The Problem of Conflicting Social Spheres: Effects of Network Structure on Experienced Tension in Social Network Sites

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ABSTRACT
We propose that a fundamental property of human psychology, the need to maintain independent social spheres, imposes constraints on the use of social network sites (SNS). We particularly focus on the consequences of visibility of communications across social spheres, and we hypothesize that technological features of SNS may bring social spheres in conflict, thus leading to increased levels of online social tension. A survey study among Facebook users was conducted to test this hypothesis. Results showed that diversity of the Facebook network predicted online tension. Moreover, the number of kin in a Facebook network was a crucial component because it predicted online tension whereas number of work and social contacts did not. Further, evidence was found to support the idea that tension might impose an upper limit on network size. We conclude with a discussion of these findings and describe how they support the thrust of recent modifications to SNS designs.

Author Keywords
SNS, online tension, social spheres, network diversity

ACM Classification Keywords
H5.m. Information interfaces and presentation: Miscellaneous.

INTRODUCTION

For several years now researchers have tried to assess the impact of the Internet and its various applications on the way we form and maintain relationships [4, 20, 28]. With the recent expansion of social network sites (SNS) [5, 6], whose explicit function it is to keep people connected, the possibilities for managing social contacts have become seemingly limitless. In this paper we present a theory in which we argue that the mechanisms designed to facilitate connectivity create new, unintended, problems that constrain the growth of personal networks. Due to the highly visible communications encouraged by SNS, social exchanges between users sometimes have negative consequences beyond their intended audience. SNS exchanges are therefore more likely to lead to tension and to destabilized social networks than offline exchanges. Ultimately, the overt visibility of communication may off-set the beneficial social effects of technology that have been reported in the literature. After having presented the theory, we present the results of a survey study in which we focus on one particular aspect of our framework, the overlap between different social spheres.

There is some evidence to support the view that the Internet in general, and SNS in particular, facilitates the growth and maintenance of larger social networks. Some have found, for example, that higher frequency of Internet use is associated with growth in numbers of social contacts [4, 20, 28]. More specifically, Ellison, Steinfield, and Lampe [12] found that use of SNS such as Facebook was related to various forms of perceived social capital, but that it was particularly useful for extending the maintenance of already existing social ties. In their study, intensity of Facebook use was positively related to three forms of social capital: bonding, bridging and maintained. While bonding and bridging capital are established categories [7], also referred to as strong and weak ties [13], maintained capital refers to ties that were important in the past, but are not immediately available for face-to-face contact now due to a change in location. Similarly, Donath and boyd [10] have claimed that SNS hold the potential to increase the number of weak ties.

Despite the evidence for what are generally considered positive social outcomes of SNS use, there is anecdotal evidence for what might be a pervasive emergent problem. One aspect of this problem is often stated as a concern about privacy [1], e.g., when somewhat personal photographs of a person can be seen by those for whom

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they were not intended (perhaps by employers or by family). However, identification of privacy concerns may only be a starting point for an analysis of the effects of SNS on social networking. Here we contend that the problem concerns a fundamental property of human social networks, the need to maintain independent *social spheres*, which imposes constraints on the communication between users of social networking sites (SNS). We particularly focus on the effects of situations in which the content of communication intended to be consumed *within* a social sphere becomes available in *another* social sphere and we hypothesize that the increased visibility of communication in SNS, or similar social media, may lead directly to increased levels of social tension. We call this the *problem of conflicting social spheres*.

Conflicting social spheres can generate tension within a network, either between network contacts or between contacts and the person maintaining the network. However, tension has received little attention in research on social networks. Some forms of online conflict have been discussed by researchers, mostly in the form of flaming and often connected to the consequences of anonymity [19, 22]. Social tension on SNS, however, occurs between easily identifiable actors who are often in long lasting connection with each other. What is more, tension does not necessarily imply open conflict, yet can put a strain on networks, for example in the form of social blunders and gossip.

Tension can become especially problematic when positive interactions within one particular relationship have a negative effect on a neighboring, connected relationship. In the case of SNS use, a user might, for example, post an entertaining message to a friend, only to find that this has negative effects on family relations because of a family member reading the post. This incident can then further affect the whole triadic structure (e.g., the family member dislikes the friend) which will make social interaction involving these contacts more difficult. Unintended tension is likely to occur when different social spheres are involved.

