." (Chartrand & Bargh, 1999)

Previous research indicate that the consequences of mimicry could lead to many positive behaviours and feelings, such as increasing trust, liking, emotional convergence and even opinion. Since psychologists realize the power of mimicry, they try to apply for the benefit of individual humans and human relationships, such as teacher and student relationship in education, or therapist-patient relationship in psychotherapeutic. In these studies, mimicry has been proven to increase liking and trust between mimickers and mimickees.

Recently, researchers have begun to noticed the potential of mimicry in the human computer relationship and then establish the idea of "Virtual Mimicry". However, due to the lack of adequate research and the limitation of previous technologies, researchers are still not able to fully understand virtual mimicry and how to apply it to behaviour change intervention. Therefore, more evidence for virtual mimicry study is needed to build a solid unconscious behaviour change intervention system. Thus, it is important for us to continue to explore how virtual mimicry could be applied as an unconscious behaviour change tool in the human computer interaction area.

1.1 Research purpose and experiment

The purpose of this study is to explore the effect of virtual mimicry to improve unconscious behaviour - change intervention. This study will explain what mimicry is and how we could use the positive consequences of mimicry to influence users' unconscious preference to healthy foods. The aim of the experiment is to prove that virtual mimicry can increase user's positive feelings, including liking, trust and virtual agent can use virtual mimicry to increase people's unconscious tendency to specific content (preference for food). To achieve our purpose, we design a pre-test – post-test control group design experiment. Based on previous literature, the

software FaceRig is used to create and control our experiment avatar and IAT (Implicit Association Test), with liking and trust scale being implicit and explicit measurement.

1.2 Result of experiment

After having recruited 30 people for the experiment, it is found that there are no significant differences between the mimicry group and the control group (non-mimicry) in liking and trust towards our avatar. There are also no significant differences in the Implicit Association Test to health food and unhealthy food between the two groups. The result does not match our expectation. There are many factors that might cause this result such as a small sample, participants' background and mimickee effect. Another important factor that we discover is the effect of Uncanny Valley between participant and avatar during the experiment.

1.3 Structure

As we mentioned above, the purpose of this study is to explore the effect of virtual mimicry to improve unconscious behaviour change intervention. In Chapter 2, we first review relevant literature in sociology and psychology to establish a foundation for understanding the mimicry in the human-human relationship. We then review the related work of virtual agent and behaviour change technique for wellness. In Chapter 3, we will provide the design of our experiment, including experiment equipment, design of dialogue, the experiment process, and the materials that we use to measure implicit and explicit attitude. Chapter 4 will present the result of the experiment and the discussion about it. In the Chapter 5, we will continue discuss the result of experiment and point out some factors that might have influence our result. Finally, we will draw out the blue print for the future unconscious behaviour change studies base on the research in Chapter 6.

Chapter 2 Literature review

2.1 Perspective on Mimicry

You smile, I smile. People mimic each other in nearly every single social interaction. Even though the mimicry happens so frequency in our social interaction, most of time both mimicker and mimickee are not aware of it. Mimicry is unconscious behaviour. Specifically, Non-conscious mimicry is defined as the tendency of people to mimic each other without any intent or awareness. In theory, there are four major types of mimicry: Facial mimicry, Behavioural mimicry, emotional mimicry, Verbal mimicry. These four types are not separate elements; they will combine most of time.

It has a been long history when people discovered nonconscious mimicry behaviour, however, many researchers used empathy (Gordon Allport, 1968), sympathy (Charles Darwin, 1965) or other terms to describe mimicry behaviour at that time. In 1964, Scheflen first discover that postural configuration was a source of information about an ongoing social interaction. Latter in the postural study indicate postural information could be unconsciously used by people to orient themselves in a group. (Bernieri & Rosenthal, 1991).

Since Mimicry has become a major topic in psychology and sociology area, many different theories try to explain the mechanical system behind mimicry. From a biology perspective, Mirror neurones is the key point for people to understand mimicry. Science define mirror neuron is a neuron that become active when animal act a particular action or observe others do the same action. Mirror neuron was discovered in monkey brain area F5 when neuroscientists studied how monkey understand behaviour. (Di Pellegrino et al. 1992, Gallese et al. 1996, Rizzolatti 2004). The major function of mirror neurons in Monkey is action understanding, both Kohelr (2002) and Umilta (2001) experiments show the activity of mirror neurons correlates with action understanding.

Meanwhile, neuroscientists demonstrate that mirror- neuron system also exists in human being. By using Brain Imaging method such as EEG and fMRI recording, neuroscientists revealed that when an individual observe an action by other, their motor cortex will become active. Similar to the monkey's mirror neurons, human mirror neurons system is correlated with action understanding, there are some experiments like Iacoboni et al, (1999,2001), Rizzolatii & Arbib (1998) show Mirror-Neuron system has strong relationship between limitation learning and communication system.

However, the studies of mirror neuron in humans are just began, no any mirror-neuron system that is widely accept by the public so far, and there are still have many types of mirror neurons that we don't fully understand. But many experiments in neuroscience and cognitive psychology can support the idea that Mirror neuron is the essential biology base of mimicry in humans, without it or any damage in the pre-cortex area might lead to social disorder like Autism, Social Anxiety disorder, we will also have a further discussion in this part. (Rizzolatti, 2004).

2.1.1 Types of mimicry

Base on previous research, there are four types of mimicry: Facial mimicry, Verbal mimicry, Behavioural mimicry and Emotional mimicry. All these types have different parts but also link to each other tightly:

2.1.1.1 Facial mimicry

We always tend to react with congruent facial expression when looking at an emotion face (Dimberg, 1982) Facial mimicry is the most obvious mimicry for people to notice. Back to 1970, Andrew Meltzoff (1983) discovered that even new born babies are able to react to the facial expression from the other. Further, infants with 9 months old can even response to their mother's joy and sadness facial expression (Termine&Izard 1988). Meanwhile, Mother will open their mouth unconsciously when they try to feed their babies (O'Toole and Dubin 1968).
Facial mimicry not only is a communication tool but also lead to emotion change. For example, Dimberg (2000) shows that positive and negative emotional reactions can be elicited both rapidly and unconscious, Basing on **Facial- Feedback Hypothesis**, Facial muscle activity is essential for the occurrence of emotion experience, he claims that "evocation of facial reaction may constitute an important mechanism and form the basis for affecting emotional experience." Dimberg (2000. Another common phenomenon in our life is that marriage couple become similar to each other in facial appearance as time go by. Zajonc et al. (1987) compared photographs of couples when they were first married and 25 years later and he points out "After 25 years the two spouses are perceived as more similar in appearance by the subjects, and that they are judged more likely to be married to each other." To explain this phenomenon, he uses **Theory of Emotional Efferent** emerged. Theory of Emotional Efferent is very like Facial - Feedback Hypothesis, they both admit the strong relationship between emotion experience and facial muscles. As couples tend to share emotion, feeling state, increase their empathy to each other, physical features of their face will become similar as well. In short, Zaionc's (1987) study shows that physical appearance and emotion of couple will convergence. Besides, many evident indicate that automatic facial mimicry can facilitate social interaction, including interpersonal rapport, emotional contagion and emotion recognition. (McIntosh et al., 2006; Ekman, 1993; Lundquist & Dimberg, 1995; McIntosh, 1996; Niedenthal et al., 2005).

2.1.1.2 Verbal mimicry

People mimic speech pattern and characteristics of others. Like facial mimicry, Simner (1971) and Sagi & Hoffman (1976) shows 2-4 days' new-born infants will mimic crying to response other babies crying which also known as contagious crying study. Previous research support that partners tend to match each conversation tendencies in many ways. Cappella and Panalp (1981) found that when participants were asked to communicate with each in 20 minutes, participants would mimic the speech rhythms of their counterparts. Besides, people mimic the accents (Giles & Powesland, 1975) and speech rate (Webb, 1969) of their counterparts.
Another important study researchers notice is the **Contagious Effect of Laughter.** Provine (1992) observed response of 128 subjects in three undergraduate psychology class to laugh stimuli produced by a"laugh box". He points out that laughter generated by a laugh box is a sufficient stimulus for laughter and smiles. He believes Contagious Laughter provides a reliable,

potent and entertaining classroom demonstration and it is a good example of social coupling process the synchronises the biological and behavioural state of a group. Although the effects of Canned Laughter (a fake laughter made to encourage audience laughter in the television show) are still conversional (Platow et al. ,2005), previous research indicates that the verbal mimicry can improve the participants' laughing when they hear a laughter track.
Recent research suggests "**The Echo Effec**t" as a new direction to study verbal mimicry, Kulesza (2014) shows repeating others' words can increase an individual's tendency to perform prosocial behaviours. He demonstrates that verbal mimicry is more powerful mechanism than dialogue and it can facilitate one's willingness to engage in helping behaviour.

2.1.1.3 Behavioural mimicry

People mimic posture, gesture and motor movements of another in daily social interaction. One good example of Behavioural mimicry is the effect of televisions on children and young. The previous literatures in social learning have been strongly support the idea that TV violence can lead to aggressive behaviour (Bandura, 1977; Berkowitz, 1993). Butterworth (1999) points out that human and primate young have an innate tendency to imitate whomever they observe. Observation of specific aggressive behaviours around them increase children's likelihood of behaving in exactly that way (Huesmann, 2003).
Another common phenomenon in our life is that people will unintentional mirror each other's behaviour during their conversation. In Chartrand and Bargh (1999) experiment, participants are asked to describe various photographs with two different confederates. Confederates varies their mannerism throughout the interactions: confederate 1 will keep rubbing his face during the conversation while confederate 2 will keep shaking foot. The results of their experiment show that the behaviour of participants unintentionally matched that of strangers with whom they worked on a task. Chartrand and Bargh (1999) creates **"Chameleon Effect"** to explain this kind of tendency to adopt the postures, and mannerisms of interaction partners. Chartrand and Bargh (1999) propose Chameleon Effect is "The mechanism behind mimicry and behavioural coordination and thereby is the source of the observed smoother social interaction interpersonal bonding produced by the (nonconscious) mimicry." Moreover, their latter experiment shows perception of another's behaviour could unconscious increase perceivers' tendency to behave in a similar manner. The more confederates rubbed their face the more participants will rubbed faces as well.

2.1.1.4 Emotional mimicry

Emotional Mimicry means the action for observation spontaneously mimic emotional expression. Compare to the other three types of mimicry, emotional mimicry is more complicate and implicitly. We always have a need to the communication of emotions. We feel and express emotions towards the people we care about, and if people do not response any emotions back to us we will feel upset (Fischer et al., 2016). For example, In the love relationship, we want to share our feeling with partners as well as expect they share theirs. Emotional Mimicry helps us to read and understand other's feeling/emotion automatically.
Another prove for emotional mimicry is that Emotion is contagious, In the book "Emotional Contagion" Hatfield, Cacioppo, and Rapson(1992) define mimicry as 'The tendency to

automatically mimic and synchronise expressions, vocalisations, postures, and movements with those of another person, and consequently, to converge emotionally' (Hatfield, Cacioppo, & Rapson, 1992). Emotional Mimicry play an essential role in emotional contagion. Hess and Blairy (2001) shows that mimic expressions of happiness and sadness will arouse emotional contagion however, they also proves that angry and discuss can't arouse emotional contagious. Iacobini et al. (2009) studies emotional contagion patterns and factors that affect how people emotionally engage in art context. In their art project, they uses facial expression recognition technology to detect the audience's emotional state and then respond to the audience with the same emotional expression with their emotional video portraits. Their result that short emotional video can stimulus to elicit visible emotional reaction in the observer match Hess and Bilary idea and Iacobini also points out that automatic mimicry and counter-mimicry correlated to some extent to whether the audience felt to be interacting with a real person.

However, Emotional mimicry is less ubiquitous than the other kinds of mimicry behaviours and it is not always occurred between people. Present studies argue that mimicry or mirror normally base on the similarity personality traits between senders and receivers, they point out that exposure to similar sender would foster concordant affective reactions, otherwise it would foster discordant ones. Some research show spontaneous mimicry only occurs when the observer and target have a stronger bonding. For example, People will laugh more often with their friends than stranger when they watch movie. It might explains why some previous emotion contagious shows angry and disgust or other emotions are not able to arise observers' emotion (Hess, 2016; Hatfield, 1994).

Since emotional mimicry is related to our ability to recognise, understand and share the emotion states of others, it is very necessary to talk about what would happen if an individual lose his/her ability to mimic emotional? There are many examples in disorder disease like Autism, Social Anxiety Disorder etc. that can give us the answer. Autism is a developmental disorder which is associated with an impairment of basic automatic social - emotion process (Mclntosh & Reichmann-Decker, 2006), Individuals with Autism Spectrum Disorder (ASD) show impairment in social interaction and emotional understanding, deficits in communication and language skills (McIntosh et al. 2006; Kanner, 1943; Rogers & Pennington, 1991). Children with autism have demonstrated a lack of mimicking or imitating facial expression. Children with autism often fail to spontaneously mimic facial expressions as measured (Sevlever & Gills, 2010). The research in adult with ASD also show they have impairment in the facial feedback system, which is a system that links facial expressions to emotional states.

In conclusion, this part shows us the definition of different kinds of mimicry and evidences for all these different forms of mimicry world. Unsurprisingly, mimicry happen in almost every relationship in our social interaction from new born babies - their parents, old marriage couple, friends to strangers. Different theories behind mimicry revealed how essential it is for us to mimic others in social interaction and lead us to following questions: why we will be born with this kind of unconscious behaviour? what is function of mimicry? And how can we truly understand the mechanisms behind it and use it in building human computer relationship? All these questions will be answered in the next part.

2.1.2 Consequences of mimicry

"Automatic mimicry has it's roots in the functional purpose it served in our evolutionary past."- Chartrand and Maddux(2005)

Why we would mimic others? What is the purpose of the non-conscious mimicry? In this part, we will discuss three main consequences of mimicry: Liking, Trust and Rapport, Prosocial behaviours, and Emotion Convergence. From an evolutionary perspective, Non- conscious Mimicry is functional and adaptive. Just like monkeys in the jungle, ancestors of human being need to learn how to communicate with each to survive. (Chartrand and Bargh,1999; Condon & Sander, 1974). Apparently, Mimicry (both Verbal and Non-verbal mimicry) is a good way to improve their ability to communicate survival information, especially in the dangerous environment, the faster our ancestors can receive the important information from others behaviour the bigger chance they can survivor. With the help of mimicry, we can build a direct link between perception and behaviour and because of Nature selection the survivors can pass on these kinds of link to the next generation of human over the history. By the way, these kinds of link are not only existing in human being but many other animals. But as our societies change the function of mimicry also change. The meaning of survival in modern society is more like fit into groups and being accept by the other ("A Social Glue"). Chartrand and Bargh (1999) establish the theory of Perception - Behaviour Link to explain the mechanism of mimicry. The theory of Perception - Behaviour link believe the reason why we tend to imitate other is because perception automatically elicits corresponding behaviour. Previous studies point out perceiving a behaviour is neurologically similar to performing that behaviour as well. Moreover, Perception - Behaviour link is not unidirectional which means perception can lead to action as well as action can lead to differential interpretation.

