Reading, Writing, Relationships: The Impact of Social Network Sites on Relationships and Well-Being

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Abstract

The social web has emerged concurrent with a decline in Americans' community involvement and number of close friendships. Hundreds of millions of people connect online, but they appear to have fewer confidants and trust each other less. However, contrasting research finds that web users have better social integration and stronger relationships than their offline counterparts. This thesis resolves these contradictory views through a detailed examination of social network site (SNS) use and changes in relationships and individual well-being.

The research is conducted at multiple levels looking at how different types of SNS use—direct interaction with others and more "passive consumption" of social news—influence the number and quality of individuals' social ties and their aggregate social capital and well-being, including perceived social support, happiness, and physical health. The studies combine objective measures of SNS use (communication activity from the server logs of a popular social networking site) with self-reports of tie strength and well-being to accurately differentiate types of use with different partners. Longitudinal methods reveal how well-being changes over time with SNS use and are moderated by personal characteristics such as social communication skill and recent job loss.

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2. The strength of many ties: Personal network shapes on Facebook

2.1. Introduction

People have many kinds of relationships in their lives. Loved ones, coworkers, high school classmates, and extended family comprise a personal network from which individuals draw support. Yet, not all connections are equally close, and social scientists have measured the difference in closeness, or tie strength, for decades (Granovetter, 1983; 1973; Marsden & Campbell, 1984; Wellman & Wortley, 1990). Strong ties are the people we trust and depend on the most, while weak ties connect us to different social circles and novel information. Social network sites (SNS) like Facebook, Google+, and MySpace are a boon to the field, supplying vast amounts of relationship data to researchers attempting to quantify tie strength and its components (Gilbert & Karahalios, 2009; Lewis, Kaufman, Gonzalez, Wimmer, & Christakis, 2008; Petróczi, Nepusz, & Bazsó, 2006). Yet these SNS also change the way people interact, allowing users to accumulate hundreds of connections, many of which would have atrophied had technology not intervened (Burt, 2000; Hampton et al., 2011; Litwak & Szelenyi, 1969). One concern is whether keeping hundreds of acquaintanceships active is a good thing: Do the extra connections add value, or do they compete for attention and crowd out stronger, more meaningful relationships? Do social network sites increase our innate carrying capacity for relationships?

Furthermore, SNS introduce new paradigms for interaction, particularly the ability to learn about friends' lives without talking to them. This "passive consumption" of friends' profiles, photos, or news stories (Burke, Kraut, & Marlow, 2011; Burke, Marlow, & Lento, 2010b) allows people to manage much larger social circles than those they directly communicate with (Backstrom, Bakshy, Kleinberg, Lento, & Rosenn, 2011; Marlow, 2009). Frequency of interaction is a well-established component of tie strength (Granovetter, 1973; Marsden & Campbell, 1984), but whether that interaction needs to involve both parties directly is an open question. Is talking necessary, or is it enough to monitor the details of friends' lives?

This paper explores tie strength in a popular SNS, Facebook, and examines how the personal networks of individuals differ when they have very few or very many friends. Facebook has over 800 million active users, half of whom log on to the site on any given day (Facebook, 2011). A typical user has 130 friends on the site (Facebook, 2011), though millions have several hundred or several thousand connections in their personal networks. For a given user, how many of his or her ties are strong, how many are weak, and how related are the two numbers? I analyze the distribution of tie strengths in individuals' personal networks, and compare the shape of these distributions of typical users to the shape for those with an order of magnitude more

friends. To keep in touch with so many friends, Facebook users take advantage of unique features of SNS, including mass-broadcasting and passive consumption of friends' social news. Whether these features facilitate an efficiency of scale or simply dilute relationships is unclear; this study quantifies the association between these features and tie strength.

2.2. Tie strength

People vary in their closeness to each other. Sociologist Mark Granovetter initiated much of the academic discussion of tie strength by proposing that differences in closeness can be measured through a "combination of the amount of time, the emotional intensity, the intimacy (mutual confiding), and the reciprocal services which characterize the tie" (Granovetter, 1973). Subsequent theoretical and empirical work has confirmed and expanded on these factors (Burt, 1995; Granovetter, 1983; Lin, Ensel, & Vaughn, 1981; Marsden & Campbell, 1984; Putnam, 2001; Wellman & Wortley, 1990). Strong ties are our closest confidants and typically arise from a densely knit clique of mutual friendship and support. They are the ones we turn to when making major life decisions, and whom we ask for a ride to the doctor's office (Wellman & Wortley, 1990). Strong ties not only furnish psychological support; they are thought to buffer the effects of stress on the immune system, leading to improved physical health (Cohen, Gottlieb, & Underwood, 2004; House & Landis, 1988). Having strong, supportive relationships is a critical component of emotional and physical well-being.

On the other hand, less intimate relationships have a different value. In his 1973 paper, "The Strength of Weak Ties," Granovetter advanced the idea that weak ties are not a source of alienation, but rather connectors to different social circles and the resources of those circles (Granovetter, 1973). While strong ties tend to be homogenous—both because people flock toward similar others and because spending time together increases similarity (Lazarsfeld & Merton, 1954; McPherson, Smith-Lovin, & Cook, 2001)—weak ties are diverse. They know things we don't, since our closest friends tend to get their news from the same sources and echo redundant information (Marsden, 1987). So, having weak ties who travel in different social circles exposes us to new ideas and opportunities. Information gain is particularly likely when an individual is the sole bridge between different communities (Burt, 1995). Weak ties are more likely to relay novel information about job openings, though connections between weak and strong ties are advantageous in securing higher-status jobs (Granovetter, 1983; Lin et al., 1981; Montgomery, 1992). There are social benefits to breadth of ties.

After giving an "intuitive" definition of tie strength, comprised of time, intensity, intimacy, and reciprocal services, Granovetter spawned thousands of investigations with an understatement: "Discussion of operational measures of and weights attaching to each of the four elements is postponed to future empirical studies" (Granovetter, 1973). Since then, researchers have conducted largely survey-based and observational

or "personal network" model, in which all nodes are connected to a focal person and (2) the sociocentric or "complete network" model, in which all ties bounded by some external definition, such as organization membership, are included (Marsden, 1990). Network composition measures are similar for both kinds of networks, but the focus of this dissertation is the former: personal networks centered around an individual.