A social sphere is defined here as a partial ego-centered network with many internal connections between individuals but few, if any, connections to other parts of the ego's network except through the ego. Such sub-structures have variously been called clusters [16] or social circles [18, 26], although the latter usually refers to smaller aggregates of people. With the term social sphere we further want to emphasize that these network parts often show distinct sets of norms governing the style and content of social interaction. The different cultures of social spheres necessitate a change in communication when moving from one to the other. Simply put, people will talk differently to their best friends than to their work colleagues or their family and about different things (and differently to their family than to their best friends and work colleagues etc.). The normative power of social spheres is further demonstrated by research on organizational behavior which has shown that access to social groups is restricted if people do not signal attitudes that conform to group norms [26].

Little is known about the role of social spheres in SNS networks. Research on social networks in general typically shows that social contacts come from different life domains, were made at different life stages, and vary greatly in importance to the focal individual [16, 23, 11]. In the case of Facebook, research by Ellison et al. [12] and Lampe, Ellison, and Steinfield [21] shows that the accumulation of social contacts follows primarily an offline to online direction. Offline networks are, in part, rebuilt online. This implies that Facebook profiles will list not only lasting and close friendships, or social acquaintances, but contacts of all kinds, useful or important for diverse reasons. While maintaining friendships and acquaintances is probably still of most importance to users [17], the recent interest in the possible consequences of having work or family contacts on Facebook shows that online networks are expanding in other directions as well.

What we are proposing is that increasing sociality through increasing the visibility of communication, which is a primary purpose of SNS, has the potential to harm social networks. We are not so much concerned about the occurrence of individual events that are related to privacy. Rather, we are proposing that the general likelihood of problematic events within one network depends on the composition of this network. We argue that the occurrence of online tension depends on network diversity and on the presence or absence of specific social spheres in the network. In the following we first expand on the implications of SNS for social spheres, and then we report results of a survey among Facebook users.

The implications of SNS for social spheres

SNS technologies encourage people who share a friend to share a social space. This social space provided by SNS typically lacks boundaries and segmentation that are characteristics of offline networks. Boundaries between social spheres occur naturally in offline networks, mostly due to spatial/temporal separation of contacts. This elaborate structure is dropped in online environments. As online networks grow and become more diverse, it is likely that members from otherwise separate social spheres become part of it. Interacting within different spheres, however, requires much more caution if technology makes social information immediately visible to everyone in the whole network. Close family, close friends, school friends, university peers, work colleagues, bosses, work and hobby friends, and so forth are all able to observe communications within spheres other than those to which they belong. As a result, users may have to actively uphold structural (offline) features of their networks that are ignored by technology if they want to avoid social clashes.

There are three particular ways in which SNS might encourage the visibility of potentially harmful social information across social spheres and thus lead to tension.

1. *Broadcast*. SNS make much use of mechanisms that broadcast information sent by one person to others which means that many social interactions are visible to a large number of people, and to people across different social spheres. The more network members are also listed as each other's friends the better any individual can monitor what is going on in other segments of the network. This is realized by many users. As Joinson [17] has shown, social investigation and surveillance is one of the main motives for use among Facebook users.

2. *Persistence*. Dyadic interactions and their products are persistent on SNS which means that they are visible to others in the network for a longer time than offline interactions. Elements (texts, pictures etc.) that led to tension do not fade on SNS and memory about them can be refreshed easily. Also, elements that carry the potential of creating conflict can do so over a longer period of time.

3. *Awareness*. The technology might impact on user awareness of which contributions are available when. Acquisti and Gross [1], for example, have observed that users of SNS are often unaware of their potential audience when uploading private information. Also, the vast majority of users do not make use of settings that restrict access to information [15]. Also when communications are technologically mediated people sometimes show reduced sensitivity to the consequences of social action, for example flaming [19, 22], perhaps due to a reduction in awareness of the fact that there are real people at the other end of the communication.