2.1.2.1 Liking, Trust and Rapport

An abundant evidence show that mimicry can increase the liking and create affiliation and rapport between people. Mimickers are liked more and more attractive in their group. For example, a waitress who mimic what their customer would get more tips. In van Baaren's (2003) experiment, a trained waitress are require to treat different to customers and see if the average of tips will also different between customers. their research shows the table where the waitress mimic what customers said will have more tips than the non-mimicry. In the speed- dating research, men expressed greater desire to have a second date with the women - confederates who mimicked them (Guéguen,2009/2007). In Guéguen (2013) second study show participants in the mimicry condition are likely answer more Intimate questions than Non- Mimicry participants. Scientists describe the phenomenon that people use mimicry to increase their social bonds, establish and maintain social relationship with others as The Chameleon Effect. In the above behaviour mimicry part, Chartrand and Bargh experiment has successful proved the participants will unintentional mirror each other's behaviour during their conversation. They show us that participants shook their foot or rubbed their face more when the confederate shook their foot or rubbed their face during their dissuasion. Later, in their second experiment, they asked

Confederate mimic the participant's behaviour (posture, gesture) in the experimental group while in the control group Confederate didn't mimic anything during their discussion. In the end, participants are asked how they feel about the conversation and rate their liking to Confederates. The result of liking rate in experiment group is higher than the control group. Their experiment proves that behavioural mimicry can improve people's feelings of liking and trust.
Research in Coordinated Movement and Rapport also reveal that mimicry can strengthen positive feelings in our relationship. Interpersonal coordination is helping us to negotiate our daily face to face encounters. In social psychology, La France (1971) suggests that movement similarity can provide a common backdrop to ongoing interaction. For example, we can see couples or close friends share similar behaviour (posture, gesture) in their daily activities. Previous study show that posture sharing will increase rapport in group situation. Charney (1966) studied postures of both client and therapist during a single psychotherapy hour, his result show that a progressive increase in mirroring posture during the hour and correlated this with an increase in rapport between client and therapist. La France (1976) Investigate the relationship between Posture sharing and self-report indication s of rapport in a group situation, he points out that the greater the amount of mirroring and congruent postures evidenced by students and the teacher the higher the ratings of involvement. His result show that there is a significant positive relationship between this posture share index and rated rapport ($r = .46$, $p < .005$).

2.1.2.2 Prosocial Behaviours

Apart from increasing liking, trust and rapport, mimicry should have consequences at a behavioural level for it to be truly adaptive (Dijksterhuis & Bargh, 2000). van Baaren et al.(2004) is the first team try to prove that mimicry is powerful tool of eliciting prosocial behaviours. His experiments' result show that mimicry can elicit participants to help confederate to pick up the drop pen and to donate more money to the charity then the non- mimicry participants. van Baaren claims that a confederate who mimicked the posture (position of arm, legs, etc.) of participants elicited the willingness to prosocial behaviours. In addition, Stel, van Baaren and Vonk (2008) found participants will also donate more money than others when they are asked to voluntary mimic confederate.
Recent research on the verbal mimicry has demonstrated that repetition of words is important in increasing an individual's tendency to perform prosocial behaviours. Kulesza et al.(2014) named this phenomena as **The Echo Effect**. The idea of Echo Effect is built on the Chameleon effective which show us behaviour mimicry can improve rapport and liking in our social interaction. In Kulesza's research, 330 customers at a currency exchange office participated in the real world experiment, they were randomly assigned to one of five conditions. Cashiers are trained to imitate customers' verbal statement in the first condition. Each time cashier would ask customers to donate money to the charity when they finish currency exchange servers. In the end they calculated the value of donations from customers in each condition and found donations in the mimicry conditions is higher than other conditions. Kulesza and his co-workers demonstrate that echo effect can lead to mimicked individuals engaging in prosocial behaviours more frequently than those who are not mimicked.
One theory that support mimicry enhance prosocial behaviours is Familiarity Theory (Guéguen, 2005). Familiarity theory believe mimicry is associated with greater feeling of familiarity with the mimicker (Guéguen, 2009), Guéguen point out that "when a solicitor seemed to familiar with

the subject solicited , he/she agreed more favourably to help the solicitor". Previous research support that people tend to help another person who is similar to them. People have same race (Bickman & Kamzam, 1973), apparel appearance (Suedfeld, Bochner & Matas, 1971), religious (Keasey and Keasey ,1971), or social status (Goodman & Gareis, 1993) will increase their prosocial behaviours and tend to help each other more. Besides, Similar political attitudes could led to altruism (Suefeld, Bochner and Wnek, 1972). Familiarity Theory point out mimicry enhances familiarity of the mimicker that in return leads the mimickee to evaluate the mimicker more favourably, then this kind of feeling influence our judgement and behaviour in social interaction (Guéguen, 2009).

2.1.2.3 Emotion convergence

Emotional mimicry occurs unintentionally and among even strangers. Previous studies on emotional contagion has indicate that "people automatically mimic facial expressions, vocalizations, and postures when they interact with another person, which leads both individuals to experience similar emotions." (Barsade, 2001; Dimberg & Ohman, 1996; Hatfield et al., 1994) Emotion has many functions, but the primary function is the coordination of social interaction (Anderson et al. ,2003; Frijda et al.,1994). The study of Anderson et al. (2003) in couples and roommates prove that emotion convergence will occur over time in a long-term relationship and emotional similarity would benefits close relationship. Emotional convergence means emotions of individuals in the relationship will become progressively similar over time. This progress is vital for people to robust their social relationship. Such as in the partner relationship. Similarity will lead their relationship to become more stable and harmonious (Acitelli et al., 2001; Wróbel et al. 2015). This progress also known as **Similarity Complementarity Hypotheses**.
Being emotionally similar would help coordinate the thoughts and behaviours of partners, therefore, it can increase people attraction, mutual understanding and social cohesion. Moreover, not only emotions will be similar over time, cognitive and behavioural between partners will also convergence. People in a long- term relationship, will have more tendency to mimic others' gestures, vocal and facial expressions when they interact with each other. Emotional mimicry explains how emotional transmit between a close relationship. Overall, mimicry could lead to experience similar emotion during people interact with each other. People in long-term relationships will become more similar to each other. and eventually occur emotion convergence. In return, emotion convergence will improve value, attitude and behaviour convergence among relationship partner (Acitelli et al., 2001).

2.1.3 Conclusion

Nonconscious mimicry could be a powerful persuasive method. As we mention above, mimicry could not only unconsciously increase liking, trust rapport and pro-social behaviour in a short time, it could also lead to emotion, attitude, and behave convergence in a long period interaction between mimickers and mimickees. For example, Bailenson and Yee (2005) discover that mimickers are thought as more persuasive than non-mimickers. Hermans (2012) points out that

many studies have proved that people will adjust their intake base on eating companions. Their study suggests that behavioural mimicry may partially account for social modelling of food intake.
However, mimicry is a complex unconscious behaviour. Different scientists from psychology, sociology and neurology have established many theories to explain the mechanism behind it and what the consequences of mimicry are. It is difficult to come to a conclusion about which single theory is the best, especially because some of theories have been widely accepted by the academic community whilst some of them are still controversial. By focusing on three main consequences of mimicry in this part, we could discover that there are many common factors which exist in all these theories. If we connect all of them then we could have a better understanding of how mimicry works in our daily social interaction. It is possible to show the reason why we tend to mimic others and how it could subconsciously affect an individual's behaviour. For example, the chameleon effect reveals that why people tend to each other is because they want to establish and maintain their social relationship. Coordinated Movement shows us the more similar the movement the more liking and rapport between people.
The Echo effect reveals that even the verbal similarity in verbal could increase our liking and change our decision. Meanwhile, the Familiarity Theory supports the idea that people will agree more favourably to help the solicitor if they feel the familiarity with the mimicker. From the dimension, Emotion Convergence and complementarity hypotheses emphasise the increase of emotional understanding as a result of mimicry over the time. For example, an old married couple will become very similar, from their appearance to the way they talk and walk. All those theories are focusing on different dimensions of mimicry, but can also be combined as a whole system. In short, normal people will always unconsciously mimic other behaviour. The stronger we desire to be accepted by the other, the stronger tendency we will have to unintentional mimic. Mimicry increases people's positive emotion and behaviour within two people, and helps us to establish long-term relationships. Moreover, people who engage in a long-term relationship will have more influence on each other's views and behaviour, and eventually converge their emotion, cognitive and behaviour together. Besides, mimicry is not a one direction behaviour, both individuals will have the same mimicry behaviour, In other words, the mimicker could also be the mimickee.
So far the mimicry research has been revealed how human and human use mimicry to establish and maintain their relationship and in return to change an individual's perspective and behaviour. The first assumption in this article is if mimicry unconsciously occurs and can lead to behaviour and perspective change between human -human interaction, then it could also have the same effect on human - computer interaction.

2.2 Related work

It is an era that many people consistently interact with their mobile device more as much as real person, we had reviewed previous works in psychological, sociological, neurology, and linguistic to show how mimicry influences people behaviour and helps us to establish and maintain our social relationship.
Mimicry is one of the original mechanical that help us to understand, communicate and make a decision in our social interaction. Previous evidence has shown us unconscious mimicry is the powerful tool that allow we to catch an emotion from the other, and response our own emotion as

well. Mimicry as “social glue” between human - human interaction, it is not just establishing a simple relationship but also increase the Trusting, liking, rapport and therefore it will be a potential persuade tool. Specifically, mimic has been applied in the psychotherapy by therapies to increase their reaction with patients and education environment by teachers to encourage students. Therefore, we are confident to believe that mimic can be used to persuade people to change both their opinion and behaviour.

Human build their relationship not only with human but with their pets, objects and computers, the consequences of mimicry can enhance our liking and rapport, strengthen our bond in long term relationship, influence our prosocial behaviour in human - human interaction. Media Equation Hypothesis believe that human will response to the computer in the way response to the computer, therefore people will also apply social rules to computer automatically. In Reeves and Nass (1996) book, they test whether people response socially to the computers. In their experiment, they invited 22 people and require them to work with computer. Then participants will evaluate the computer that they used and tell Reeves and Nass how they felt about that computer. People will give more positive feedback to the same computer’ performance compare to other conditions. The result of the experiment show that people will treat computer as social initiators and apply normal social rules to computer (politeness). Besides, Reeves and Nass (1996) indicate that human will still response to the media or computer in the way they response to other person even when they know it is not a real person. Later, many science also use different methods to prove the Media Equation Hypothesis, for example (Garau, 2005) Garau and his team mates test participants’ heart rate and electrodermal activity (EDA) and reveal that people can response to virtual computer characters as social actors and the higher levels of virtual characters’ responsiveness the more social response. Thus, if mimicry in a human-to-human situation could lead to positive consequences of behaviour unconsciously, we could expect that Virtual mimicry in human- computer situation can also elicit our behaviour with our conscious process.

Despite many interest in studying mimicry behaviour between human- human relationship, the potential for computer use unconscious mimicry as a persuasive tool to change human behaviour remains unclear. Since mimicry is unconscious, it is complicate to probe if mimicry happen as well as how consequences of mimicry can influence users in human-computer relationship. In the transitional mimicry experiment, many extras factors could influence the result. Therefore, we must be more careful when we create the virtual environment to stimulate the potential of virtual mimicry in behaviour change of users. Before the further discussion on designing our experiment, it is very important for us to review some of study cases in practical world to show how modern application systems use mimicry as a persuasive tool to increase users’ positive emotion and health behaviour. In this article, I define Behaviour change technology as technology that is intended to change attitudes and behaviours using persuasion. There are many forms of Behaviour change technology, From simple text notification software, video game like to most advance Digital agents.

2.2.1 Behaviour change technologies for wellness

For the past few years, there has been a fast development of behaviour change technologies for wellness. Health behaviour change system including many different topics, such as improving

healthy diet, breaking and establishing old habits, encouraging physical activity, and emotion management. To better understand the pros and cons of modern behaviour change technologies for health behaviour change in mobile device, I list several applications and programs that base on different behaviour change technologies.

2.2.1.1Digital Pets

Tamagotchi was a very popular digital pet's simulation game. To feed Tamagotchi player must walk, run more on their daily life otherwise their digital pets will "die". Another famous application that has successful encourage player to do more exercise is **Pokémon Go**. Similar to Tamagotchi, Pokémon Go is an augmented reality game that require player to walk out of the door and find different Pokémon and "catch" them.
From Tamagotchi craze to Pokémon Go craze. They have proved previous researchers' ideas. Both Tamagotchi and Pokémon Go try to deliver healthy life style messages by using social relationship between user and digital pets. J.P Pollak (2010) points out that by providing incremental rewards and building a strong relationship between children and digital pets they can deliver persuasive messages successfully. However, these kinds of relationship between user and digital pets will become very weak if users lose interest to continue play the game and it might lead to behaviour change relapse after they stop play the game.

2.2.1.2 Self-monitoring

Self-monitoring interventions have been successfully applied in many behaviour change topics such as increasing study behaviour and increasing social behaviour (Parker and Kamps 2011). Many of wellness softwares provide food and exercise tracking functions for user to implement self-management and self-monitoring. For example, **BALANCE (**Denning et al. , 2009**)** is a mobile application that for long term wellness management. It allows users to enter their food information and automatically trace their activities. Smart bands and Smart watches such as **Fitbit** and **Apple Watch** are more advanced solution which combine hardware (sensors) and software to record user daily exercise data and motivate users to continue their health activities. However, Self- monitoring applications as a conscious behaviour change method require users themselves have a high motivation and strong will power.

2.2.1.3 Interactive health communication (IHC) technologies

Interactive health communication technologies has been widely used in clinical health care area to assist patient to promote their physical activity and health nutrition. The Interactive Health Communication program like **PACE +** (Patient-centred Assessment and Counselling for Exercise plus Nutrition) (Prochaska et al., 2000). The PACE+ is computer-mediated physical activity program which is designed to promote adoption and maintenance of physical activity and healthy nutrition with teenage and adult patients when they are at home. Interactive health communication technologies can "serve to systematise and shorten the time required for assessment of multiple health behaviours by collecting, compiling, and summarising self-report information." (Prochaska, 2000). IHC could assist care provider to make a plan base on

individual patient need and prevent behaviour change relapse. However, IHC requires patients to understand and well- received the material, since care provider need to change their plan base on Individual information.