Despite the interest in structural and demographic composition of personal networks (Burt, 1995; Campbell et al., 1986; Fischer, 1982; Ibarra, 1992; Lin et al., 1981; Marsden, 1990), less work exists examining composition along another dimension: distribution of tie strength across a large network. In particular, a focus of this chapter is the potential tension inherent in maintaining many strong and weak ties. Does an abundance of weak ties cause an individual to spread attention too thinly, leading to the decay of stronger ties? Wellman and Gulia begin to approach the question, testing competing hypotheses that large, diverse networks (ones containing more weak ties) will either provide more support-givers—both in raw numbers and as a percentage of ties—or that large networks will provide fewer support-givers. They find partial support for the former: large, heterogeneous networks supply more companionship, services, and emotional support, though large networks do not have a greater percentage of support-givers (Wellman & Gulia, 1999). Similarly, happiness increases with network size but decreases with the number of strangers in the network (Burt, 1987). Weak ties compete for attention and provide dissimilar information, increasing the cognitive effort required to sort out their opinions, but a small number of them accelerates creativity (Zhou et al., 2009). There is a curvilinear relationship between personal network size and satisfaction with support—more ties may provide more support, but it might not be the highest quality (Stokes, 1983). As Ibarra puts it, "There are instrumental and expressive benefits that can be gained from mutually exclusive features of personal networks, and all managers . . . must negotiate trade-offs and balance competing tensions to develop a maximally effective network" (Ibarra, 1993).

Implicit in this argument is that all ties require a modicum of attention, a limited resource, and that strong ties require extra care and feeding. Cultivating masses of weak ties while interacting regularly with strong ties may diffuse one's attention or lead to information overload (Eppler & Mengis, 2004). Therefore relationships are often described in terms of a hierarchy, with a small group of intimate friends at the core, and layers of ties of decreasing closeness spreading outward. Evolutionary psychologists argue that the human brain evolved to manage connections between a limited number of friends, with micro-groupings forming to reduce the risk of predation, resulting in natural strata such as the support clique (of approximately 4-5 close friends), the sympathy group of 12-15, the affinity group of 50, and the active network of roughly 150 (Sutcliffe, Dunbar, Binder, & Arrow, 2011). The size of the tiers is hypothesized to be the result of a cost-benefit tradeoff: Very close relationships require more time to maintain and obligate individuals to reciprocate any support they receive (such as a ride to the airport at 4 a.m.). Humans can only sustain a few of these time-consuming relationships. For less intimate ties, Dunbar and colleagues posit that the neocortex size of humans allows them to manage a social circle of approximately 150 people, a number that has been established through

Hampton, 2007): "Who are the people you feel closest to? This might include people you discuss important matters with, really enjoy socializing with, or anyone else you feel especially close to. Select up to 6 people. It's also okay to select no one." They chose close friends from a typical Facebook friend selector box (the tool commonly used for event invitations and friend list creation). After participants chose up to 6 friends (M = 4.4), the system randomly selected 2 or more additional alters (totaling 8), and presented a list of alters to the participant. For each alter in the list in random order, the system presented a set of questions, including "How close do you feel to X?" and "Which of the following describe your relationship with [tie name]?" Figure 3 shows the survey questions.

This iteration through alters is similar to the approach taken by (Gilbert & Karahalios, 2009), with a critical difference. In this study, the goal is to identify strong ties, so participants select strong ties first, rather than

Figure 3. Survey questions about an alter.

	Ego-reported tie strength		
	Value	SE	*p*-value
(Intercept)	3.92	0.03	0.000 ***
Ego age	0.00	0.00	0.010 *
Age difference	0.00	0.00	0.000 ***
Ego is male	0.17	0.03	0.000 ***
Same gender	0.31	0.02	0.000 ***
Ego in a relationship	-0.10	0.03	0.000 ***
Alter's friend count	-0.47	0.01	0.000 ***
Live in the same city	0.20	0.04	0.000 ***
Days since they became FB friends	0.47	0.01	0.000 ***
Days ego has been on Facebook	-0.18	0.01	0.000 ***
Days alter has been on Facebook	-0.11	0.01	0.000 ***
Alter initiated FB friendship	-0.25	0.01	0.000 ***
Family members	1.46	0.02	0.000 ***
In a relationship together	1.92	0.04	0.000 ***
Members of same work network	0.12	0.05	0.010 *
Attended same event	0.22	0.06	0.000 ***
Appeared in same photo	0.12	0.02	0.000 ***
Checked-in together	0.17	0.03	0.000 ***
Appeared in same thread	0.26	0.01	0.000 ***
Ego age x Age difference	0.00	0.00	0.000 ***
Ego is male x Same gender	-0.22	0.03	0.000 ***
Facebook activities			
Directed communication	0.16	0.00	0.000 ***
Passive consumption	0.10	0.00	0.000 ***

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$

$R^2_{y,\hat{y}}$: 0.43
AIC: 476980.5, BIC: 477382.7
Number of Observations: 134,480
Number of Groups: Egos: 11,701
Number of Groups: Alters in Ego: 82,358

Country effects and all non-significant variables omitted for space.

Table 3. Model of tie strength controlling for static and co-appearance variables, with composite versions of directed communication and passive consumption activities. Directed communication is more strongly associated with tie strength than is passive consumption.

Survey respondents commented on the connection between Facebook activities and their relationships with others. Many mentioned sending or receiving directed communication, and that doing so made them feel closer to the other person. One woman described her husband's Facebook use:

> *"he frequently comments on my stuff and I feel loved".*[1]

Another respondent said,

> *"Facebook has a role in my relationship with Cassy. We comment on each others status', post funny/embarassing things on each others walls- its like another element to our relationship. There are some things I would write on her wall even though I could easily text her…"*

Passive consumption is typically described as a good component of relationships:

> *"I feel closer to her because I see her daily photos and comments."*

For relationships that would otherwise decay, many participants said the site preserved the link,

> *"Made it easier to stay in touch, without it I'm not sure we'd even talk still."*

However, maintaining these weak ties is not always beneficial. Facebook cemented ties where at least one half of the pair did not want the relationship.

> *"Went to high school with Sharif. Never very close. He requested me and I ignored the request - neither confirming nor denying - until I ran into him on the street two block from my house. Whoops. Then I confirmed."*

> *"He's a Facebook friend out of social obligation - we don't actually like one another very much."*

> *"I wouldn't be friends with Peter - I'm not friend with Peter - except for FB."*

> *"I haven't a clue who she is. She must have snuck in as a friend. Maybe a friend's friend? I'll have to block her."*

A few participants also noted that Facebook supplanted direct communication, since they felt like they had hit their social quota for that tie:

> *"I know too much about her life from Facebook - doesn't make me motivated to contact her just to see how she is doing."*

The model of tie strength also reveals some asymmetry: The majority of the most informative features are actions taken by ego, not alter. The "Initiated by" column in Table 2 shows the actor. Some of the top features are ego viewing alter's profile, ego writing a message, commenting, liking, poking, or writing on alter's wall. Because ego reported the strength of the tie, it is not surprising that ego's activities are more strongly

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[1] Open-ended quotes are included for illustration, but have not been systematically analyzed in the present study. Quotes have not been edited, but names have been replaced. All are in response to the question, "Has Facebook affected your relationship with [tie name]?"

associated with tie strength than alter's. However, the relationship is not entirely unreciprocated: when alter initiated contact at least once in the past three months, tie strengths are $\beta = 0.59$ points higher. This feature indicates that the tie is still active in the minds of both parties. Symmetry in relationships is not often measured because of the expense of collecting survey data from both sides of the dyad (Marsden, 1990). In the few studies where both parties reported tie strength, reciprocation (each person naming the other as a friend) ranges from 40-70% of ties, with reciprocation levels higher the stronger the tie (Marsden, 1990; Petróczi et al., 2006).