The first two of these technological attributes, broadcast and persistence, create dilemmas for the user. On the one hand, broadcast technologies are a useful tool because they encourage increased sociality, but on the other they increase the risk of unintended social tension. On the one hand, persistent content offers increased opportunities for asynchronous communication, but on the other it increases the risk that the content is consumed beyond its intended audience and therefore again increases the risk of tension. Trade-offs are intrinsic to most aspects of design, but in the rush to socialize the web it is perhaps forgotten that design interventions are unlikely to have only positive impacts.

Conflicting social spheres may play a crucial role in SNS and help to explain some ongoing concerns in media debates. When Facebook opened up to users without network membership (which effectively erased the last remnants of network "exclusivity" with which this SNS had started) new and pressing questions emerged. Would a college student post pictures from last night's party if she knew that her grandmother (or worse, her parents) can access her profile? Should company members add work colleagues (or bosses) to a profile that is used for social purposes? These scenarios, and the other examples given before, are effectively about having contacts from two different social spheres. As such, these questions can be directly addressed by our theoretical perspective.

Social Spheres, Tension, and Privacy

Social spheres and social tension can be related in two different ways. First, it might be that with increased diversity in a network, the probability that members from different social spheres will produce problematic situations increases. Second, another possibility is that there are critical social spheres, e.g., core family members, that have a higher probability of getting into conflict with the rest of the network. We will treat these two scenarios as our first research hypotheses. Testing them requires information on the composition of online networks.

The problem of conflicting social spheres is related to a general class of dynamics in social networks that determine structural stability [8, 27]. For example, social networks have a tendency towards transitivity (striving towards all positive ties within the network) and homophily (more similar individuals become more easily connected) [24]. The contribution of the problem of conflicting social spheres to research on communication technology is the claim that specific features of the medium for social action can exacerbate the extent to which social networks are likely to manifest tension.

Conflicting social spheres are not necessarily about privacy, that is, not about privacy in the sense of protecting personal information against unauthorized access by others. Although the technologies that may reduce this kind of privacy may also lead to tension, the absence of privacy does not necessarily lead to tension, and tension problems may arise in the absence of privacy violations. Conflicting social spheres rather point to a privacy problem that rests on the loss of control over private space. The user can no longer regulate with whom to share this space, and as a result, is unprepared for the diversity of social encounters. In other words, the problem is not about others secretly going through compromising material inadvertently left unlocked, but about compromising material forced on every contact within the whole network. From this perspective, increasing visibility necessarily reduces privacy, just as it raises the likelihood of conflicting social spheres.

Until March 2008, Facebook provided only limited possibility for the user to segment their network and thus to control the flow of and access to information [9]. This provided us with the opportunity to conduct a first test of the role of conflicting social spheres in SNS. In general, we expected that online tension would depend on network diversity, and we were particularly interested in the three big social spheres of family, work, and social contacts. We further expected that technological features related to broadcasting and access to social material, such as pictures and messages, were a source of conflict to users.

METHOD

Sample

A total of 232 participants (Ps) who were students and staff at the University of Manchester, UK, responded to an online survey that was specifically targeted at Facebook users. Of these 232, 184 filled in the measures used in this study. The mean age of users was 26.1 years (SD = 7.1) with 50% of all respondents falling into the range from 22 to 27 years. This range is markedly higher than other reports of user age [e.g., 12], and reflects the fact that we were able to sample beyond a student population by including university staff. Female users were in the majority with 63%. There was no discernible difference in terms of age and gender distribution between those who completed the questionnaire and those who did not.

Procedure and Measures

Data was collected using an online survey that was accessible from January until March 2008. The study was advertised within the university via email on the student volunteers' board and in the staff news as a study on Facebook networks. Respondents were prevented from using the same IP address twice in order to avoid multiple responses from the same person. The vast majority of responses (82%) were received between mid-January and mid-February. In addition to age and gender, the following variables were assessed in the questionnaire:

Network size and composition off-line and on-line

The size and structure of Ps' networks was assessed using the summation method by McCarty et al. [23]. This measure consists of a list of 16 social categories: immediate family, other birth family, family of spouse or significant other, best friends/confidantes, just friends, school relations, childhood relations, people known through hobbies, coworkers, people you know but do not work with directly, people known through others, people from religious organizations, people providing a service, neighbors, rest. Ps are asked to put down how many contacts they know in each category and to treat categories as non-overlapping. An estimate of the total network size is then obtained by summing up all 16 numbers reported. In the study by McCarty et al., this method has shown convergent validity with other methods. In the present study, Ps were asked two numbers for each category: how many people they knew in total (online and offline) and how many people they had on their Facebook profile (excluding the rest). Students were instructed to count fellow students as people they worked with if there was no better fitting category.