2.2.2 Embodied Conversational agents (ECAs)

Embodied Conversational agents is one of the most important behaviour change technology that have strong relate to Virtual mimicry. As we all know, Face to Face dialog has been widely used as a major experiment method to test effect of psychology theories in interaction for a long time. For instance, In behavioural mimicry chapter Chartrand and Bargh (1999), will observe how participants interact with confederate in their describe picture task. In human computer interaction area, Embodied conversational agents (ECAs) is the most common mention to study psychology effect between human and smart device, therefore it is also reliable method for mimicry behaviour. Embodied conversational agents(ECAs), which are Virtual computer characters that simulate face to face conversation with users (Cassell, 2001). The benefits of ECAs system are it could facilitate human - computer interaction, for example Embodied agents could stimulate eyes gaze at other people and human-like postures to improve user experience during the conversation. It can thus provide a much stronger test of the chameleon effect of mimicry than a confederate study.
One of the most famous ECA is **Clippy** from Microsoft Word Application. Clippy is a animated character that aim to assist user to use Microsoft Word. Due to technology limitation at the previous time, many Virtual agent research are constrained by lack of the image processing technology or mature emotion simulation system. This might explain why different previous studies has conflicting results. There are many different types of ECAs, such as emotional agent, social agent, relationship agent. Even though they have different orientation but overall they are still similar systems (Cassell, 2001).

2.2.2.1 Caring ECAs

ELIZA is a program that designed to have conversation with human (Werizenbaum 1983), It is the early stage of Caring program, which bases on chat board and response to user text. Foe example, when user tell ELIZA they are unhappy, and ELIZA will replay with empathy sentences. Klein et al. (2002) developed an affect management agent called **Casper**, which is a system that aim to actively support users in their ability to manage and recover from negative seminal states. CASPER is able to use text menus with displays of the empathy and relieve users' frustration. **FearNot!** (Woods et al., 2003**)** is another computer application developed by **EU VICTEC** project to help children to deal with bullying. All these Caring ECAs are trying to help users to copy with their emotional problems and improve their feelings.

2.2.2.2 Car assistants

ECAs has greatest potential to enhance car assistants in the future. There have a serial study by Verberne and his team (Verberne et al., 2015) to explore how to improve users trusting in car assistants. **Virtual Driver** start to raise attention as the autonomous vehicles become next big

thing. Even though Self-Driving Cars are not yet become an affordable commercial product, many companies such as GOOGLE, Benz and Tesla has been tried to explore the potential of Virtual Driver in smart system. In Verbene experiment, Participants drive car in the driving simulator and cooperate with Virtual Driver Bob. Verbene points out that facially similar Virtual Driver was trusted more than facially dissimilar Virtual driver in the driving simulator experiment. Therefore, participants might accept Virtual Driver advices if it look similar to human driver themselves.

2.2.2.3 Virtual Coach

Laura is a long term relationship virtual agent focusing on encouraging people to exercise. It belongs to **MIT Fittrack program**, this program consists 10 minutes daily conversation with Laura. During their conversation, Laura will shows gestures, eye head movement and facial expression. The purpose of Bickmore et al.(2003) Fittrack program experiment is to inveagate the whether the relationships between human and computer could "increase efficacy of health communication and health behaviour change delivered by the agent".
In their study, participants are divided into three groups: Relational, Non Relational and Control group. Laura will assist participants to set exercises goals, monitor their daily exercise data and provide exercise information. In the Relational group, Laura will try to establish working alliance relationship. The result of their study show Relation group have significantly higher Working Alliance scores than Non- Relation group after 30 days intervention($t(57)=2.26$, $p<0.05$) But "there are not significant differences between the Relational and Non-Relational groups with respect to gains in physical activity"`(Bickmore et al., 2005).

2.2.2.4 Virtual Reality Psychotherapy

Studying in VR also confirm that People react towards avatars similarly to real people (Verberne et al., 2015) so virtual reality is becoming an increasingly popular tool in social psychology and neuroscience. **The Second Life** is an online video game that allows users to create their own 3d avatar and do the social interaction in the virtual world. Boulos (2007) study how to use second life game to improve medical and health education. In their 3-D virtual learning environments, Boulos, Hetheringtont & Wheelert discover that users who are avatar represent as student will show their gravitate toward pedagogical agents with avatar that closely resemble their own real life (Boulos, 2007) the result match the Appearance Similarity theory that student would be more attracted to study with a virtual avatar who are similar to them. Besides, Second Life also provide a virtual psychotherapy for users. For example, MSU **SL Prototyping Center (Missouri State University Second Life Prototyping Center)** is designed by Missouri State University to explore therapy. Therapists will control virtual avatars in the virtual center to implement psychotherapy to patients. In some case, Patient feel more relaxed in Virtual therapy than face to face therapy and they have higher rate to finish their session with virtual avatar than face to face therapy (Brahnam, 2014).

2.2.3 Implicit Association Test (IAT)

Implicit Association Test (IAT) is a computer-based designed to measured attitude indirectly (Greenwald et al., 1998). IAT are designed to assess automatic associations between a contrasted pair of target and attribute concepts (Greenwald et al., 1998). There are many famous cases that IAT has been used in social psychology to reflect participants attitude or tendency, such as IAT for gender bias, Self-esteem IAT, Valence IAT or to IAT for president preferences. In health psychology, IAT is one of the most popular indirect measure for estimating individual implicit attitude toward food. Comparing to self-report to assess food preferences, IAT use reaction time of people's respond to different subject to reflect the strength of association between each category. The faster responses between two categories means higher associated. Indirect measure like IAT could better reflect individual self- conscious without influence by the other factors.

Many studies have shown that attitude could predict eating behaviour. Roefs and Jansen (2002) used an IAT to measure obesity adults' attitude toward high-fat food and low-fat food. Craeynest et al. (2007) uses adapted version of the IAT to investigate over-weight children implicit attitude toward healthy and unhealthy food. Raghunathan (2006) and Werle et al.(2013) use adopted previous IAT to discuss the relationship between healthy and unhealthy food and taste. In his experiment, they assess association between a pair of the different food picture (health and unhealthy categories) and attribute concepts (tasty words and untasty words). Basing on previous successful IAT for food experiment, in this project IAT is chosen as our a major implicit attitude measure method (Craeynest et al., 2007).

2.2.4 Conclusion

The studies in this review have shown that users would have the similar tendency to mimic virtual agents even if they realise they are computer systems. Moreover, if avatars try to mimic users it could increase the users' positive emotion such as liking, rapport and trusting and eventually lead to pro-society behaviour. Recently research indicates the potential of mimicry to be applied in different software designs, such as car assist system, AI robot and health care system. Compared to the transitional mimicry experiment environment, virtual environment and Embodied conversational agents can be more precisely manipulated and it could offer us a more opportunities to make a further study.

The study about virtual mimicry between human and Embodied conversational agents is still a new area. Previous experiments have inconsistent results, but something that most experiment results agree in is that virtual mimicry is similar to the normal mimicry in our life and can lead to positive impressions of the avatar. No surprise, the evidence from this literature review has support that consequences of virtual mimicry are nearly the same as the consequences of nature mimicry. In other words, we can assume that all the mimicry behaviour consequences. Thus, we can conclude that there exists a "Digital Chameleon Effect" between user and virtual agents. Based on the Chameleon Effective Mimicry help us to understand emotion from the other (human or computer), the more we share emotion, gestures and posture between each other the more we become similar in our interaction. In the long term relationship, it could also cause emotion contagious. Not only emotion are shared with others, our value are also be shared at the

same time. Therefore, unconscious mimicry could influence how we feel and what we think, it could lead to emotion and value convergence between human- human as well as human-computer (virtual agents). This kind of convergence phenomenon would influence our decision making.

In this project, unconscious mimicry as a complex unconscious behaviour will be used to test how avatar could persuade users to make a difference in their task. Basing on the experiment from Hale and Hamilton (2016), Bailenson and Yee(2005)'s method to implement virtual mimicry during an interactive photo description task, several of parameter such as liking, trusting, similarity will also be used to evaluate the level of mimicry. I believe it is essential for us to understand mimicry in order to understand how people can be influenced by computer information. It might be possible to fill the gap that enhance behaviour change technology theories.

I argue that virtual mimicry could increase liking and rapport between human - computer interaction and help us to establish and maintain human- computer relationship. Beyond only building strong relationship, embodied conversation agents as persuaders could use this close relationship to achieve an unconscious behaviour change or decision change.

Chapter 3 Methodology

3.1 Hypothesis

Base on previous literature review, the first hypothesis of this paper is: **Virtual Agent mimic can increase users positive feeling, including liking, trusting.** And if mimicry can increase people positive feeling between human and computer, then people who are unconscious mimic by Virtual Agent, will tend to be persuaded by Virtual Agent than non-mimic people. Therefore, our second hypothesis will be: **Virtual Agent can use Virtual Mimicry to increase people unconscious tendency to specific content (preference for the food or exercise).**
There is not much research about mimicry. To test first hypothesis, our experiment is inspired by the Hale and Hamilton's experiment. Therefore, we choose Liking scale, trust scale and IOS scale as our major explicit measure. Besides, to better manipulate how the virtual agent mimic the participant, we follow the Wizard of OZ principle to use FaceRig software to control our Virtual Agent Lisa. And to test the unconscious tendency to the content, we create a IAT for food.
The aim of this experiment is to prove virtual mimicry could have same effect like the human-human mimicry, and we could use it to increase user's unconscious tendency to health food and behaviours. The goal of experiment was to evaluate if participants whom has been mimicked by Virtual agent behave more unconscious tendency to Virtual Agent's preference to healthy food than participants whom are not be mimicked by Virtual Agent.

3.2 Experimental design

The experimental design is a pre-test and post-test control group experiment design involving two conditions, virtual mimicry condition and virtual non-mimicry condition.

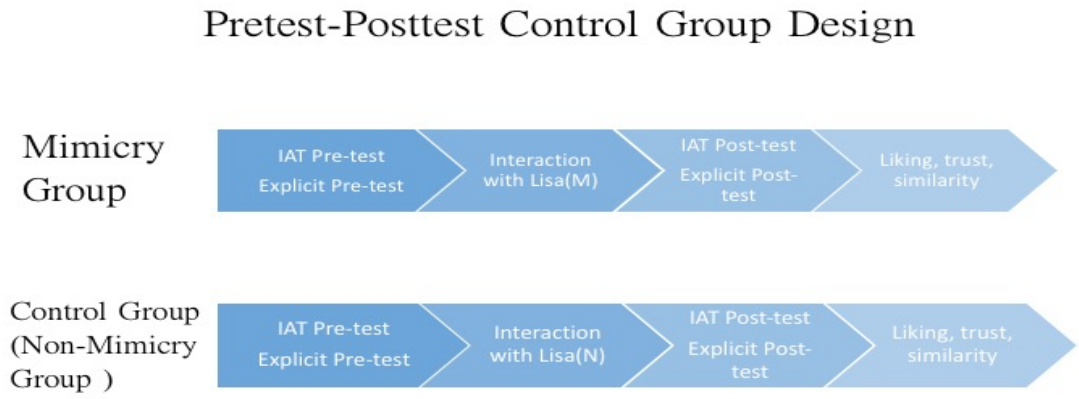


Figure1: Pretest - Posttest Control Group Design Experiment

3.2.1 Materials

3.2.1.1 FaceRig

To Control the Virtual Agent in our wizard of OZ experiment we use software FaceRig. FaceRig is a program that allows users with webcam to digitally embody characters. FaceRig is basing on image-based face tracking technique from ULSee Inc. FaceRig is able to maps users' facial movement in real time and transform into the virtual avatar. The functions of FaceRig include: Instant digital cosplay, real time voice processing, Avatar customise and online Broadcast. It also allows users streamed the output to Webcam- based service (see Figure5) (FaceRig, 2016). In this project, one research assistant will operate FaceRig software in the main computer, We choose one of the female avatar designed by FaceRig the basic model and White colour as interaction background. We also design some interact principles base on the previous social psychology experiment as follow:
Avatar's facial expression. FaceRig will converts human assistant facial expression to virtual avatar's facial expression. In the mimic condition, avatar will tend to mimic participants emotional expression and posture with more happy face(smile, language). In the non-mimic condition, avatar will non-mimic any participants' facial expression or any posture.
Avatar's head movements. We could control Avatar's head movement such as nod its head and turn its around. (Bailenson&Yee,2005; van Verberne, 2013). In the non-mimic condition, Avatar will not mimic. For instance, in the mimic condition if participants move his/her head, avatar will also move its head to the same direct just like mirror.
Avatar's Conversation Goal. Avatar share or imply its prefer for health food and exercise during their interact with participants in both conditions. Besides, avatar will also try to establish a relationship with participants by sending voice message like "I will love to be your friend" "I am your helper". We use Liking Trust and Similarity scale to measure the if the Goal of establishing the short-term relationship has achieved.

3.2.1.2 Implicit Association Test (IAT)

In this project, we want to measure the implicit tendency of people's attitude to the health food and. Therefore, we design the IAT for food preferences. IAT for food provides a measure of the strength of associations between mental categories such as "Pleasant and Unpleasant" and attributes such as "Healthy food and Unhealthy food" disciplines. IAT for food provides a measure of the strength of associations between mental categories such as "Pleasant and Unpleasant". The examples are in Figure

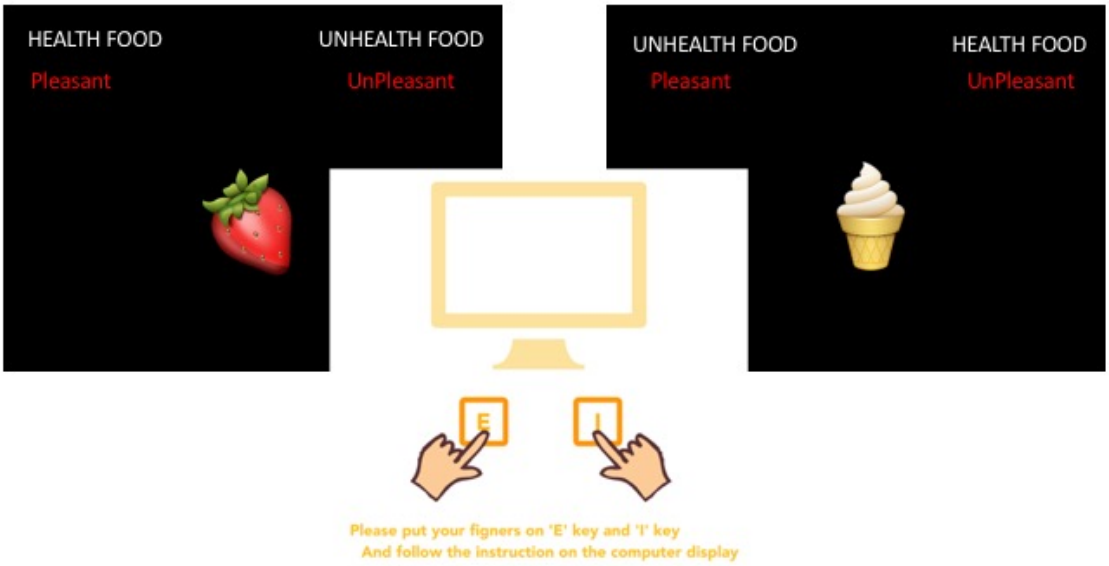


Figure 2: FreeIAT software interface and instrument(Meade, 2009)

3.2.1.3 Virtual Mimicry Control Guideline

All the research assistants had been train to follow the Virtual Mimicry Control Guideline to interact with the participants before the experiment. Through the online video chat service (Skype), assistants can observe all participants' movements and give participants feedback by control virtual agent in real-time. The instruction for assistant to control Virtual agent to mimic participants' movements are as follow:

Facial expression. Virtual agent will express the same facial expression according to the Participants facial expression. For example, if participants smile then Virtual agent will smile in the same way after 1 seconds.