The majority of the highly ranked features are from the 90 days before the first wave, rather than the month before the survey, reflecting the bursty nature of Facebook interactions. Longer-term interactions are more important in predicting tie strength than very short-term ones are, though both are significant.

After accounting for relationships, family members, and Facebook activities, many features found to be important in offline studies of tie strength, such as demographic similarity and number of mutual friends, are less important. In many cases, these "offline" variables simply overlap with Facebook activity (e.g., being co-tagged in a photo or co-appearing at a location is highly correlated with living in the same city).

2.5.2. Validation of tie strength model

Several techniques were used to evaluate the accuracy of the tie strength model. First, a baseline model was built containing only the static and co-appearance features listed in Table 1. Many of these features are reflective of offline interaction (e.g., being in a relationship, or being photographed together), so they form a reasonable comparison. This baseline model is significantly worse than the full tie strength model. The baseline model has an $R^2 = 0.22$, while the complete model with the Facebook communication variables explains far more variance, $R^2 = 0.53$, $p < 0.001$. The baseline model also has a higher (worse) BIC = 480,279 than that of the full model, BIC = 461,093. Figure 5 shows the correlation between the estimated and self-reported tie strength, $r = 0.73$.

The model was also evaluated using eight-fold cross-validation using holdout test sets (Witten & Frank, 2005). In this method, the data were partitioned into a training set, consisting of the participants' ratings of seven of their friends (7/8ths of the data), and a holdout test set with the remaining friend (1/8th of the data). The model described in Section 2.5.1 was re-trained using only this training set, and then applied to the test set, to generate a predicted tie strength score. This predicted score was compared to the true score. This technique was repeated eight times, once for each partitioning of the eight rated friends per participant. Across test sets the mean $R^2 = 0.43$, and the model correctly distinguishes between the strongest ties (those of tie strength = 7) and other ties in 71.2% of the cases, with chance being 14.3%.

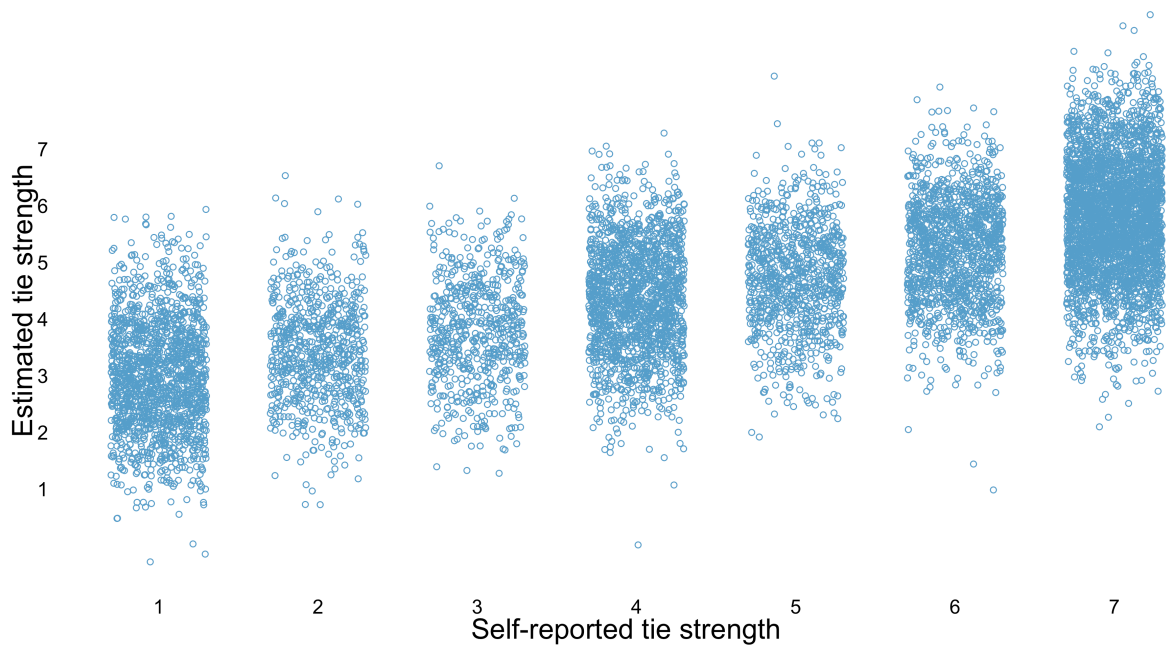

Figure 5. Estimated versus self-reported tie strength. The *x*-axis shows the participants' ratings of tie strength (on a 7-pt Likert scale, with jitter added for visibility), and the *y*-axis shows the continuous estimates produced by the model. The correlation between estimated and reported tie strength is *r* = 0.73.

This model is comparable in accuracy to its predecessor (Gilbert & Karahalios, 2009), which also had an overall $R^2 = 0.53$, and distinguished between strong and weak ties with 85% accuracy. There are many reasons why this model is an improvement, however. The previous model was an excellent fit for its context and time; it was performed in 2008 with students and staff from a university in the U.S., and participants ranged in age from 21 to 41. The present study has a much more diverse user base, consistent with the increasing diversity of Facebook as a whole. The present study has participants ranging from 18-85+, from 91 countries around the world. Sample demographics are important factors when developing a model. For example, training and applying this model to younger users—those 35 and under—yields even better performance, with an $R^2 = 0.62$. Conversely, a model of users older than 35 has an $R^2 = 0.49$. The present model, with its $R^2 = 0.53$, performs very well across a broad range of users. In the three years between these studies, Facebook has grown from 100 million to 800 million users. Therefore, study participants are no longer describing a small set of homogeneous friends (e.g., other members of their college network) but rather their grandparents, coworkers, exes, and even people they don't remember meeting (participants marked 1909 friends (2.3% of all ties) in the survey as "I don't know who [tie name] is.") In Chapter 4, the tie strength model is also sufficiently good to identify the ties that provide social support, bridging social capital, and even health improvements. Therefore, despite the absence of computationally complex features, such as linguistic

properties of communication exchanges and estimated tie strength of mutual friends, the present model performs well. The present model is computationally simple enough to be computed daily across the billions of ties on Facebook.

For clarity of presentation, tie strength scores are not ipsatized, or standardized to account for each individual's bias in using the seven-point rating scale (e.g., by centering each indivdiual's ratings at his or her mean and dividing them by his or her standard deviation (Fischer, 2004)). Because the majority of the eight rated ties are people the rater "feels closest to" it is not clear that the mean and standard deviation are better points of reference than the original scale. However, an analysis using ipsatized tie strength scores produces a model with feature ranks nearly identical to the non-ipsatized model, but with a lower $R^2 = 0.26$ resulting from the information lost in the standardization. As survey participants generally used the majority of the scale, with the median user having a range of 5 (out of a possible 6) points between his lowest and highest tie, the non-ipsatized scores are used here.