Our focus was on family, work and social contacts as the potentially most important social spheres in networks. We therefore further grouped the 16 categories as follows. For family contacts, immediate family, other birth family, and family of spouse or significant other were summed up. For work contacts, coworkers and people you know but do not work with directly were added together. For social contacts, best friends/confidantes, just friends, school relations, childhood relations, and people known through hobbies were taken together. It seemed ambiguous whether the remaining categories reflected voluntary social contact or not, so we decided to exclude them.

In addition, an index of network diversity was created by counting the number of categories that had a count of at least one for each P. Values of 16 therefore meant that the respondent had entered numbers for all categories available which in turn meant maximum diversity.

Finally, we asked Ps directly how many contacts were listed on their Facebook profiles. This gave us a comparison to the summation method with which we could test for the internal validity of our measures.

Online tension

Eight items were used to measure online tension. Ps were asked to indicate on a scale from 1 to 7 how often they had experienced the following on Facebook, involving themselves or amongst others: expressed criticism, social blunders, damaging gossip, and breaches of trust (e.g., "How often have you experienced expressed criticism directed at yourself?"). Items were averaged to form a reliable index (Cronbach's $\alpha = .88$) with higher numbers indicating more tension.

Technology features related to tension

In order to gain more detailed information on the components of Facebook that trigger online conflict, Ps were asked the question "Which features of Facebook have led to the most social blunders for you so far?" The response format in this case was open-ended text.

Intensity of Facebook use

We were further interested in behavioral indicators of Facebook use that could determine opportunities for encountering online tension in the first place (unlike, for example, the intensity measure used by Ellison et al. [12]). Two indicators of the intensity of Facebook use were assessed. First, traffic intensity was measured by asking Ps how many posts they had sent and how many they had received in the past week. The two items were correlated highly ($r = .71$; $\alpha = .83$), and therefore were averaged to form an index ranging from 1 to 7 with higher numbers indicating stronger traffic. Second, Ps were asked how much time they had spent on Facebook during the past week. This variable was scaled in minutes. It was not combined with traffic intensity since this would have lowered scale reliability considerably to $\alpha = .06$.

User cautiousness when adding friends

A single item directly assessed whether users paid attention to the fit in their network when adding new contacts. Specifically, they were asked to rate the statement "When I add new contacts I sometimes think about how they will fit in with my other contacts." on a scale from 1 to 7 where higher numbers indicated a higher degree of agreement.

RESULTS

Network Size and Composition

The distribution of total network size showed a median of 202.5 meaning that 50% of all users reported a network size of up to 202. The mean of total network size was M = 305.36 (SD = 274.84). This value corresponds well with the ones reported by McCarty et al. [23] (Study 1: M = 291; SD = 259; Study 2: M = 281; SD = 255). Facebook networks, unsurprisingly, showed a lower median of 85.5 in their distribution. Mean size in this case was M = 137.20 (SD = 138.71). This value was almost identical to the mean size derived from the direct assessment of Facebook contacts: M = 138.90 (SD = 128.70). Both estimates were highly correlated: r = .84; p < .001. In the following analyses, the estimate derived by the summation method is used.

Network composition according to family, work, and social contacts is summarized in Table 1. For a comparison of both networks, absolute numbers were transformed into proportions by dividing category size (e.g., family on Facebook) by the corresponding network size (e.g., size of the Facebook network) for each P. T-tests for dependent samples were conducted to compare values within each category. All differences were significant (t(172) = 9.56; p < .001 for family; t(173) = -10.01; p < .001 for social; t(172) = 2.11; p = .04 for work contacts). Effect sizes d were biggest for family (d = 0.79) and social contacts (d = 0.63) whereas the effect size for work/study contacts was rather low (d = 0.14). Taken together, these findings indicate that family contacts on Facebook were under-represented and social contacts were over-represented when compared to the social network as a whole.