Head movement. Virtual agent will reflect the same head movement from participants. For example, if participant nod their Head once then Lisa Virtual Agent will also nod its head once. If participant turn their head to the right side, then Virtual agent will turn its head to the left side.

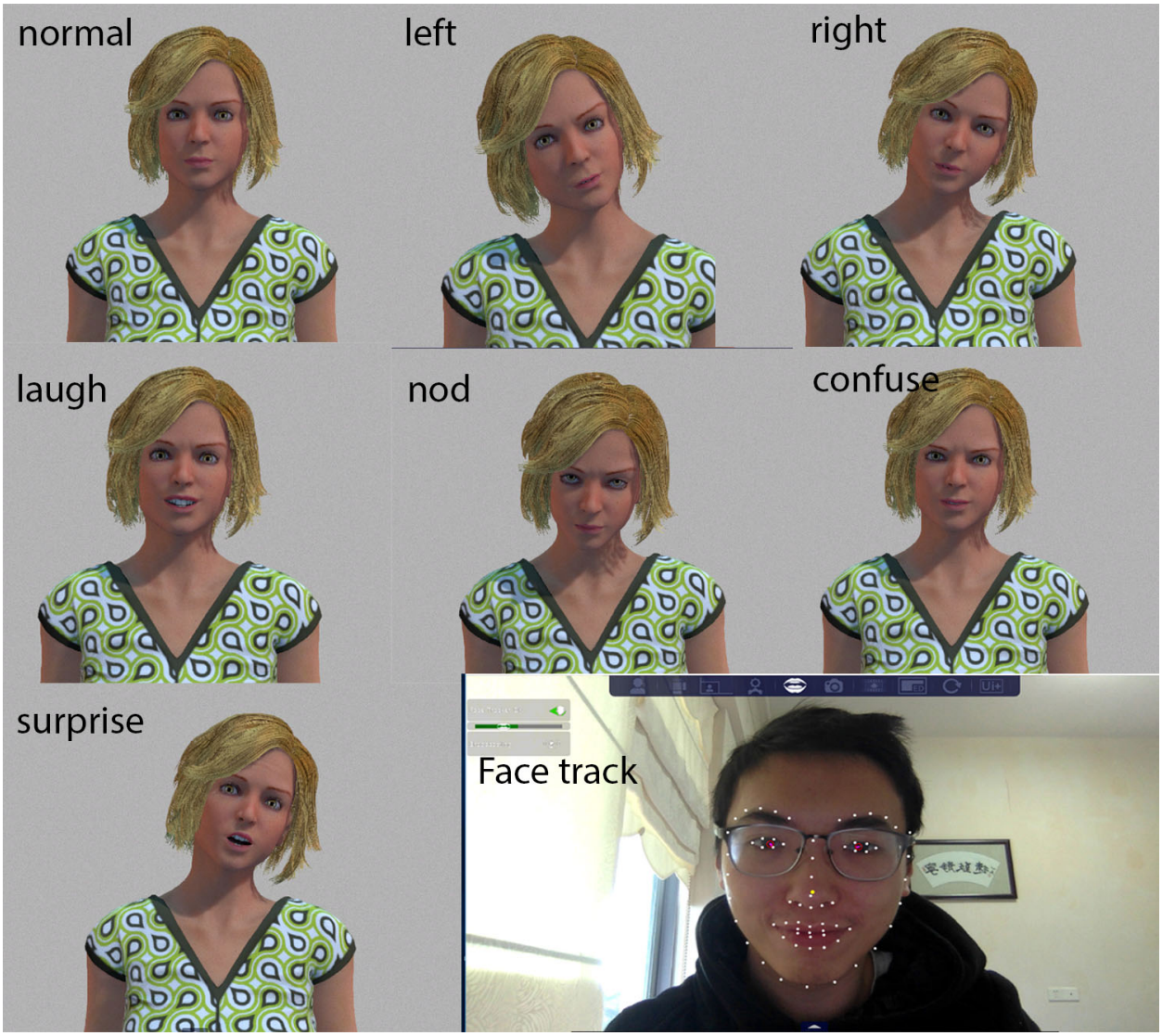


Figure3: FacrRig software and using face tack to control Lisa head movement and facial expression

3.2.1.4 Conversation Dialogue

Designing Conversation Dialog is a very challenging problem. To make sure our experiment is consistent in the way how virtual agent interact with participants, we will train research assistant to follow the pilot and framework basing on our two-experiment goal, establishing relationship and unconscious persuade. In the Dialogue Framework, Four Conversational Move that help assistant to continue and adjust their talk with participant. Social dialog, such as “How are you doing tonight” “It is nice weather”; Verbal Mimic, Agent will repeat the sentence from participants; Describe Photo, Virtual will describe the content of photo in the describe photo task; Share Value, Virtual agent will try to share health value such as preference for vegetable food and exercise.

The Dialog Pilot

1.Greeting
2.Ask about participants feeling
3.Ask about participants' background
4.Introduce the photo description task
5.Finish the photo description task
6.Ask participants feeling about the agent
7. Guide to finish the questions
8. Introduce the IAT task
9. Farewell

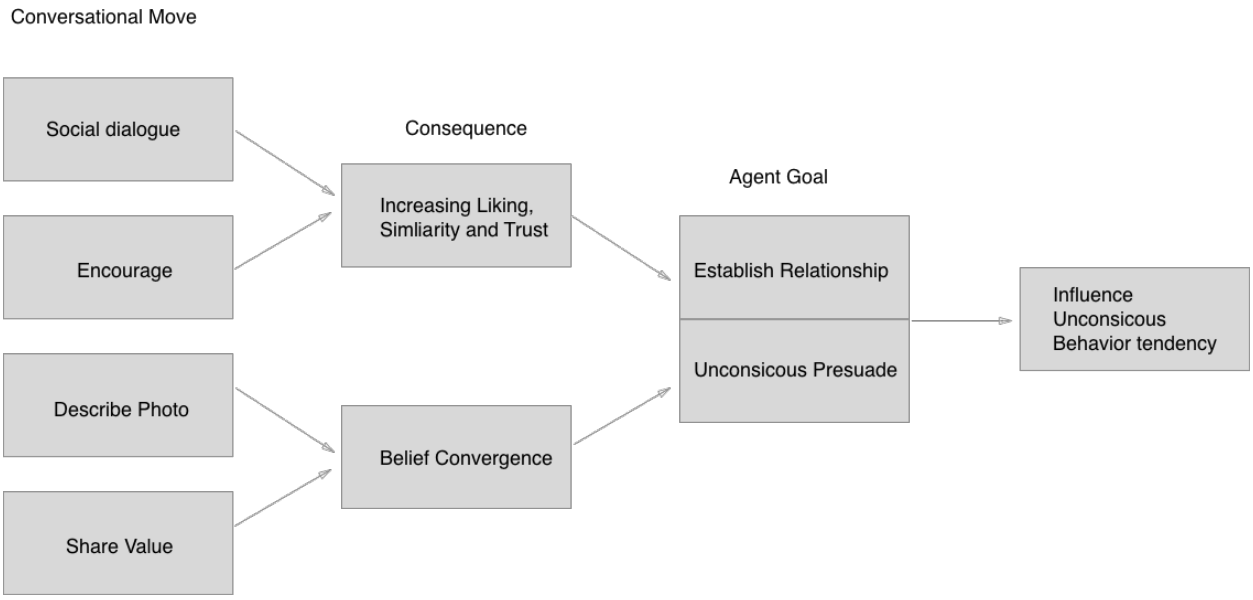


Figure 4: The Structure of Conversation Design

The Human- computer Conversation guild book for the Researcher as Virtual Agent(sample)

A = Agent (Lisa)
P = Participant

Personality
Lisa love exercise such as swimming, jogging.
Lisa love health food, vegetable and

A: **Hi - My name is Lisa, I am your virtual agent for this experiment. May I have your name?**

P: My name is Harrison
A: **Hello, XXX(Harrison). How are you doing today?**
P : I am fine.
A: **Okay. In this experiment I will be your teammate to help you finish the tasks. The first task called describe photo task. We will take turn to describe 2 photos to each other and guess what is the content of photos. If you are still unclear what you should do in this task please contact our assistant. If you think you are ready, please say yes.**
P: Yes.
A: **Great. I will be the first one to describe my photo.**
The colour of my photo is yellow, there are two items.
This is very common food in most of the restaurant.
Now You can guess what is content of picture.
P:…
A: **Do you want more information?**
P:
A: **They are very high calorie food. It is not a good idea to eat them every day cause it is unhealthy. Do you want to know the answer?**
P: Yes, please
A: **The photo I have is beef burger and fry chips**. **Do you love them?**
P : Yes
A: **When is your last time eat burgers**
P: Today.
A: **Today. Could you tell me why you like them.**
i don't like burger

P:…
A: hmm **I don't like burger.** Now is your turn to describe your photo to me.
P:There are many colour in my photo, red and orange and yellow.
A: Are those a food?
P:Yes, there are many different food
A: Are those vegetable ?
P:…
A:**I Love vegetable**, **What about you?**
P:…
A: They taste yummy and very health. What do you think?
P:…
A: **Now my turn again. My photo is about a person.**
He seems very relax and have a good time.
He sit on the sofa and stare at the front
Now You can guess what is content of picture.
P:…
A: **The photo I have is about a men who is watching TV and drinking**
Correct. **You are doing good.**
P:..
A: Do you want the answer?
P: Yes please

A: **The photo I have is about a man watching TV in his room and drinking beer**
A: **Okay, now it is your turn to describe the second picture you have to me**
…
A: You are doing excellent. **I Love exercise, my favourite sport is running, What about you ?**
P:
A: **It sound interesting, Could you tell me more about your hobbit**
…
A: You are a good friend.
A: Look like the mission accomplished on this mission .We are doing a great work together. See you.

3.3 Procedure

3.3.1 Participants

Thirty participants were recurred from university of Birmingham, all of them had never interacted with the Virtual agent before. They were separated into two different groups. Two different conditions were evaluated as we mention before: Mimicry condition (That Virtual agent will mirror participants facial expression, head movement) and Non-Mimicry condition (Virtual agent will show neutral facial expression and will not follow any head movement), each condition has balance female and male participant.

3.3.2 Experiment procedure

On arriving in the lab, participants were told they were taking part in a virtual communication study and completed a consent form. They sat at a desk in front of a computer screen and camera were set up to record their head movement and face. An assistant will explain how the Virtual agent will help participant and the purpose of the experiment is to improve the AI agent:

This study we are doing in this lab is to improve our software AI Lisa's performance. Lisa is a new Virtual assistant which is designed to help people in their daily life basing on the online video chat software. We want to know how you feel about Lisa after you communicated with Lisa. In this study we will have three main task for you to finish, it will costs you about 40 minutes in totally. After each part of the experiment you could choose to tell Lisa or our assistant to have a rest.

After participants agreed to continue study. They were asked to finish the background questionnaire, the demographic background, including age, sex, ethnicity. Next, Assistant introduced IAT task as the Pre-task for participants original unconscious tendency:

In this part, you will be presented with a set of words or images to classify into groups using the 'e' and 'i' keys on the keyboard. For each section, there are four categories, you will need to classify items as quickly as you can while avoid to many mistakes.

After finished the demographic questionnaire and pre IAT task, the assistant will open the Skype software and Introduce Lisa as the participants virtual assistant for the experiment, Then the participant begin to talk to the Virtual agent. Virtual agent will introduce itself and try to establish the relationship with participants following the dialog structure. During the conversation, Virtual agent will try to mimic every participant's movement (smile, blink eye, head movement) in the mimicry condition, while in the non-mimicry condition Virtual agent did not mimic.

Next is **Photo description task**. participant met LISA in front of the computer screen and completed a photo description task with it. LISA appeared as a life-sized person seated on the other side of the desk, facing the participant in the lab environment. In the task, the LISA and participant would take 4 turns describing a photo to the other for 30 seconds. Lisa greeted the participant and smiled at the start, then began the task by describing a photo the participant could

not see. At the end of their description, the avatar smiled again and then it was the participant's turn to describe a photo, which was present on the paper in front of the participant. Virtual agent will try to reply to participant base on their description. At the end of the task, the virtual agent said goodbye to the participant and end the Skype call.
After finish the Photo description task, Participants were presented post IAT task. An experiment assistant will then explain the IAT task again. The Participant will presented with a set of words or images to classify into groups using the 'e' and 'i' keys on the keyboard. The participants will need to classify items as quickly as he/she can while avoid to many mistakes. An experiment assistant will highlight that if participants go too slow or make too many mistake, they will need to do the task again. After finish the IAT with food. The participant will have chance to have rest. Then continue the IAT task with exercise just like the previous task:

In this part, you will be presented with a set of words or images to classify into groups using the 'e' and 'i' keys on the keyboard again. For each section, there are four categories, you will need to classify items as quickly as you can while avoid to many mistakes.

After post-IAT test, participants rated the level of their feelings of liking, trust and similarity on the self-continuous scale from 1 'Very Strongly Disagree' to 7 'Very Strongly Agree'(We use Likert-type items with a scale of 7)
Finally, An assistant explain the really purpose of the experiment: to study if mimicry from virtual agent can influence human tendency and thank you for their participant,

3.4 Measure

The Measurement of this project consists of explicit measure and implicit measure. The Explicit measure include: Liking, trust and similarity to the Virtual agent after the description picture task, pre-reaction time to health and post-reaction. In the post questionnaire, this experiment used Aron and Smollan (1992) IOS similarity scale, Reysen (2005 Human and Human Likability scale, Jian(1998) People and Automation Trust scale and Rapport scale. The data analysis tool is IBM SPSS 24.