2.5.3. Distribution of tie strength across personal networks

To answer Research Question 2, the model of tie strength described in Section 2.5.1 was applied to all 2.4 million friends of the study participants[2]. Figure 6 presents the distribution of tie strengths across egos' personal networks. The plots are divided based on the total number of ties ego has, to show the differences between Facebook users with just a few ties and those with several thousand. The first point to notice is that the centers of the distributions shift to the left as egos have more total ties. Someone with fewer than 50 ties on the site has an average tie strength across his or her network of $M = 4.3$, while someone with more than 500 ties has an average tie strength of $M = 3.1$ (different at $p < 0.001$). The average Facebook user has 130 ties (Facebook, 2011), and these users have an average tie strength of $M = 4.0$. When people increase their network size, they are primarily adding acquaintances and less-close ties, reducing their average tie strength across their personal network. These shifts are not necessarily detrimental, however, given the bridging social capital benefits derived from talking with weak ties (Granovetter, 1973) (see also Chapter 4).

All of these weak ties are not crowding out strong-tie relationships, however. "Heavy frienders" are maintaining more strong tie relationships, as well. A linear regression of friend count on the number of strong ties (those of strength 7 on a 7-point scale), reveals that the number of strong ties goes up with overall friend count (see Table 4). Someone with fewer than 50 ties in their personal network has an average of 1.56 strong ties. Someone with a personal network size of 500 or greater has twice as many strong ties, $M = 3.65$, $p < 0.001$. Choosing a lower threshold, such as 5 (on a 7-point scale), for differentiating strong and weak ties magnifies the differences. Someone with a personal network size of 50 or smaller has an average of 13.4

[2] Using the *predict* command from the *nlme* package in R to generate Best Linear Unbiased Predictors, or BLUPs. {Pinheiro:2009tv}

Figure 6. Distribution of tie strength across individuals' personal networks. Distributions differ depending on the overall number of ties the individual has, with those with 500 or more ties having far more weak ties. However, the number of strong ties also increases with network size. Vertical lines show the mean tie strength of each group.

strong ties, while someone with 500 or more total ties has 67 ties of comparable strength, $p < 0.001$. Put another way, people who have extremely large collections of Facebook friends are able to communicate frequently enough to maintain those relationships, and thus maintain an above-average number of strong ties. Facebook does appear to facilitate an economy of scale with its lightweight interaction tools, such as the "like" button and inline commenting in the News Feed, so that people are able to interact with large numbers of ties without neglecting their closest friends. These differences are also evident in the average tie strength across one's top-N friends: people with larger personal networks have stronger ties in their support cliques (top five friends) and sympathy groups (top 15 friends). Figure 7 shows the average tie strength for users' top five and top 15 friends: as personal network size increases, tie strength of top-n friends increases ($p < .001$). The correlation between network size (friend count, logged base 2 and standardized) and mean tie strength of

	Est. # of strong ties	Beta	SE	*p*-value	
(Intercept: Someone with fewer than 50 ties)	1.56	1.56	0.47	0.00	***
50-149 total ties	2.14	0.58	0.49	0.23	
150-349 total ties	2.66	1.10	0.47	0.02	*
350-499 ties	3.13	1.57	0.49	0.00	**
500 or more ties	3.65	2.09	0.48	0.00	***

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$

Table 4. Estimated number of very strong ties (tie strength of 7 on a 7-point scale), based on the overall number of ties in one's personal network. People with larger personal networks have more very strong ties.

Figure 7. Average tie strength of top-n friends by personal network size (total number of ties, logged and standardized). Those with larger personal networks have greater average tie strength among their closest friends (their top 5 and top 15 friends) than do people with smaller personal networks.

top 5 friends is $r = 0.36$, and for top 10 friends, $r = 0.43$. Weak ties are not supplanting strong ties.

Research Question 2.

Individuals with large personal networks have many more weak ties.

They also have more strong ties, indicating the weak ties do not crowd out the strong.

One important point, however, is to avoid the ecological fallacy and not draw inferences based solely on these aggregate statistics (Kraut & Rosenn, 2011). There is large variation between individuals in the makeup of their own networks. The distributions shown in Figure 6 are smoothed across individuals; each curve represents the average across hundreds of people. Yet individuals with the same number of total ties vary greatly, as shown in Figure 8. Here we see six randomly selected "average" Facebook users—each has between 129 and 131 ties—and they have very different network compositions. Person 1 in the figure has a personal network composed of far more weak ties than person 6. Figure 9 further illustrates the wide differences between individuals. It shows the number of ties held at each level of closeness. While there is greatest variation around 2, 3, and 4—the acquaintance level—there is still substantial variation at 6 and 7, the number of closest, strongest ties one maintains.

Figure 8. Distributions of tie strengths in the networks of six "average" users, each with approximately 130 total ties. Individuals vary greatly in the makeup of their own network.

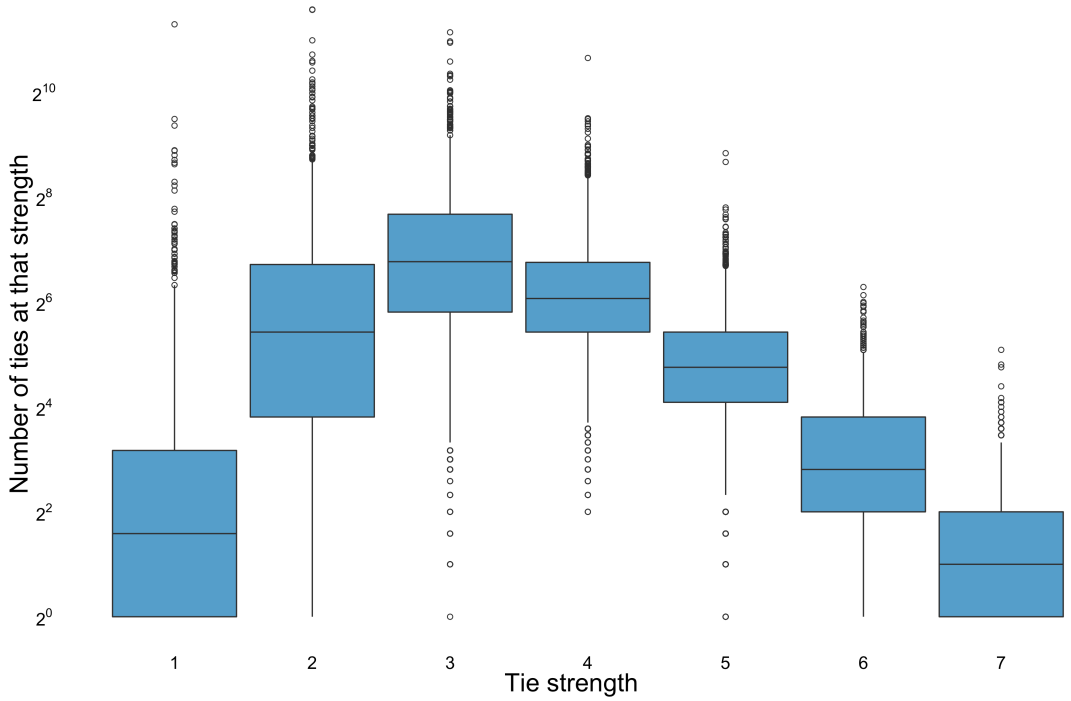

Figure 9. Individuals have wide differences in the number of ties they maintain at different levels of tie strength. Boxes represent the middle 50% and whiskers represent the 95th percentile.