Network size and composition were affected by user age. While the correlation between age and total network size was negligible (r = -.14; p = .06), online network size decreased significantly with increasing age (r = -.40; p < .001). Further, age was also correlated with the proportion of family contacts in the Facebook network (r = .51; p < .001) and the number of social contacts (r = -.35; p < .001). This may reflect different user purposes in different age groups. Older users tend to have smaller networks that contain more family contacts and are less focused on social contacts.

In contrast to user age, user gender had less of an impact on networks. Differences between male and female users were found for the proportion of family contacts. Female users (M = 0.15; SD = 0.13) reported a higher proportion of family contacts than male users (M = 0.10; SD = 0.11) in their total networks: t(153) = 2.69; p < .01. This was reflected by proportions in the Facebook network where females (M = 0.063; SD = 0.093) again reported higher figures than males (M = 0.037; SD = 0.04): t(168) = 2.52; p = .01.

Online Tension and Facebook Network Characteristics

Online tension was positively correlated with Facebook network size: r = .47; p < .001. Unsurprisingly, correlations with the number of family (r = .30), work (r = .30) and social contacts (r = .42) were likewise significant (all p < .001). In order to test whether any of these network components had a specific impact on tension, a set of regression analyses was run in which network size was controlled for. In three analyses, the number of either family, work or social contacts was entered as a predictor simultaneously with network size. The only network component that retained a significant effect was number of family contacts: β = .16; p < .01. Higher numbers of family contacts on Facebook meant more online tension – independent of the size of the Facebook network.

	Family	Social	Work/Study
Total network	0.134 (0.125)	0.456 (0.199)	0.218 (0.168)
Facebook network	0.053 (0.079)	0.588 (0.228)	0.202 (0.223)

Table 1. Mean proportions of family, social, and work contacts in the total network and the Facebook network. Standard deviations are in parentheses.

It should be pointed out that this finding cannot be accounted for by user age or gender. Although age was positively correlated with the proportion of family contacts, as reported in the previous section, the correlation between age and tension was negative (r = -.36; p < .001) which means that younger users experienced more tension. Likewise, although female users had reported a higher proportion of family contacts than males, no gender differences in tension emerged (p > .40).

In a next step, we tested whether network diversity was related to tension. Since diversity and network size were positively correlated (r = .35; p < .001), we again used a regression analysis. Diversity and network size were entered simultaneously as predictors of tension. The positive coefficient for diversity (β = .21; p < .01) indicated that tension increased with increasing diversity, independent of Facebook network size. This finding indicates that tension is a result of processes *between* social spheres rather than *within* spheres.

It could be that experienced online tension is also related to more family contacts and more diverse networks offline. Such an association would be an indicator that online tension merely follows from offline tension and is not caused by SNS technology. We therefore repeated all analyses using the corresponding variables from the offline network (number of family, work, and social contacts as well as diversity) as predictors. The only significant finding to emerge was a weak correlation between number of offline social contacts and online tension (r = .22; p < .01) which did not hold up once network size was controlled for.

Feature	Count
Explicitly reported none	44
The Wall (incl. Super Wall)	31
Pictures	28
Status updates	6
Chain mails	4
Event planner	2
Mini feed	2

Table 2. Reported features of Facebook related to online tension. Only features with a count > 1 are listed.

Technology Features Related to Online Tension

126 Ps entered an answer to the question which feature of Facebook in their experience had led to the most social blunders. Table 2 lists all answers with a count of more than 1. To begin with, many Ps reported that there was no feature they found problematic (35%). The others reported common features that were all about easy broadcast and accessibility of text or pictures (e.g., making public comments, reading other people's conversation, tagging someone in pictures, commenting on pictures etc.). Three out of the six respondents who listed status updates referred to relationship updates as a source of blunders.

In order to investigate whether the number of family contacts and the diversity of the network had any effect on the features users reported, we defined two user groups with high and low risk for tension. The low risk group included users with networks that had less than 3 family members and a diversity score of less than 9. Those two thresholds were the median scores on both variables. The high risk group included users who reported more than 2 family members and scored higher than 8 on diversity. Out of 33 responses given in the low risk group, 42.5% indicated no problematic features, 18% mentioned the wall and 9% were about pictures. In the high risk group, 48 responses occurred with 33% indicating no problematic features, 25% indicating the wall, and 25% pictures. Thus, high risk users were less likely to mention no conflict, and more likely to mention both the wall and pictures when compared to low risk users.