3.4.1 Explicit measures

Likability scale. Liking of Lisa was measure by Likability Scale from Reysen (2005) with 11 items including such as "Lisa is friendly; I would ask Lisa for advice (1(very strongly disagree)-7(very strongly agree))". Alpha at .95. Each question was scored using a Likert scale format. All 11 items were positively score, with higher scores representing higher likability of Lisa.

Trust scale. Trust scale between Participant and Virtual agent is from Jian(1998) include 12 items, such as "I can trust the system" using a 7-point scale from 1 (Not at all) to 7(extremely). The first 5 times is negative scored and the 7 items is positive scores, with higher scores representing higher trust to Lisa.

Inclusion Of the Other in the Self(IOS) Similarity scale. The similarity is measure by using "Inclusion of other in the Self (IOS) Scale" from Aron& Smollan (1992). IOS Scale is a single

item, pictorial measure of relationship closeness. It consists of seven pairs of circles, participants will asked to choose the items to indicate their relationship with the others. In this study including three IOS Scale, the relationship with Virtual agent(LISA), relationship with Best Friend, and relationship with other (general people). Higher scores corresponded to pairs of circles that increasingly overlapped, and thus represented greater self-other overlap.

Explicit attitude toward healthy and unhealthy food scale. To measure participants explicit attitude toward healthy and unhealthy food, we created 9-point explicit attitude toward foods scale from 1 (Very unpalatable) to 9(very palatable). All 12 items were positively score. The first 6 items are healthy foods, with higher scores representing higher likability of healthy foods and last 6 items are unhealthy food. with higher scores representing higher likability of unhealthy foods.

3.4.2 Implicit measures

Implicit attitudes toward Healthy foods and Unhealthy foods – IAT effect
The Implicit Association Test (IAT) measures the strength of associations between Healthy food and Unhealthy foods and evaluative pleasant and unpleasant attitude. For example, if participant have faster reaction times for healthy foods together with pleasant words then it indicates the participant have a more positive implicit attitude toward healthy food. Basing on the score of the reaction time, we could also label implicit attitude with slight, moderate, or strong to reflect the strength of implicit preference.

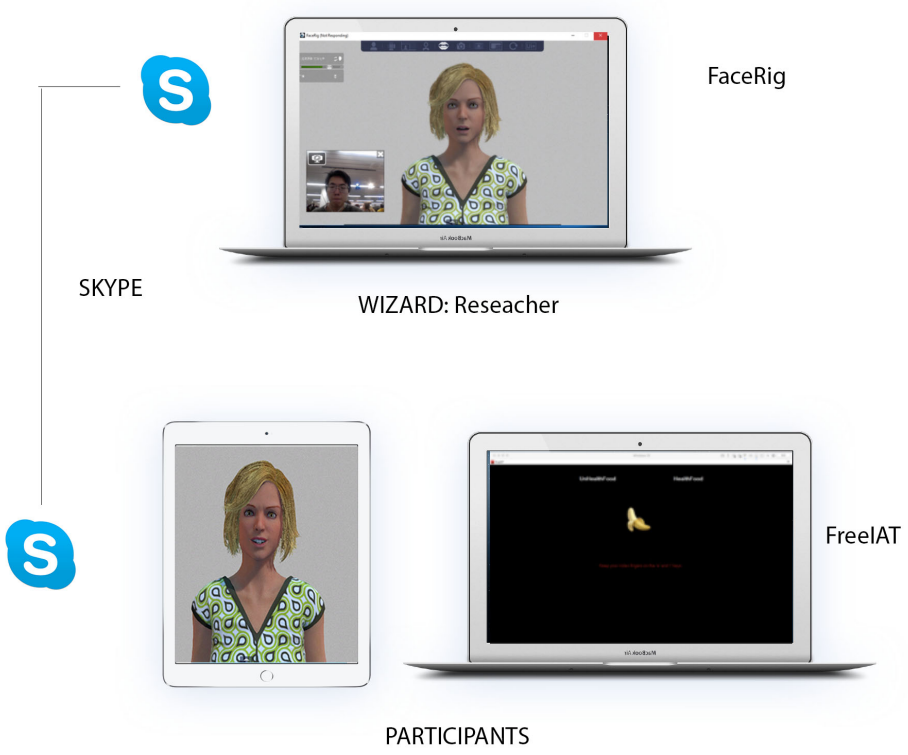


Figure 5: Virtual Mimicry system: Two MacBook, one IPad pro, two major software: FreeIAT and FaceRig.

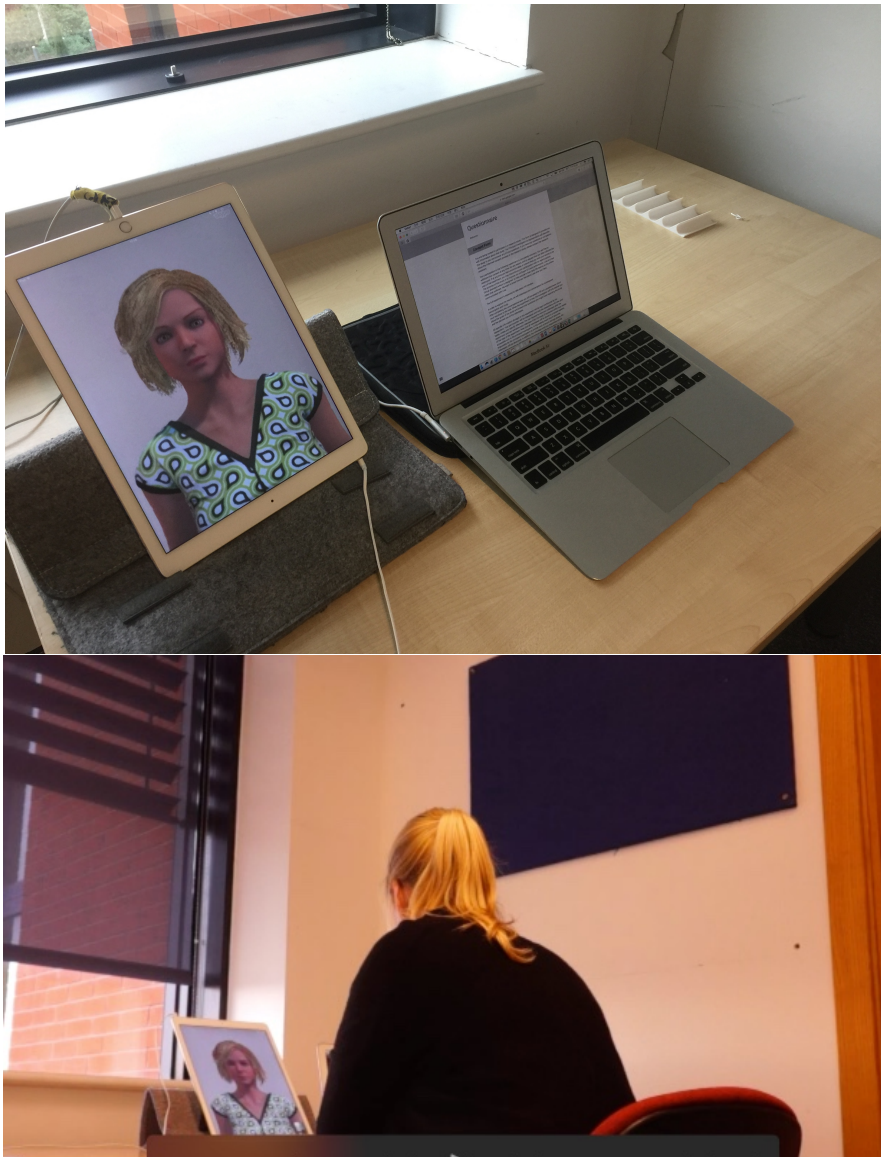


Figure 6: Experiment Setup

Chapter 4 Results

4.1 Subjects

Thirty-three participants from University of Birmingham were randomly recruited through friends and email advertisements into the study. Frist three participants withdrew from the study due to the internet problem and they both indicated they could not hear what Lisa said. In the end, we had Thirty participants and randomly arranged them into mimicry group and non-mimicry group: 15 in the Mimicry group and 15 in the Non- Mimicry group (see Table1). 70 % Participants ranged in age from 18 to 25 years and 26.7% Participant ranged in age from 26 to 46. In mimicry group, 40% were Male and 60% were Female. 33.3% participants first language is English and 66.7% participants first language is non- English. In non-mimicry group, 26.7% were Male and 73% were Female. 20% participants first language is English and 80% participants first language is non-English.

Tablet 1 Subject demographics

		Mimicry	Non-Mimicry	All
Number of subjects		15	15	30
Gender	Male	40%	26.7%	33.3%
	Female	60%	73.3%	66.7%
Age	18-25 years	53.3%	86.7%	70%
	26-49 years	46.7%	6.7%	26.7%
	50-64 years	0%	6.7%	3.3%
Race	Asian	40.0%	73.3%	56%
	White	53.3%	26.7%	40%
	Black	0.0%	0.0%	0%
	Others	6.7%	0.0%	3.3%
English is first language	Yes	33.3%	20.0%	73.3%
	No	66.7%	80.0%	26.7%

4.2 Explicit measure

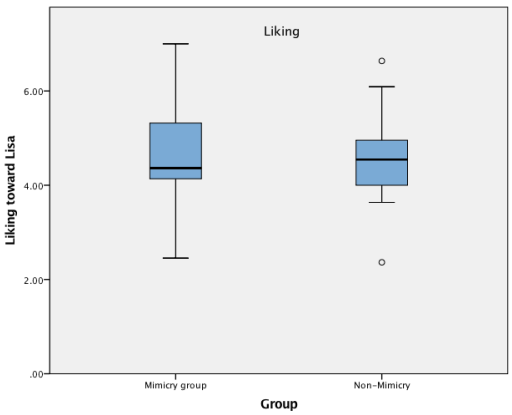
Liking, trust and similarity toward Lisa

To test the first hypothesis whether mimicry could increase liking trust and similarity toward Virtual Agent(Lisa), we conducted Independent-Samples T Test in IBM SPSS 24 to test the effect of virtual mimicry. Mimicry as independent variable and ling, trust and similarity as dependent variable. However, there were no significant different between Mimicry group and Non-mimicry group in liking and similarity scale, which means virtual mimicry from Lisa did not increasing participants' liking (t (28)=0.114, p>0.05) and similarity feeling to Lisa (t(28)=0.896, p>0.05). Furthermore, mimicry did not affect trust in Lisa in this experiment, there are no significant different between two groups in trust scale.(t(28)= 0.651, p > 0.05)

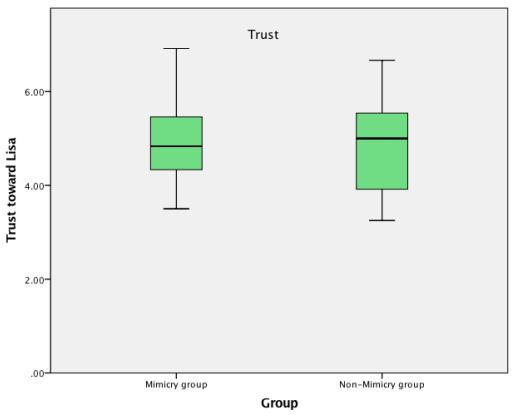
Explicit attitude toward healthy and unhealthy foods

We conducted Independent T- test in IBM SPSS 24 to analyse the effect of nonconscious virtual mimicry to Explicit attitude toward healthy and unhealthy food, results of the questioners indicated that there were no significant different in explicit attitude toward healthy and unhealthy foods between two group (t (28) = 1.298, p > 0.05; t(28) = .140, p >0.05).

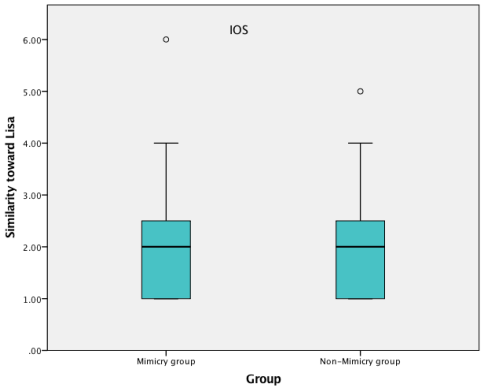
Besides, we conducted Bivariate Correlations in IBM SPSS 24. The negative correlation between the Liking toward Lisa and Post explicit attitude toward unhealthy foods shows the more participants like Lisa the less they will range unhealthy foods as palatable after the conversation with Lisa, r = -.566, p < 0.05. However, there were no significant correlation between Liking toward Lisa and Post explicit attitude toward healthy food.



Boxplot Liking of Lisa by All Subjects



Boxplot Trust of Lisa by All Subjects



Boxplot Similarity to Lisa by All Subjects

Figure 7: boxplot of explicit measure

Tablet 2 T - Independent Samples Test Trust Liking and IOS

	Mimic	N	Mean	Std. Deviation	F	P
Trust	Mimicry	15	4.9667	0.94323	0.324	0.651
	No-Mimicry	15	4.8	1.04975		
Liking	Mimicry	15	4.6642	1.14801	0.071	0.91
	Non-Mimicry	15	4.6182	1.06584		
IOS	Mimicry	15	2.2	1.47358	0.094	0.896
	Non-Mimicry	15	2.1333	1.30201		

4.3 Implicit attitude toward healthy and unhealthy foods

Data from the FreeIAT software were prepared basing on the scoring algorithm developed by Greenwald, Nosek, and Banaji (2003). The resulting score of the algorithm is called an IAT D score. A negative value indicates that participate has an association between unhealthy food and pleasant words, which means participant has more implicit tendency to eat unhealthy food, and a

positive value indicates that participate has an association between healthy food and pleasant words, which means participate has more implicit tendency to eat healthy food. D score vary between -2 and +2, and the breaking point from previous studies is 'slight' (.15), 'moderate' (.35) and 'strong' (.65) association between two targets.
We conducted Independent-Samples T Test in IBM SPSS 24 to test the effect of nonconscious virtual mimicry to influence users' unconscious attitude toward foods, results of the pre-test IAT indicate that subjects are no significant different between two group (t (-.867) = 20.114 , p > 0.05) before they talk to Lisa. The mean and standard deviation of D score in the mimicry group is M = .483, SD = .479 and the mean and standard deviation of D score in the non-mimicry group is M= .6, SD = 0.229. Therefore, participants in both group have a moderate implicit association between healthy food and pleasant than they do between unhealthy food and pleasant. However, there is also no significant difference in the comparison of pre-test IAT score and post-test IAT score between mimicry group and non-mimicry group (t(-.533) = 28, p > 0.05).