2.6. Conclusion

This study examines the markers of relationship closeness as well as the tie-strength composition of individuals' Facebook networks. Accurately modeling the digital traces of closeness and understanding communication patterns that comprise it are important for several reasons. Prior to this work, communication theory could not explain whether tie strength was primarily characterized by reciprocal communication, or if more passive "monitoring" of ties' daily lives is also highly predictive of tie strength. This work demonstrates that both talking to friends and passively keeping track of their social lives are significant components of tie strength, but the former is more strongly associated with strong ties. People directly engage their closest friends by writing them messages, commenting on their social news, and giving positive feedback through the "Like" button. They also look at their close friends' profiles (and their close friends do likewise), and when they view these profiles, along with photos and stories of their friends, they feel closer, but less close than if they had sent a message. These results are consistent with previous findings that Facebook users focus their communication activities on a small circle of ties, but use passive consumption to keep track of much larger circles (Backstrom et al., 2011; Marlow, 2009). The present study does not test whether direct communication or passive consumption increase tie strength, but the correlations are suggestive. (See Chapter 3 for an analysis of the relationship between these activities and changes in tie strength.)

Moreover, this work adds to the literature on the tie-strength composition of large personal networks. Much work has explained structural dependencies between weak and strong ties, e.g. (Burt, 1995), but we did not know whether large numbers of weak ties would crowd out more meaningful strong-tie relationships. This issue is of special concern due to the new ease of building large networks of "friends" and "followers" on social media sites. In this work, I demonstrate that when people have very large personal networks, they primarily consist of weaker ties and acquaintances, bringing down the average tie strength across their network. However, these "heavy frienders" are not doing so to the detriment of their closest relationships; they have more very close friends (on average) than do individuals with a more curated friend network. Facebook allows people to maintain large numbers of relationships at varying levels of closeness, and the weak ties do not crowd out the strong ties. Social network sites appear to increase our innate carrying capacity for relationships.

Practically, the model of tie strength can be used to improve the quality of personalization and the overall user experience on social network sites. Tie strength is highly correlated in the present study with wanting to read news about the tie ($r = 0.71$), so simply improving the underlying model of tie strength will yield higher quality, more desirable News Feed stories. The present tie strength model has far less complex features than its predecessor (Gilbert & Karahalios, 2009), but yields comparable accuracy on a much more varied user base. Social advertising also depends on choosing the right friends to name-drop in an ad ("Charlie and Erica

both liked this product!") and knowing which ties will be most influential. This study lays the groundwork for future controlled experiments on tie strength and commercial influence. Facebook and Google+ have both moved to an audience-based model of privacy, allowing users to choose which circles of friends can see their content, but populating those circles requires significant effort. A good model of tie strength can initially populate those circles, reducing the burden on the user. These findings provide guidelines for designers hoping to improve the user experience and foster the right mix of relationships to maximize user happiness.

2.6.1. Limitations and future work

Like all observational studies, this work is limited in its ability to infer causality. Participants were surveyed over a short time period, two months, and we cannot determine whether their communication patterns cause their relationships to be close, or if preexisting close relationships generate communication. It's likely that both are true. By collecting tie strength reports multiple times, I have reduced the error inherent in single-wave survey-based design, and by pairing those reports with server logs of behavioral data, I am not limited by participants' memories of their communication with ties, or their omission of people they don't like very much (Labianca & Brass, 2006). However, the model does not tell us what communication patterns increase tie strength over time—how or whether Facebook supports ties growing closer—simply how close they feel at a snapshot in time. Chapter 3 examines these changes. Furthermore, the cross-sectional design limits interpretation of the tie strength distribution findings. We see that people with many ties have more strong ties, as well, but we do not follow individuals over time as they grow or shrink their personal networks. A longitudinal study would clarify whether large networks do create an economy of scale, or whether underlying attributes of people—such as extraversion—cause them to both build large networks and spend more effort maintaining them.

The tie strength model presented here is sufficiently accurate to surface benefits of strong and weak ties (as seen in Chapter 4), but it could be further optimized. The present model takes a kitchen-sink approach, including as many features as possible without stepwise addition or investigation into interaction effects. Gilbert and Karahalios (2009) demonstrated that pairwise interactions between communication features and structural features (such as the imputed tie strength across mutual friends) significantly boost accuracy. These structural features and interaction effects were omitted to keep the computational complexity down, so that the current model could be calculated at scale on a daily basis. Furthermore, all communication activities were binarized because they were rare in a single month, and communication history was only collected for three months prior to the beginning of the study. The high coefficients of these 90-day features suggests that the model could be improved by including longer-term interaction as well. The present study is also agnostic to the content of communication. Future research is needed to examine whether private messages are higher in self-disclosure, positive emotion, nicknames, or other markers known to increase closeness (Berscheid & Reis, 1998; Collins & Miller, 1994).

Additionally, tie strength reports are one-sided. We only know how close one person feels toward the other, but do not know how mutual the feeling is. As seen in the tie strength model, ego's activities are more predictive of tie strength than are alter's, indicating asymmetry in relationships, consistent with prior literature (Marsden, 1990; Petróczi et al., 2006). To a degree, one-sidedness is useful, allowing site designers to customize weights on news stories and ads so that individuals get the most tailored user experience on the site. Basing a model on only mutually agreed-upon tie strength might make weak or incipient ties appear weaker than they are. However, reciprocal action may be important for passive consumption features—a model trained only on the other's viewing behavior would be creepy, alerting alter (through news stories and ads featuring ego) that ego may be "stalking" alter. The present model assumes tie strength is asymmetric (and thus a different weight is calculated for ego-to-alter and alter-to-ego), but goes beyond self-report-based studies by including a rich selection of behavioral data from both parties.

An open question in this work is to what extent social network site use reflects offline relationships, and how much it changes those relationships. The question becomes increasingly important as the social web grows internationally, into older and younger populations and into mobile ubiquity. Clearly many features in the tie strength model are independent of Facebook, such as living in the same city or being family members. But what about communication on the site? Is an online message simply a sign that two people feel close, or does it bring them closer together? The next chapter examines this question. In an international proclamation earlier this year, Pope Benedict warned of online communication supplanting more consequential interactions: "It is important always to remember that virtual contact cannot and must not take the place of direct human contact with people at every level of our lives" (Pullella, 2011). The present findings contradict this sentiment, showing that "virtual contact" *is* direct human contact and a predictor of meaningful relationships. Social network sites facilitate relationships with "people at every level of our lives." There is strength in many ties.