Online Tension as a Constraint on Facebook Network Size

We further explored whether online tension might act as a constraint on network size. Several analyses One possibility is that tension changes the relation between user activity and network size.

Typically, increased user activity is an indicator for a larger network size and vice versa: both traffic intensity ($r = .28$; $p < .001$) and time spent on Facebook ($r = .27$; $p < .001$) are positively correlated with network size. Two moderation analyses [2, 3] were carried out to see if these relationships were contingent on the level of tension. In the first analysis, tension and traffic were centered, an interaction term was computed by multiplying the two, and all three resulting variables were entered as predictors in a regression of network size. The interaction was significant ($\beta = -.25$; $p < .01$) indicating that the relation between traffic and size changes for different levels of tension. A simple slope analysis, which involves separate regressions at different set levels of the moderating variable, was carried out to further illustrate this interaction. The analysis showed that at low levels of tension, traffic was a stronger predictor of size ($\beta = .50$; $p < .001$) than at high levels of tension ($\beta = .13$; $p = .08$). High and low levels were defined as one standard deviation above and below the mean. Figure 1 illustrates this interaction.

The second analysis followed the same logic, only with time spent on Facebook instead of traffic. Again, tension and time interacted with each other ($\beta = -.29$; $p < .01$). As with traffic, time was a stronger predictor of size at lower levels of tension ($\beta = .47$; $p < .01$) compared to higher levels of tension ($\beta = .17$; $p = .02$). This pattern is illustrated in Figure 2.

In sum, online tension interacts with both facets of user activity. When tension is higher the relationship between user activity and network size is reduced. This might be because users have to invest more effort in the management of tension instead of the expansion of their network.

User Adding Behavior

Finally, we were interested in the role that users' consideration of fit among network contacts might play. Experienced tension and cautious adding behavior were unrelated with each other. But cautious adding had an impact on the relation between user activity and online tension. This was demonstrated in a moderation analysis (described above) in which traffic, adding behavior and the corresponding interaction term were entered as predictors of tension in a regression. The interaction was significant ($\beta = -.16$; $p = .04$), and a simple slope analysis showed that at high levels of cautiousness traffic did not predict tension ($\beta = .10$; $p = .26$) whereas at low levels of cautiousness it did: $\beta = .32$; $p = .01$. One interpretation is that users can escape tension even at high levels of use when they try to counter balance problems in their network right from the beginning. The downside, however, could once again be a restriction in network size since cautious adding behavior was negatively correlated with the size of Facebook networks: $r = -.25$; $p < .01$.

DISCUSSION

Summary of findings

Our main findings can be summarized as follows. First, diversity of the Facebook network predicts online tension. This is direct support for our theory. It implies that tension occurs between rather than within spheres. The more a heterogeneous off-line network is compressed into an online social space, the greater the visibility of

communication between social spheres, and the higher the potential for tension. In particular, we argue that it is the lack of segmentation and the unrestricted flow of information in the online space that encourages a problematic overlap between spheres.

Second, the number of family members in an online network predicts online tension. We see this as evidence that a particular social sphere is hard to reconcile with the rest of a network that consists mostly of friends and acquaintances. This is all the more interesting given the fact that family contacts were markedly under-represented online. It seems that family members are only slowly entering Facebook networks where they have an increased likelihood to be involved in problematic situations. This might be because of the very intimate ties to some family members, but also because of the gap between the norms within a family and the norms within other social spheres.

Importantly, overall network size is not sufficient to explain the observed perceptions of tension. Although network size was positively related to tension, this effect was controlled for in the analyses.

Interestingly, we found no evidence for work contacts to play a central role for online tension. Although many anecdotes invoke the dangers of Facebook in the workplace, the number of work contacts did not predict tension when network size was controlled for in our study. It may be that work contacts indeed cause little tension, turning anecdotes into unfounded rumors, in contrast to family members who have qualitatively different relationships with the user. Alternatively, problems with work contacts may rest not on numbers, but on specific individuals (e.g., an employer, a competitive colleague). Clearly, only future research making use of different methods and samples can put these speculations to test.