Table 3 T - Independent Samples Test
IAT Pre-test and Post-test

	Mimic	N	Mean	Std. Deviation	F	P
D score pre	Mimicry	15	0.483073	0.4790767	6.631	0.393
	Non-Mimicry	15	0.602067	0.2297079		
D score post	Mimicry	15	0.61208	0.2443619	0.355	0.081
	Non-Mimicry	15	0.799853	0.3195763		

Tablet 4 T - Independent Samples Test

	Mimic	N	Mean	Std. Deviation	F	P
Different: Dscorepost - Dscorepre	Mimicry	15	0.129	0.36077	0.116	0.598
	Non-Mimicry	15	0.1978	0.34556		

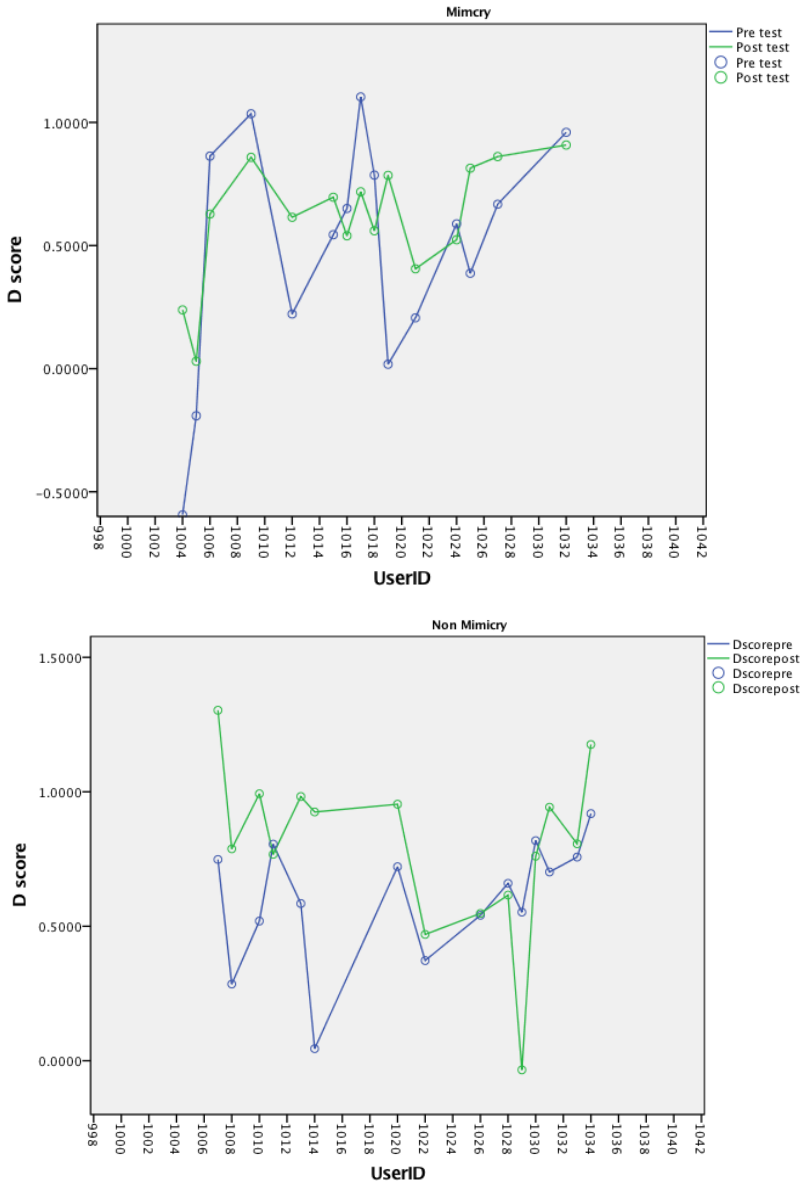


Figure 8: Compared Pre-test D score and Post-test D score

Chapter 5 Discussion

The results from the above study indicate that there are no significant differences between the mimicry group and the non-mimicry group in liking, trust and similarity towards the virtual agent Lisa. Furthermore, there were no significant differences in explicit and implicit association to healthy food and unhealthy food between the mimicry group and the non-mimicry group. Unfortunately, our results in this experiment did not prove our two original hypotheses: 1. Virtual Agent mimicry can increase user's positive feelings, including liking, trusting and similarity. 2. Virtual Agent can use Virtual Mimicry to increase people's unconscious tendency to specific content (preference for certain food). Therefore, in this part we will discuss the factors that might cause our results and the lessons that we have learned from this preliminary study. Besides, we will also showcase the pilot for the future research that we have finished.

Subjects

During the experiment, some subjects often did not behave in the way we expected they would. Some of them would not even move their head during the interaction with Lisa in mimicry condition. Therefore, Lisa's head movement and facial expression may not have been sufficient for participants to arouse the virtual mimicry effect in the experiment. Besides, based on the demography of 30 subjects, we also discover that most of the subjects' first language is not English. Since this experiment strong relies on the conversation and interaction between human and Virtual Agent Lisa, this problem might cause participants to focus too much on understanding the meaning of the conversation instead of interacting and building relationship with Lisa.

Measure

The second factor that we found is the self-report questionnaires that we used in the experiment. As the Liking, Trust and Similarity scale did not provide us with any significant result, the reason for this situation might be that the normal scale which we use in human-human interaction measure is not fit in the human and computer interaction. It is true that questionnaires might not be perfect to assess user experience in general for human-computer interaction. Anyway, we still need more evidence to prove if this scale works well for a Virtual Agent.

The Mimickee Factor

"The consequences of mimicry may depend critically on the personality or other features of the participants being mimicked. People who highly value personal gain or feel independent from others may not show expected positive reactions to being mimicked. " Joanne Hale & Hamilton (2016). Indeed, individual difference in personalities is always a big factor that affects research outcomes. In the previous mimicry studies, Stel et al

(2011) claim that participants who are defined as proself (focus on personal gain) will not be affected by positive consequences of mimicry.
Besides, from the interview with participants, we found that some of them realised that Lisa tried to mimic their head movement during the experiment. Previous studies indicate that people may respond negatively to mimicry when they are aware they are being mimicked, and the prosocial effect of mimicry might also break down because of that. In a study of Bailenson (2008), he discovered that participants who were aware of being mimicked by a virtual agent will rate the agent significantly less warm and trustworthy than the others who were unaware (Hale & Hamilton, 2016; Wojciech et al., 2016).

The Uncanny Valley

Another important factor that we discover from the interviews is the effect of Uncanny Valley between participants and virtual agent Lisa during the experiment. This finding was a surprise to us, and something we like to have a further exploration on in the following part. The definition of the uncanny valley is "human replicas that appear almost, but not exactly, like human beings elicit feelings of eeriness and revulsion among some observers."(MacDorman,2006). Since Lisa is a human like 3D virtual agent, it has great possibility that Lisa will elicit participants' feeling of revulsion. One participant replied "I felt uncomfortable when I talked to Lisa and I tried to avoid eye contact with her." Another participant also mentioned "I found it weird when Lisa talked about her favourite food because I knew she is a computer." This suggests that participants might not be affected by virtual mimicry from Lisa because the Uncanny Valley effect has a stronger influence on them. This finding leads us to explore the relationship between the uncanny valley effect and virtual mimicry and we also start another pilot to observe this effect. In the pilot, we used a 2D avatar to replace the original 3D avatar and recruited five students from the University of Birmingham to take part in the experiment. However, we did not find there were any significant differences between Mimicry and Non-Mimicry in the IAT D score as well. Of course that might be because of the small number of samples.

Tablet 5 T - Independent Samples

Test for 2d pre-test and post-test.

	Mimic	N	Mean	Std. Deviation	F	P
Different: Dscorepost - Dscorepre	Mimicry	2	0.3511	0.60677	0.826	0.328
	Non-Mimicry	3	-1.742	0.42624		

Chapter 6 Conclusion

Background conclusion

Mimicry, also known as mirroring, is one of the most common unconscious behaviours in the psychological area. Psychologists believe that people always have the unconscious intend to mimic other postures, mannerisms and facial expression during their interaction to understand others emotion and thinking**.** Mimicry is a complex unconscious behaviour which consists of four types: behaviour mimicry, facial mimicry, verbal mimicry, emotional mimicry.
Previous research indicate that the consequences of mimicry could lead to many positive behaviours and feelings, such as increasing trust, liking, emotional convergence and even changing opinion. Moreover, people who engage in a long-term relationship will have more influence on each other's views and behaviour, and eventually converge their emotion, cognitive and behave together. Therefore, mimicry has been applied as a powerful persuasive tool in the human and human relationships, such as teacher and student relationship on education, or therapist-patient relationship on psychotherapeutic. Moreover, researchers notice the potential of mimicry in the human computer relationship and then establish the idea of "Virtual Mimicry". Virtual Mimicry is a new direction in behaviour change technique.
Traditional behaviour change technique applications focus on conscious behaviour-change such as Digital Pet Tamagotchi, Pokémon Go, Self- Monitoring Application Balance and Fitbit, IHC technologies PACE+, most of them normal require user have strong Self-control and high will power to continue to use which is not productive in some cases. Although there are very few studies use virtual mimicry as directly tool to change participants' behaviour, Research in Embodied Conversational agents and relationship agent have strong related to virtual mimicry. For example, Virtual coach Laura, which is an MIT Fittrack program, uses head movement, gestures and facial expression to combine healthy information to encourage people to healthy behaviour. Study in car assistants and virtual reality psychotherapy also point out that mimicry could increase similarity between users and virtual avatar and therefore increase their liking and trust towards virtual avatar.

Experiment conclusion

The aim of this experiment is to prove virtual mimicry could have the same effect like the human-human mimicry, and we could use it to increase user's unconscious tendency to healthy food and behaviours. The goal of the experiment was to evaluate if participants who were mimicked by a Virtual agent unconsciously develop a stronger tendency to the Virtual Agent's preference to healthy food than participants who were not be mimicked by the Virtual agent. To exam that, this research had built its own virtual mimicry system which includes: two Macbooks, one Ipad pro, two major software: FreeIAT and FaceRig. Then we designed a pre-test – post-test control group design experiment based on previous HCI research. We also choose IAT (Implicit association test) as implicit measure and liking, trust, IOS and Explicit attitude towards food scale as explicit measure. However, due to many factors we did not find any significant difference between Mimicry and Non-Mimicry group in both explicit and implicit measures.

These results maybe be because of subjects' background, or experiment materials, or mimickee factor, or uncanny valley. One finding that surprises us is from the data of mimicry group, 6 out of 15 participants have lower D score of IAT in the Post-Test then Pre-Test, this means after the conversation with Lisa they have a negative effect towards healthy food. After the interview with some participants, we discovered that uncanny valley effect might occur. Thus, we tried to implement a new pilot with 2d avatar. However, due to the limitation of time and number of samples, we did not find any significant difference between the two groups.

Limitation

One of the challenges of this project is that virtual mimicry itself is a brand-new concept, there are very limited research about how it works and how we could apply it as an unconscious behaviour-change technique. Moreover, it also relates to many different research areas from psychology, sociology to cognitive psychology, HCI and robotics. Thus, more evidence is still needed to build a complete knowledge system of virtual mimicry in the future.
Another challenge of this project was recurring participants within a limit time. Because this was a laboratory experiment, and we only had about two weeks to use the laboratory and other equipment. Eventually we only had thirty people taking part in this experiment. Our results might be affected by the lack of participants.

Future work

The purpose of this project is to explore the effect of virtual mimicry to improve unconscious behaviour - change intervention. As a preliminary study to virtual mimicry in behaviour-change area, there are still many areas that are unexplored. This project only discussed a small part of the overall questions. Because of the limitations of this project, our results are not what we expected. Hence, this project raises more questions, for example, how to avoid uncanny valley in virtual mimicry? Will there be any difference if we use a male avatar or change the way Lisa moves her head? What if we use verbal virtual mimicry instead of facial and behaviour mimicry? Will there be any better measure to test unconscious behaviour change? All these questions are so fascinating to motivate us to continue to explore. I believe Virtual Mimicry has a great potential in improving unconscious behaviour-change technique in the future.

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Appendix A

Guidebook for conversation (Photo Description Tasks)

Lisa loves exercise such as swimming, jogging.

Lisa loves health food such as vegetable, yoghurt

Red: Routine script

Purple: Optional script

Hello

Welcome to our experiment

LISA: Hi - My name is Lisa, I am an online virtual agent for this experiment. May I have your name?

P: My name is Harrison

LISA: Hello. How are you doing today?

P: I am fine.

LISA: Great. Would you like to tell me a little bit about yourself, such as your major, favourite activities, favourite food, or your favourite TV shows?

P: Online game

LISA: It sounds nice. I am Lisa, as you can see I am a virtual agent bases on the video chat server and I have many different habits, such as tennis, running, and swimming. My favourite colour is green and My favourite food is banana and apple. And I always want to be everyone's friend.

LISA: It is my pleasure to meet you. I will be your assistant during the whole experiment.

In this experiment, I will try to help you finish the tasks. During the experiment, if you have any problems please let me know and wait for the researcher to come to help you. If my voice is unclear to you, you could ask me to repeat it.

If you have finished the first task on the computer, please Click on the Next button on your computer screen go to our next task.

The next task called the describe photo task. We will take turns to describe 2 photos to each other and guess what is the content of photos. You could see the example on the computer screen. Try to guess items of the photo base on my description.

If you are still unclear what you should do in this task please contact our assistant. If you think you are ready, please say yes.

First turn

LISA:Great. I will be the first one to describe my photo.

The colour of my photo is yellow, orange and brown; there are two items. This is very common food in most restaurants. Now You can guess what is the content of a picture.

LISA: Do you want me to repeat?

LISA: Nice try, Do you want more information?

P:Yes

Could you repeat it, please?

P:No

LISA: They are very high-calorie food. You have to do a lot of exercise after you eat them, try to guess again?

P:

LISA: You are doing great. Do you want to know the answer?

P: Yes, please

LISA:The photo I have is about beef burger and chips. Do you like them?

If say yes.

Could you tell me why you like them?

If say no.

When did you last eat burgers?

LISA:I like vegetable more. I also enjoy fruit such as apple and banana when I am hungry. What do you think about that?

If love vegetable.

Could you tell me why do you like them?

If love unhealthy food.

When did your last eat burgers?

LISA: I love banana. they taste good and low in calories. What do you think about that?

LISA: You did a great job to guess the photo. Now it is your turn to describe your photo to me.

Please Click on the Next button on your screen to our second turn.

Second Turn

LISA: In this turn you need to describe the photo below the screen and I will be the one to guess the content. You could tell me the colour of the photo, the person of the photo, what they are doing, what kinds of items are in the photo and what you think about them.