3. Classes of Facebook activities and changes in tie strength

3.1. Introduction

Relationships are dynamic. Lovers grow more intimate, parents and children negotiate the vagaries of adolescence, best friends fight, coworkers depart for other companies. Communication is a critical component of relationships in all their phases (Duck, 2007; Dunbar, 1998), and the internet provides myriad channels for communication. But since the inception of the internet, scholars have questioned its effect on relationships (Kraut et al., 1998b; Nie, 2001), and the debate has been reinvigorated by the emergence of social network sites (SNS) like Facebook, Google+, and MySpace (Burke, Marlow, & Lento, 2010b; Copeland, 2011; Pullella, 2011), whose ostensible purpose is to facilitate sharing and connection with the people that matter in one's life. The sites are extremely popular; 59% of adults in the United States use at least one (Hampton et al., 2011), and more than 800 million people around the world use Facebook, with half logging in on any given day (Facebook, 2011). That members of these sites can have very strong relationships with each other is not in dispute; 40% of SNS users have "friended" all of their closest offline confidants online (Hampton et al., 2011). However, whether these sites simply reflect relationships being maintained more effectively through other channels, or add value to relationships is an open question.

The present study examines the connection between Facebook use and changes in relationships over time. It compares frequency of communication for 80,000 pairs of friends on the site, on the phone, over email, and face-to-face, and uses those communication patterns to model changes in self-reported relationship strength. Facebook use is associated with increases in closeness over and above the effects of more traditional communication channels. Additionally, different ways of using Facebook have different effects on changes in tie strength. Grounded in theories of interpersonal communication and tie strength, I compare the relative effects of focused, one-on-one communication, mass-broadcasts to wider circles of friends, and passive activities, like viewing a friend's photos. I also explore differences between semi-public and private exchanges, and between "one-click" interactions and more thoughtful, composed messages. The results inform communication theory and social network site design by clarifying the effects of different classes of communication on relationships.

3.2. Relationship formation and maintenance

People seek out communication with those whom they like, and communication with these partners helps to grow and maintain the relationship (Duck, 2007; Homans, 1973). People grow to like those they communicate

and spend time with, and that liking drives further communication (Newcomb, 1961). Starting in the 1930s, a voluminous empirical literature demonstrates that frequency of interaction between a pair increases their likelihood of forming a friendship or romantic relationship. For example, people marry others who live close to them when they are of marriageable age (Bossard, 1932). Office workers form friendships with those seated closest (Gullahorn, 1952). The likelihood of friendship is an inverse function of the distance between residences (Festinger, 1950; Newcomb, 1961). This law of propinquity has been validated using geographic location and friendship data in modern social networking sites, as well (Backstrom, Sun, & Marlow, 2010). Although people can come to like others simply by seeing them multiple times (Moreland & Zajonc, 1982; Zajonc, 1968), in this research tradition, physical proximity is often used as a proxy for the amount of social interaction between pairs (Festinger, 1950; Newcomb, 1961). A substantial body of empirical research shows that communication frequency drops exponentially with the distance between a pair (Allan, 1979; Zipf, 1949). Regular contact is at the heart of the relationships with friends.

Because relationships depend on regular interaction and time is limited, not all relationships are equal. Many scholars have described the differences between emotionally close friends ("strong ties") and less close acquaintances ("weak ties") (Burt, 1995; Granovetter, 1973; Putnam, 2001). Strong ties are the people we trust and depend on the most. They provide psychological and tangible support, such as being there to discuss major life decisions or providing a ride to the doctor's office (Wellman & Wortley, 1990). Strong ties not only reinforce psychological health; they are thought to buffer the effects of stress on the immune system, leading to improved physical health (Cohen et al., 2004; House & Landis, 1988). Weak ties, on the other hand, provide novel information and expose us to different perspectives and opportunities (Granovetter, 1973). They bridge social circles, and thus know about job opportunities and innovative practices (Burt, 1995). There are social benefits to both kinds of ties.

Building a portfolio of relationships—some close and trusting, others diverse and inspiring—requires sizable investment (Hill & Dunbar, 2003). Therefore, some relationships decay as they become less useful to us (Burt, 2000). As the sociologist Claude Fischer writes, "In general, we each construct our own networks. The initial relations are given to us—parents and close kin—and often other relations are imposed upon us—workmates, in-laws, and so on. But over time we become responsible; we decide whose company to pursue, whom to ignore or to leave as casual acquaintances, whom to neglect or break away from. . . . By adulthood, people have 'chosen' their networks" (Fischer, 1982). Some relationships may be less susceptible to degeneration than others. Kin relationships are generally more resilient than non-kin, requiring less maintenance (Roberts & Dunbar, 2010). Explanations for kin preference are generally rooted in evolutionary science, with humans selecting for the successful reproduction of their genes (Sutcliffe et al., 2011). Developmental psychology also points to the support given by parents during children's vulnerable early years fostering a more permanent attachment that is resistant to atrophy (Berscheid & Reis, 1998). On the other hand, non-kin relationships may be more dependent on communication to endure. "Friendship ties may be

much more vulnerable to breaks in face-to-face contact than kin groups because there are no institutional pressures for permanence" (Litwak & Szelenyi, 1969). In particular, nascent friendships may be the most liable to failure. Each new relationship introduces an opportunity cost, a potential competitor for attention with one's other friends. Therefore, when two people first meet, they look for clues to evaluate whether the relationship's benefits will be worth its effort (Berger, 1979). This calculation is more greatly swayed by negative information or unfriendly experiences, because there is no longstanding history of trustful interactions to generate the benefit of the doubt (Sutcliffe et al., 2011). So, some relationships never get started and others fall off quickly.

3.3. Classes of communication that affect relationships

Though regular communication buffers relationships from this decay, some types of communication are more consequential than others. A central focus of this dissertation is the difference between targeted, one-on-one exchanges, wider broadcasts with larger circles of friends, and more passive "monitoring" of a tie's news. This distinction becomes important because social network sites facilitate all three forms of connection with large numbers of ties (see Section 3.4), but the three classes of communication exist offline, as well, and previous work suggests they may differ in their impact on relationships.

Directed, one-on-one communication. First, as previously reviewed, one-on-one communication is at the heart of relationships (Allan, 1979). Communication increases tie strength through two mechanisms. The first is self-disclosure. People reveal more information about themselves in emotionally close relationships than more distant ones, and this disclosure increases relationship closeness (Collins & Miller, 1994). Communication involving social support is often characteristic of close relationships (Berscheid & Reis, 1998). As a result, it is likely that relationship-oriented communication, in which partners exchange self-disclosure and support, is more likely to maintain social relationships than more neutral communication, such as small talk. These kinds of intimate disclosures generally occur through one-on-one communication exchanges, which are tailored to the specific context of the relationship. The second mechanism through which communication increases tie strength is when ties learn the details of each others' lives. Small, seemingly trivial details such as what someone had for lunch are typically exchanged through small talk (Duck, Rutt, Hurst, & Strejc, 1991; Parigi & Bearman, 2005). Though participants judge small talk as having little impact on their relationships and as less satisfying and valuable than conversations about deeper issues (Duck et al., 1991), small talk "represents a form of communication that is critical to developing relationships" (Knapp & Vangelisti, 2003, p. 197), "a way of maintaining a sense of community or fellowship with others" (p. 198), a proving ground for both new and established relationships (p. 199), and a prelude to deeper discussion.