Third, users reported the wall (e.g., public posting of messages) and pictures (e.g., tagging and commenting) as the technological features of Facebook that led most often to social blunders. We see this finding not merely related to questions of privacy settings, but more fundamentally to the question of how much ease of communication is beneficial to the structure of one's social network.

Fourth, there is some indication that tension might impose a constraint on network growth. For one thing, tension moderates the relationship between user activity and network size. In general, more user activity means larger networks (and vice versa), but not at high levels of tension. It may be that tension imposes additional maintenance costs on the user, perhaps reducing opportunity for further network expansion. Further, cautious users who are concerned about the fit among network contacts can in part escape tension. For cautious users, increased activity on Facebook is not related to tension (as it otherwise is). The disadvantage is, however, that increased cautiousness also implied a smaller network size. Simply put, being choosier avoids trouble but means having fewer contacts on Facebook.

Implications for network growth

A limit on network growth due to increasing tension would have far-reaching implications for technology-aided network facilitation. This is best explained in light of an evolutionary theory of the size and structure of human networks: the Social Brain Hypothesis (SBH) [11]. SBH postulates a layered structure of networks with each layer being characterized by a certain level of emotional closeness to ego. As such SBH is less concerned with network clusters like social spheres.

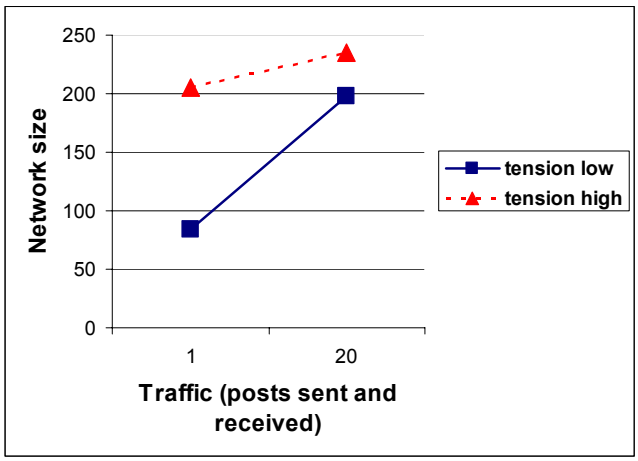

Figure 1. Illustration of the interaction between online tension and traffic when predicting Facebook network size.

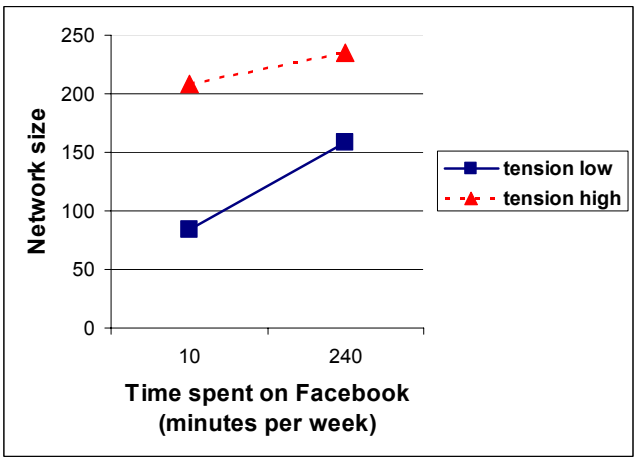

Figure 2. Illustration of the interaction between online tension and time spent on Facebook when predicting network size.

The maintenance of social relations requires cognitive effort and due to our limited brain capacities humans can only maintain a certain number of contacts at different levels of closeness. Importantly, SBH arrives at quantitative estimates for the network layers: for example around 5 for the innermost group of closest others and around 150 for the whole active communication network.

Cognitive constraints on network growth according to SBH comprise limited capacities for multiple face-to-face interaction, limited awareness of who knows what about whom in situations involving several actors (theory of mind), and other limitations of the memory system. Some of these constraints, quite obviously, can be loosened with the help of communication technology. The research on internet and SNS use referred to in the beginning suggests that communication technology can bring people beyond the postulated boundaries for network size. However, our study hints at the possibility that new boundaries are already on the horizon.

If tension is indeed a costly side-effect of growing online networks, this means that protagonists may increasingly incur the stress and time costs of repairing bonds, and/or networks may be disrupted. Ultimately, conflict due to unintended occurrence and spread of tension might impose a new limit on network growth.