You can read the instructions on the screen. If you are ready, please start to describe the content of the photo.

P:..

LISA: Is that food? Please tell me more.

P: No

LISA: Oh, Are those vegetables? Could you explain it, please

LISA: you are doing Great

Could you tell me more about the person on the photo?

Could you tell me the answer?

P: (The photo I have is a different vegetable)….

LISA: You are doing such a great job to it. I think I have almost guessed the answer.

I love fruit, they taste yummy and very healthy. What do you think?

P:

LISA: Exactly. I agree. I agree with you on this. Tell me more about your favourite fruit

P:

LISA:Nice. Now it is my turn to describe my second photo again. Are you ready?

Please Click on the Next button on your screen to our third turn.

Third turn

LISA: My photo is about a man.

He seems very relax and has a good time.

He stares at the front

Now You can guess what is the content of a picture, you could guess what he is doing?

P:…

LISA: I think You are doing good. Do you want more information?

LISA: He sits on the sofa and this is a common activity that people will usually do after work. Try to guess again.

P:

IF unclear.

Could you repeat it, please?

LISA: Excellent, Do you want the answer?

P: Yes, please

LISA: The photo I have is about a man watching TV in his room and drinking beer. I prefer outdoor exercise after work, What about you?

P:

LISA: It sounds like a good way to relax. Tell me more about your hobbies.

LISA: Wow, they sound great. As for me, I love outdoor exercise. Swimming, running, gym, they are all my favourite activities.

LISA: Okay, now it is your turn to describe the second picture you have.

Please Click on the Next button on your screen to our Fourth turn.

Fourth Turn

LISA: Again, in this turn you need to describe the photo below the screen and I will be the one to guess the content. You could tell me the colour of the photo, the person in the photo, what they are doing, what kinds of items are in the photo and what you think about them.

You can read the instruction on the screen. If you are ready, please start to describe the content of the photo.

P: There is a man

…

LISA: You are doing a very good job. Tell me more about the photo. How many items in your photo. What colour of the photo? How do you fell about it.

Is that about exercise? Could you give me more clues?

P

LISA: How is the person feel about it?

You are doing such a great job to it. I think I have almost guessed the answer.

Running

P

LISA: Wow-, I think you are doing such a good job. Could you tell me the answer?

P:

LISA: You are doing excellent. I Love exercise; My favourite sport is swimming, What about you?

IF I like SPORT.

It sounds interesting, Could you tell me more about it.

IF don't like SPORT

I think it is a good idea to do more exercise. What do you think about it?

Yes, i guess it is.

P:

LISA: I like it. You are such an interesting person.

Final

LISA: Wow, you are such a good teammate. We are doing great work together.

Could you tell me about how you feel about this tasks?

Do you think I am helpful?

Thank you. Look like our mission has been accomplished. Please hold on and wait for the researcher. He will help you to finish the questionnaire and I wish to know how you feel about me.

See you.

Appendix B

Online Questionnaires

https://docs.google.com/forms/d/17oSepP2ykX4Pnio9BTiXNM5WugVf06DPzJMoK-Ta1H8/printform

Questionnaire

Welcome

Consent Form

You are being invited to participate in a research study. This form is designed to provide you with information about this study. The Principal Investigator or representative will describe this study to you and answer any of your questions. If you have any questions or complaints about the informed consent process or the research study, please contact the research assistant.

Your participation in the following experiment is completely voluntary. You are free to withdraw this consent at any time, for any reason, and to request that any data collected be destroyed. If at any time you feel uncomfortable, or unsure that you wish your results to be part of the experiment, you may discontinue your participation with no repercussions.
The purpose of this study is to improve our software AI Lisa's performance. Lisa is a new Virtual assistant which is designed to help people in their daily life basing on the online video chat software. We want to know how you feel about Lisa after you have communicated with Lisa.

The full experiment is expected to take about 40 minutes.

In order to explore the results, we will videotape your conversation for subsequent transcription and study.
After completing the conversational task, you will be asked to fill out a questionnaire about your reactions to the task. When the experiment is over, the investigator will fully debrief you about the goals of the study and answer any questions you might have regarding the study and the planned use of the videotapes.

All specific information divulged in this experiment will be kept confidential by the researchers. Your participation will be videotaped and only the researchers will view your tapes, unless you specify otherwise. You can request to view your videotape after the experiment, and can withdraw your videotape from the study if requested within four weeks of the date of the experiment. Note that all videotapes will be stored in a locked cabinet, accessible only to the principal investigators. In the unlikely event that it becomes impossible for the principal investigators to provide such a secure storage space, the videotapes will be destroyed. In addition, the videotape and your responses will be completely anonymous. All data will be associated only with an ID number.

Please CLICK the next page if you agree to continue the experiment.

Demographic

1. **UserID**

2. **What is your gender?**
   Mark only one oval.

   - ◯ Male
   - ◯ Female
   - ◯ Prefer not to say
   - ◯ Other: .....

3. **How old are you?**
   Mark only one oval.

   - ◯ 18-25 years
   - ◯ 26-49 years
   - ◯ 50 -64 years
   - ◯ Other: .....

4. **What is your race/ethnicity?**
   Mark only one oval.

   - ◯ Asian
   - ◯ White
   - ◯ Black
   - ◯ Mixed
   - ◯ Other: .....

5. **Is English your first language?**
   Mark only one oval.

   - ◯ Yes
   - ◯ No

Food

There are 12 scales for you to rate intensity of your feeling of food. Please click own each line at the point which best describe your feeling or your impression. 0 = very unpalatable to 9 = very palatable (palatable = tasty)

6. **banana**
   Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	
very unpalatable	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	very palatable

7. **apple**
Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	
very unpalatable	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	very palatable

8. **orange**
Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	
very unpalatable	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	very palatable

9. **rice**
Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	
very unpalatable	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	very palatable

10. **strawberry**
Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	
very unpalatable	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	very palatable

11. **grape**
Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	
very unpalatable	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	very palatable

12. **pizza**
Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	
very unpalatable	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	very palatable

13. **hotdog**
Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	
very unpalatable	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	very palatable

14. **burger**
Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	
very unpalatable	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	very palatable

15. **french fries**
Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	
very unpalatable	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	very palatable

16. **chocolate**
Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	
very unpalatable	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	very palatable

17. **ice cream**
Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	
very unpalatable	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	very palatable

Skip to question 30.

Food 2

There are 12 scales for you to rate intensity of your feeling of food. Please click own each line at the point which best describe your feeling or your impression. 0 = very unpalatable to 9 = very palatable (palatable = tasty)

18. **banana**
Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	
very unpalatable	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	very palatable

19. **apple**
Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	
very unpalatable	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	very palatable

20. **orange**
Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	
very unpalatable	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	very palatable

21. **rice**
Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	
very unpalatable	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	very palatable

22. **strawberry**
Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	
very unpalatable	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	very palatable

23. **grape**
Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	
very unpalatable	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	very palatable

24. **pizza**
Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	
very unpalatable	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	very palatable

25. **hotdog**
Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	
very unpalatable	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	very palatable

26. **burger**
Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	
very unpalatable	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	very palatable

27. **french fries**
Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	
very unpalatable	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	very palatable

28. **chocolate**
Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	
very unpalatable	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	very palatable

29. **ice cream**
Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	
very unpalatable	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	very palatable

Skip to question 38.

Activity

There are 8 scales for you to rate intensity of your feeling of activity. Please click own each line at the point which best describe your feeling or your impression. 0 = very unpleasant to 9 = very pleasant

30. **biking**

Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	
very unpleasant	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	very pleasant

31. **baskeball**

Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	
very unpleasant	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	very pleasant

32. **swimming**

Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	
very unpleasant	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	very pleasant

33. **gym**

Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	
very unpleasant	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	very pleasant

34. **sleep**

Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	
very unpleasant	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	very pleasant

35. **watch tv**
Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	
very unpleasant	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	very pleasant

36. **video game**
Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	
very unpleasant	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	very pleasant

37. **shower**
Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	
very unpleasant	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	very pleasant

Skip to "TEST1."

Activity 2

There are 8 scales for you to rate intensity of your feeling of activity. Please click own each line at the point which best describe your feeling or your impression. 0 = very unpleasant to 9 = very pleasant

38. **biking**
Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	
very unpleasant	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	very pleasant

39. **baskeball**
Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	
very unpleasant	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	very pleasant

40. **swimming**
Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	
very unpleasant	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	very pleasant

41. **gym**
Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	
very unpleasant	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	very pleasant

42. **sleep**
Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	
very unpleasant	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	very pleasant

43. **watch tv**
Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	
very unpleasant	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	very pleasant

44. **video game**
Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	
very unpleasant	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	very pleasant

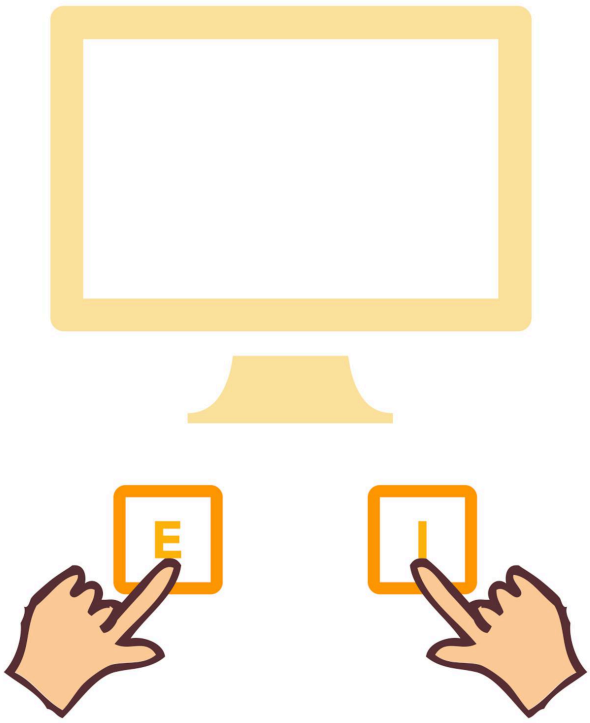
45. **shower**
Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	
very unpleasant	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	very pleasant

Skip to question 74.

TEST1

For us to better understand you, in this part you need to finish the Test 1 on the computer. Please wait for the assistant to instruct you.

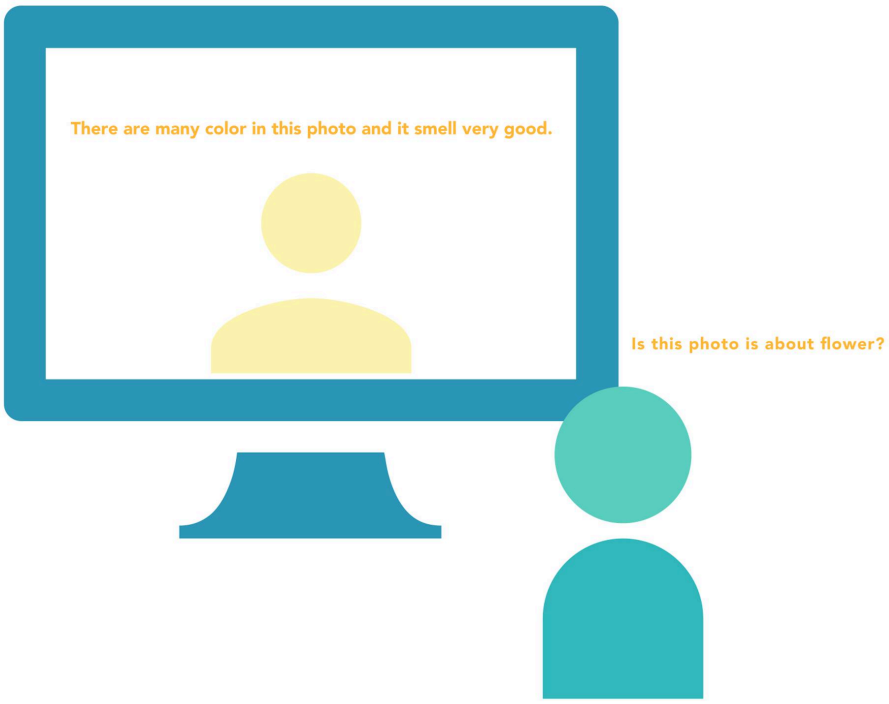


Please put your figners on 'E' key and 'I' key
And follow the instruction on the computer display

Photo Description Task1

In this task, you need to cooperate with Virtual assistant Lisa to finish Photo description. You and Lisa will take 4 turns describing a photo to the other. The first turn is Lisa to describe a photo for you to guess what is the content of the photo.

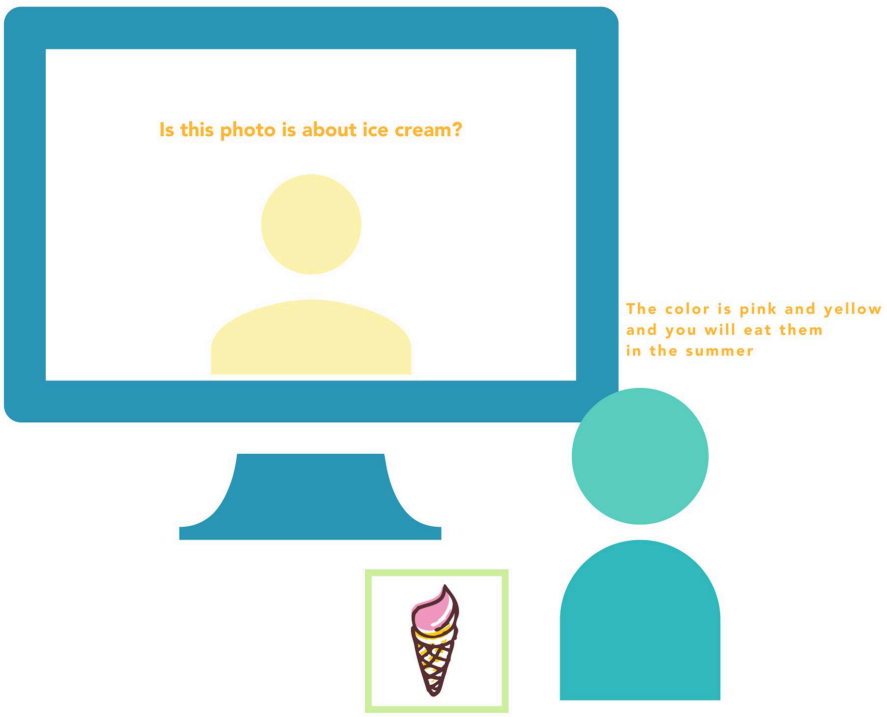
Please wait for Lisa to describe the first photo.