Broadcasts to wider circles. Learning the details of a tie's life does not necessarily require direct communication, however. Broadcasted news, such as holiday cards and stories in community newsletters facilitate dissemination of personal news to a wide audience of friends, family, and acquaintances. These one-to-many missives may include self-disclosure—such as information about a family member's recent illness or feelings about a lost job—yet they are not focused at any particular recipient, and thus are less tailored to any given relationship and its history. This one-size fits all approach is inherently less intimate and requires less effort per-capita than writing an original letter or visiting each person in your social circle.

Signaling theory provides a framework for considering the different value of directed, one-on-one communication and one-to-many broadcasts for growing relationships. Originating in economics (Spence, 1973) and biology (Zahavi, 1975), signaling theory explains how humans evaluate each other's worth, and in the present context, whether to maintain someone as a friend. The theory originates in Darwin's puzzlement over seemingly "wasteful" characteristics, such as a peacock's bright plumage or a gazelle's stotting (jumping high into the air when approached by a predator), which expends energy but does not appear to provide additional evolutionary fitness (Darwin, 1907). Why would an animal evolve to have a showy tail, when a compact one would be more efficient and better for hiding from enemies? Zahavi (1975) proposed that the peacock's tail conveys a signal to predators and peahens—that the peacock is so fit it has energy to spare on its colorful tail. Similarly, the gazelle stots to demonstrate that it has plenty of energy to make a fast getaway. These are "costly signals" which are difficult to fake; they provide reliable information about the animal's fitness. These signals serve as marks of quality in mate selection. Similarly, when employers evaluate job candidates, a degree from a prestigious university is a "costly signal" indicating the quality of the prospect (Spence, 1973). Earning a degree requires motivation and intelligence, and so candidates from good schools may have more of those traits. Friendships are comparable to job interviews and mate selection: individuals evaluate whether the companionship, support, or enjoyment of a relationship is worth the effort to maintain it—or whether other prospects might be better (Berger, 1979). One component of the decision is how much the other person values the relationship—both sides must find it worth the effort for the relationship to continue (Fischer, 1982). And so, the relatively lower effort inherent in mass broadcasts makes them less reliable signals of relationship value than higher-effort one-on-one exchanges.

Passive monitoring or "consumption" of a tie's news. Though mass broadcasts may be less valuable than personalized interactions for increasing tie strength, the act of "keeping up" with a tie's news—whether through reading a mass broadcast or indirectly learning details "through the grapevine" of mutual friends or family members—may still be valuable for building relationships. Passively monitoring a tie's news is the flip-side of mass broadcasting; both circumvent directed, one-on-one communication, but the former is inbound and the latter is outbound. Keeping up with a tie's life may be meaningful in its own right for the details learned, and it may make future direct, one-on-one interactions more efficient or satisfying, by filling in the news that occurred since the last interaction. However, when one friend learns about another in this more

passive way (e.g., by looking at the friend's online photo album or hearing news through a mutual friend), the person whose news is shared is not part of the loop; she may have no idea that anyone cares. Social media intensify the distinction between personalized one-on-one exchanges, mass broadcasts, and passive monitoring, as discussed in the next section.

3.4. Social technology and social relationships

Social network sites like Facebook change the calculus of relationship initiation and decay. After "friending" someone, the conservation of that relationship technically requires no upkeep. One person initiates a friend request, and once the other confirms the existence of the relationship, both parties begin to receive regular updates about the other's social news. The site acts as a perpetual rolodex, preserving up-to-date contact information, should they ever want to talk. It also shows the two how many friends they have in common, a tacit reminder that the relationship is embedded in the "real world" with others to enforce good behavior and support the relationship's continuation (Donath & boyd, 2004). Without an explicit "unfriending" or "hiding" of the other's news, the connection persists effortlessly.

The ease of establishing ties has led some critics to denounce social network sites as fostering superficial connections. The popular press regularly questions whether online networks increase loneliness and feelings of inadequacy (Armstrong Moore, 2010; Copeland, 2011; Pullella, 2011), often extrapolating from research performed about face-to-face phenomena (Jordan et al., 2011; Segrin & Passalacqua, 2010). Some of the debate springs from early research arguing from first principles that computer-mediated communication is less rich than in-person interaction (Sproull & Kiesler, 1986), is more effortful to produce (Brennan & Ohaeri, 1999; Clark & Brennan, 1991), and subject to misunderstanding (Kiesler & Sproull, 1992; Kruger, Epley, Parker, & Ng, 2005). Therefore, users should have difficulty maintaining relationships over the medium. Though this argument may have been supported in the earliest days of the internet (Kraut et al., 1998b; Nie, 2001), web users now have a critical mass of close friends online (Hampton et al., 2011). People most frequently use the internet to communicate with those with whom they have existing off-line relationships and communicate with them using a variety of media (Boneva, Kraut, & Frohlich, 2001; Haythornthwaite, 2002; Williams, 2006). Email and Facebook are used to plan in-person gatherings, such as parties and meetings. Teens who use instant messenger heavily have better quality friendships (Valkenburg & Peter, 2007). College students report having approximately 75 "actual" friends on Facebook (Ellison, Steinfield, & Lampe, 2011a), and users that spend more time on the site have higher levels of social capital, the feeling that they can count on their network for support and information(Burke et al., 2011; Burke, Marlow, & Lento, 2010b; Ellison et al., 2007).

Whether social network sites affect interpersonal relationships—for good or for bad—requires an understanding of how they fit into the ecology of communication modes. Though much research has established that people talk to friends over a variety of channels (Haythornthwaite, 2002; Haythornthwaite & Wellman, 1998), we do not know how SNS use correlates with the use of other channels, and whether SNS adds anything. Therefore, this study is guided by the following research question:

> *Research Question. What is the association between interpersonal communication over social network sites and other channels, such as email, the phone, and face-to-face? Is SNS use associated with changes in tie strength above and beyond the effects of these other channels?*

3.4.1. Classes of social network site use

Like the general internet, a social network site is a platform supporting a variety of communication modes. Individuals can send private messages (like email), chat synchronously (like instant messenger), share photos (like Flickr, Picasa), post news (like Twitter), meet people with similar interests (like Google Groups), read social news (like blogs and news sites), and play games. All social network site use is not equally social (Burke et al., 2011; Burke, Marlow, & Lento, 2010b), and different activities may have different consequences for relationships. Figures 1-3 show typical SNS features, including an aggregate stream of ties' news, a profile, and photo tagging.