Implications for design

It is not easy, nor often wise, to offer instant design solutions on the basis of a single study designed to test a particular, and limited, theory of social interaction. In our view a deeper and integrated consideration of a subject is required in order to shape design. However, we try here to point to how our social spheres framework combined with the particulars of the results might be used to generate design ideas. We illustrate our suggestion with a critique of recent, 2008, changes made to Facebook privacy controls.

To recap, the assumption behind the social spheres hypothesis is that in the off-line world people naturally maintain communicatively separate social spheres, each of which has its own norms of expected behavior. The challenge for the designer is to enable interaction that is sensitive to these varying norms without imposing undue overhead on the user. Crucially, the problem is not the problem of privacy in general and solutions to simple notions of privacy, we argue, are unlikely to solve the problems that we have exposed.

In 2008, Facebook introduced ”friends lists” which can be used to segment the online network and channel the flow of information [9]. Privacy settings can be set for individual network members or for whole subgroups of contacts. Assuming that friends lists can be aligned with social spheres then information broadcast may be scoped to give a level of visibility which leaves room for social interaction while minimizing unintended tension. However, it is less clear how these mechanisms can be used by an individual to restrict the visibility of information generated by others. In particular, the problem is how to control the flow of information between contacts in different social spheres.

One alternative to friends lists, therefore, would be to give the profile owner the possibility to set up profile segments on the basis of the social spheres the user moves in, and then to regulate the flow of information between these segments. It might not even be necessary to cut off spheres completely from each other. Simply to stress boundaries and to reduce the visibility of communications could be important first steps.

A general problem with a system that relies on individually assigned preferences, however, is the amount of work required to define a complex set of groups and rules for the network. It is known that even very small differences in cost can have a large impact on user behavior [14, 25]. Assuming that off-line, between-sphere constraints on communication visibility come for free (they are embedded in the geography and fabric of everyday life) it seems unreasonable to expect users of SNS to reconstruct social spheres, online, by hand.

An altogether different solution that avoids additional cost would support interaction in which within-spheres communication was the default and between-spheres communication required extra work. What is more, such a set-up could be automated. Social spheres could be identified by analyzing the network traffic between profiles. If social spheres are essentially interconnected subgroups, a cluster detection algorithm would suffice for this task.

Social spheres revisited

There is one more point to make about visibility and social spheres. So far, we have not fully addressed increased visibility *within* a sphere and *between* spheres. Both aspects could contribute to online tension. Our study has focused on situations in which different spheres are no longer separated. But even within an already well-connected circle of people, like a clique of friends or a core family, a situation in which all interactions can be monitored by all members is likely to be problematic. Gathering empirical evidence for a refinement of the theory regarding this aspect must be left to future work.

Another issue to be addressed is about the scope of the problem of conflicting social spheres. In public debate and in our examples, the focus has been on relationships between particular individuals who know each other to a certain degree. The concept of conflicting social spheres, however, should equally apply to situations in which communications of a particular type, not necessarily with a particular individual, cause tension. Consider the example of a husband noticing online that his wife and an ex-boyfriend of hers have exchanged remarks about their Tetris scores. Although he has never met this particular man and holds no elaborate attitude towards him, he is immediately uncomfortable about his wife being in touch

with this kind of person. Similarly, parents might be concerned discovering that their child communicates a lot with a barely known person who is 15 years his or her senior. Even when this person is not a stranger, conventional ideas about appropriate relationships can make the parents opposed to this type of contact. We think that the problem of conflicting social spheres also encompasses situations in which social conventions lead to a negative evaluation of whole classes of social interactions.

Finally it should be stressed that the problem of conflicting social spheres applies not only to SNS, but to any information technology that mediates social interaction. Returning once again to the processes by which increased visibility can contribute to tension, we find that they are independent of any particular SNS technology. Broadcasting implies easy monitoring and instant knowledge of other's interactions. Storage of information makes traces of interactions persistent and visible for a long time. De-contextualisation and its impact on user awareness lead to inappropriate social behavior. While SNS seem particularly suitable to promote these processes, they are by no means the only technologies that do so – as anecdotes surrounding email lists, online chats, picture management applications and so forth suggest.

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