Guess the content of the photo basing on Lisa's description

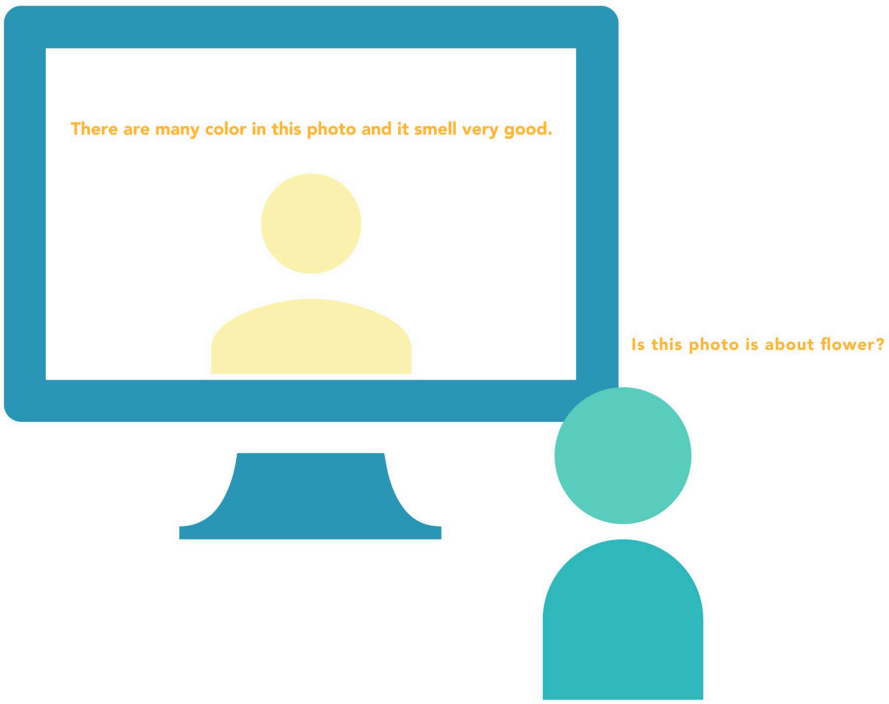
Photo Description Task2

Your turn to describe the follow photo for Lisa.



Describe the content of the photo for Lisa to guess

Please describe this photo for Lisa, you could tell Lisa who/what in the photo, the colour of photo, what is the activity of photo, and your thought about this photo.



Guess the content of the photo basing on Lisa's description

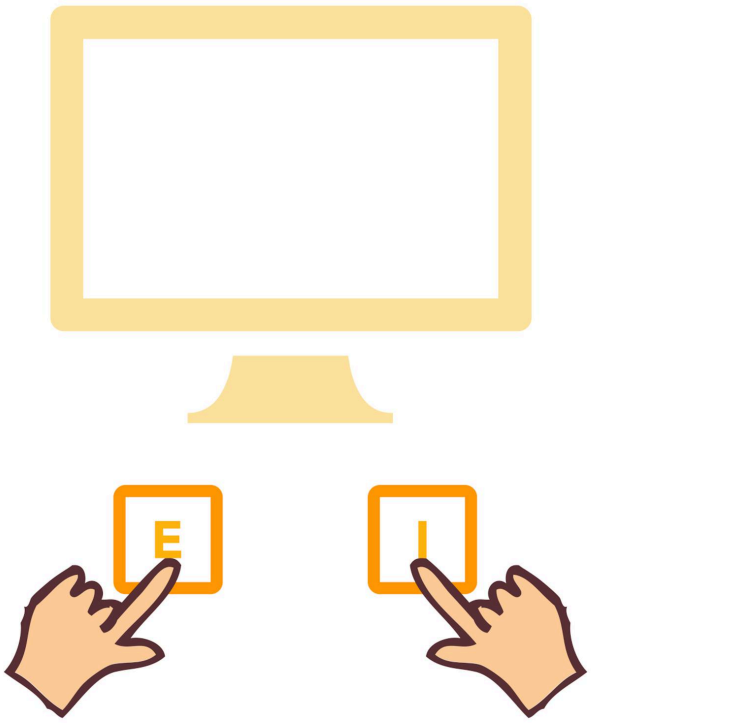
Photo Description Task

Your turn to describe the follow photo for Lisa.

Please describe this photo for Lisa, you could tell Lisa who/what in the photo, the colour of photo, what is the activity of photo, and your thought about this photo.

TEST 2

In this part you need to finish the Test 2 again on the computer. If you still have question If you still unclear what you should do please wait for the assistant to instruct you.



Please put your figners on 'E' key and 'I' key
And follow the instruction on the computer display

Opinion of Lisa 1

Below is a list of statement for evaluating trust between people and Lisa. There are 12 scales for you to rate intensity of your feeling of trust, or your impression of the Lisa while interact with Lisa. Please click own each line at the point which best describe your feeling or your impression.
1 = Not at all; 7= Extremely

46. **Lisa is deceptive (lie)**
Mark only one oval.

	1	2	3	4	5	6	7	
Not at all	⬭	⬭	⬭	⬭	⬭	⬭	⬭	Extremely

47. **Lisa's behaves in an underhanded(dishonest) manner**
Mark only one oval.

	1	2	3	4	5	6	7	
Not at all	◯	◯	◯	◯	◯	◯	◯	Extremely

48. **I am suspicious of the Lisa's intent, action, or outputs**
Mark only one oval.

	1	2	3	4	5	6	7	
Not at all	◯	◯	◯	◯	◯	◯	◯	Extremely

49. **I am wary of Lisa**
Mark only one oval.

	1	2	3	4	5	6	7	
Not at all	◯	◯	◯	◯	◯	◯	◯	Extremely

50. **Lisa's actions will have a harmful or injurious outcome**
Mark only one oval.

	1	2	3	4	5	6	7	
Not at all	◯	◯	◯	◯	◯	◯	◯	Extremely

51. **I am confident in Lisa**
Mark only one oval.

	1	2	3	4	5	6	7	
Not at all	◯	◯	◯	◯	◯	◯	◯	Extremely

52. **Lisa provides security**
Mark only one oval.

	1	2	3	4	5	6	7	
Not at all	◯	◯	◯	◯	◯	◯	◯	Extremely

53. **Lisa has integrity**
Mark only one oval.

	1	2	3	4	5	6	7	
Not at all	◯	◯	◯	◯	◯	◯	◯	Extremely

54. **Lisa is dependable**
Mark only one oval.

	1	2	3	4	5	6	7	
Not at all	◯	◯	◯	◯	◯	◯	◯	Extremely

55. **Lisa is reliable**
Mark only one oval.

	1	2	3	4	5	6	7	
Not at all	◯	◯	◯	◯	◯	◯	◯	Extremely

56. **I can trust Lisa**
Mark only one oval.

	1	2	3	4	5	6	7	
Not at all	◯	◯	◯	◯	◯	◯	◯	Extremely

57. **I am familiar with Lisa**
Mark only one oval.

	1	2	3	4	5	6	7	
Not at all	◯	◯	◯	◯	◯	◯	◯	Extremely

Opinion of Lisa 2

Please state your how strong you believe each of scales below.1 = Very Strong Disagree , 4= Neutral, 7= Very Strong Agree

58. **Lisa is friendly**
Mark only one oval.

	1	2	3	4	5	6	7	
Very Strong Disagree	◯	◯	◯	◯	◯	◯	◯	Very Strong Agree

59. **Lisa is likeable**
Mark only one oval.

	1	2	3	4	5	6	7	
Very Strong Disagree	⬭	⬭	⬭	⬭	⬭	⬭	⬭	Very Strong Agree

60. **Lisa is warm**
Mark only one oval.

	1	2	3	4	5	6	7	
Very Strong Disagree	⬭	⬭	⬭	⬭	⬭	⬭	⬭	Very Strong Agree

61. **Lisa is approachable**
Mark only one oval.

	1	2	3	4	5	6	7	
Very Strong Disagree	⬭	⬭	⬭	⬭	⬭	⬭	⬭	Very Strong Agree

62. **I would ask Lisa for advice**
Mark only one oval.

	1	2	3	4	5	6	7	
Very Strong Disagree	⬭	⬭	⬭	⬭	⬭	⬭	⬭	Very Strong Agree

63. **I would like Lisa as a coworker**
Mark only one oval.

	1	2	3	4	5	6	7	
Very Strong Disagree	⬭	⬭	⬭	⬭	⬭	⬭	⬭	Very Strong Agree

64. **I would like Lisa as a roommate**
Mark only one oval.

	1	2	3	4	5	6	7	
Very Strong Disagree	⬭	⬭	⬭	⬭	⬭	⬭	⬭	Very Strong Agree

65. **I would like to be friends with Lisa**
Mark only one oval.

	1	2	3	4	5	6	7	
Very Strong Disagree	◯	◯	◯	◯	◯	◯	◯	Very Strong Agree

66. **Lisa is physically attractive**
Mark only one oval.

	1	2	3	4	5	6	7	
Very Strong Disagree	◯	◯	◯	◯	◯	◯	◯	Very Strong Agree

67. **Lisa is similar to me**
Mark only one oval.

	1	2	3	4	5	6	7	
Very Strong Disagree	◯	◯	◯	◯	◯	◯	◯	Very Strong Agree

68. **Lisa is knowledgeable**
Mark only one oval.

	1	2	3	4	5	6	7	
Very Strong Disagree	◯	◯	◯	◯	◯	◯	◯	Very Strong Agree

Opinion of Lisa 3

Please state your how strong you believe each of scales below. 1 = Very Strong Disagree , 4= Neutral, 7= Very Strong Agree

69. **I perceive that I am in the presence of Lisa in the room with me.**
Mark only one oval.

	1	2	3	4	5	6	7	
Very Strong Disagree	◯	◯	◯	◯	◯	◯	◯	Very Strong Agree

70. **I feel that Lisa is watching me and is aware of my presence**
Mark only one oval.

	1	2	3	4	5	6	7	
Very Strong Disagree	◯	◯	◯	◯	◯	◯	◯	Very Strong Agree

71. **The thought that the person is not a real person crosses my mind often**
Mark only one oval.

	1	2	3	4	5	6	7	
Very Strong Disagree	◯	◯	◯	◯	◯	◯	◯	Very Strong Agree

72. **Lisa appears to be sentient (conscious and alive) to me**
Mark only one oval.

	1	2	3	4	5	6	7	
Very Strong Disagree	◯	◯	◯	◯	◯	◯	◯	Very Strong Agree

73. **I perceive Lisa as being only a computerized image, not as a real person**
Mark only one oval.

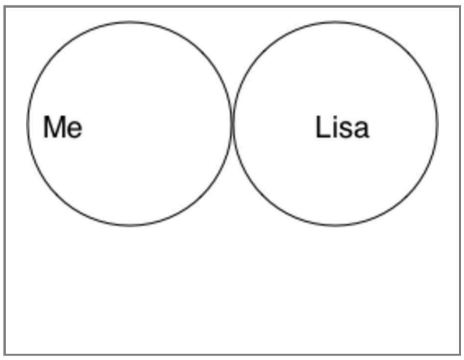
	1	2	3	4	5	6	7	
Very Strong Disagree	◯	◯	◯	◯	◯	◯	◯	Very Strong Agree

Skip to question 18.

Final

Describe your relationship with Lisa

74. **Which diagram best represents how close you feel to Lisa? (Please select one)**
Mark only one oval.



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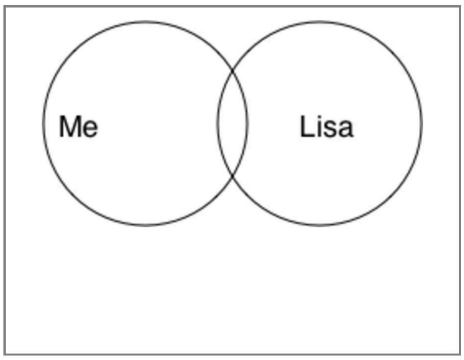

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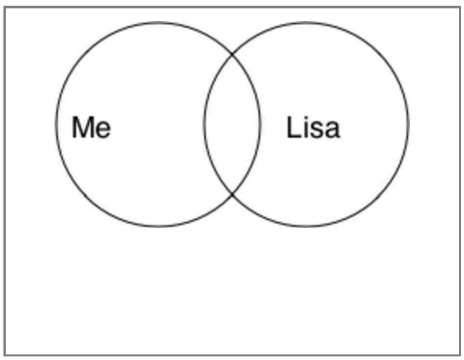

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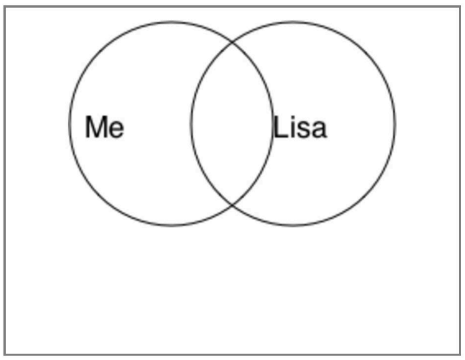

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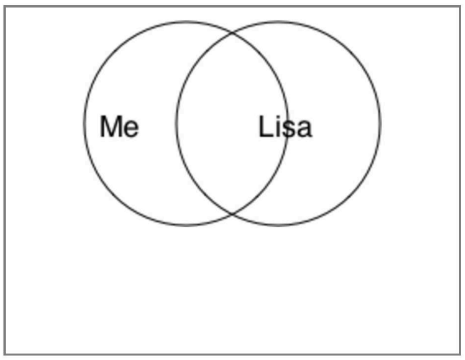

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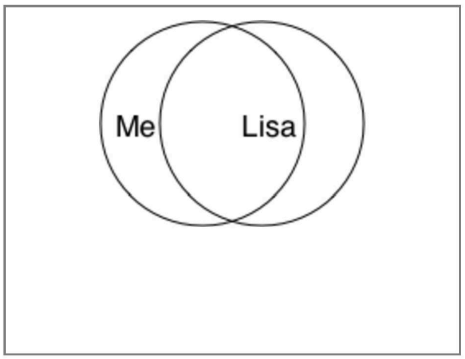

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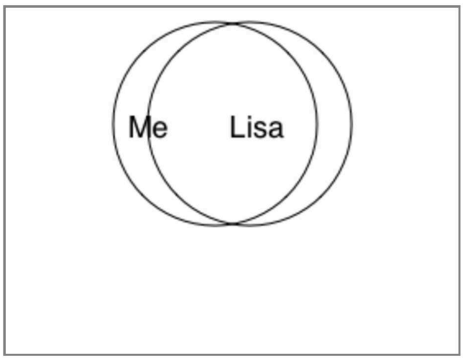

g

Appendix C

https://codex.cs.bham.ac.uk/svn/projects/2016/lxc522

Digital Dissertation

DATA for analyse

projectdata.sav

projectdata.csv