Based on the theory reviewed in Section 3.3, in this study I distinguish between three kinds of activities in social network sites: directed, one-on-one communication with a friend, mass broadcasts to wide audiences, and more passive monitoring (or "consumption") of a tie's news.

The first activity, **(1) directed, one-on-one communication** consists of personal, one-on-one exchanges, such as private messaging, commenting or liking a friend's update, and tagging a friend in a photo. In each of these actions, one friend singles out another friend. As interaction makes people feel closer (Allan, 1979; Berscheid & Reis, 1998; Duck, 2007), and frequency of interaction over comparable forms of computer-mediated communication (email and instant messenger) is associated with increases in relationship closeness (Haythornthwaite, 2002; Valkenburg & Peter, 2007), partners that exchange directed communication on Facebook should feel closer.

> *H1. Tie strength increases with directed, one-on-one communication exchanges over social network sites.*

Further subdividing directed communication, we next consider the varying levels of effort required by directed communication. The social web provides "one click" interaction, such as Facebook's "Like" button or Google's "+1" button to indicate positive feedback, "favoriting" a tweet, or sending an emoticon on an online dating site. Such actions may reduce the cost associated with maintaining relationships because they require little premeditated thought. However, the fact that they require less effort may reduce their power in communicating relationship closeness. One-click communication is cheap compared to more "composed"

Figure 1. News Feed with stories about one's Facebook friends. The News Feed contains information such as friends' recent activities, photos, status updates, and interactions with other friends. The "Like" button and comment field allow inline feedback.

Figure 2.

Facebook profile.

Figure 3. Tagging someone in a photo

communication, such as a private message or wall post, which takes more time to write. The difference is comparable to a postcard versus a lengthy, handwritten letter. Both convey the idea of "I wish you were here," but the latter took more effort. Signaling theory (Spence, 1973; Zahavi, 1975) suggests that lengthier, composed communication is a costly signal compared to one-click communication, and so the former is a more reliable signal of relationship strength. Ties should feel closer when they exchange more effortful forms of communication. Beyond the signal conveyed by the differing degrees of effort, one-click and composed communication also vary in content. One-click communication lacks substance, and thus cannot possibly contain the kind of language associated with strong ties. Composed communication is more likely to be rich in content that strengthens relationships, such as self-disclosure, support, or the details of daily life (Collins &

Miller, 1994; Oswald, Clark, & Kelly, 2004; Parigi & Bearman, 2005). Therefore, composed communication is likely to bring ties closer together, one-click communication less so.

H2. Receiving "composed" directed communication on social network sites will be associated with greater increases in tie strength than receiving "one-click" directed communication.

The second kind of activity on social network sites is **(2) passive consumption** (or "monitoring") of ties' social news. Social media allow ties to monitor each other's lives through photos, profiles, and social news, without direct interaction. Facebook began aggregating social news about ties in a stream known as the News Feed in 2006, and since then numerous forms of "social awareness streams" and "microblogging" have appeared across the web (Kivran-Swaine & Naaman, 2011; Naaman, Boase, & Lai, 2010). A typical News Feed contains ties' recent photos, their status updates (short, social posts in response to the prompt, "What's on your mind?"), and notifications of their activity, such as new "friendships" confirmed on the site or their posts on other friends' walls. This kind of activity is comparable to small talk, quick bursts of information about friends' daily lives (Knapp & Vangelisti, 1992). Studies of these online streams suggest that 40% is "me now"-focused (Naaman et al., 2010), or put less generously, "pointless babble" (van Grove, 2009), where "no moment is too mundane for some people to broadcast unsolicited to the world. Just because you have 432 Facebook friends doesn't mean we all want to know when you're waiting for the bus." (Griggs, 2009). Yet these mundane details are commonly considered the building blocks of close relationships (Duck et al., 1991; Knapp & Vangelisti, 1992). Therefore, passively consuming the details of ties' lives should be associated with increases in tie strength.

H3. Tie strength increases through passively consuming a tie's news on social network sites.

However, passive consumption is discreet, and one person can spend considerable time looking at another's photos and stories without the other being notified. Without any alert of the other's behavior, how can a tie know that the other cares? Therefore, the effect of directed communication, which notifies the recipient of the tie's interest, should be associated with greater increases in closeness than passive consumption.

H4. Receiving directed communication from a tie will be associated with greater increases in tie strength than will passive consumption of the tie's news.

The third kind of activity common on social network sites is the flip-side of passive consumption, **(3) broadcasting**. Broadcasts, such as status updates and photo sharing, are one-to-many, rather than being focused on a single target, as in directed communication. Therefore, broadcasts are likely to be less rich in relationship-maintaining language, since they are not aimed at anyone in particular, and they require little effort to produce (per reader). Because of their generic content and non-costly signal, broadcasts should affect relationships less than tailored, more costly directed communication.

H5a. Receiving directed communication from a tie will be associated with greater increases in tie strength than broadcasts by the tie.

H5b. Sending directed communication to a tie will be associated with greater increases in tie strength than broadcasting.

Interactions on social media sites take place in two general venues: the private inbox, and the semi-public wall. An individual's wall (a component of one's profile) is viewable to multiple friends, though the exact number depend on the user's privacy settings. Wall posts across individuals are aggregated and displayed as a stream in the News Feed, to be viewed by many other friends. Writing on a friend's wall, then, is a public declaration of friendship, while private inbox messages lack this avowal. Posts and comments on a friend's wall are affirmations of the relationship in the presence of mutual friends, implicitly evoking a network of observers to help reinforce the relationship (Heider, 1958; Putnam, 2001). Public exchanges signal the reliability of one's claims because they are made in front of a network of friends who implicitly enforce truthfulness and good behavior through the threat of reputation loss (Donath & boyd, 2004). Yet public exchanges, by nature of even having an audience, are less personal and may be stripped of the specific emotional support or level of disclosure that would be found in a more private inbox message (Donath & boyd, 2004; Hogan, 2010). Therefore, it is not clear whether communicating semi-publicly or privaetly would be better, but they should have different relationships with tie strength.

H6. Tie strength increases differently for semi-public and private directed communication.

3.4.2. Interactions between tie type and social network site use

As previously reviewed, different kinds of ties are more or less susceptible to relationship decay (Burt, 2000; Fischer, 1982), and so the link between social network site use and tie strength should differ by the type of relationship. Kin relationships have institutional support (a network of mutual kin) (Litwak & Szelenyi, 1969) and evolutionary pressures to persist (Roberts & Dunbar, 2010), while non-kin relationships do not. Therefore, SNS use should be less important a mechanism for maintaining kin relationships.

H7. Social network site use will be associated with greater increases in tie strength for non-family ties than for family members.

Similarly, for communication partners that frequently interact over other channels—either face-to-face, the phone, or email—social network sites may be less important for relationship maintenance. Because they have a variety of other venues to interact, these ties should be less affected by SNS communication.

H8. Social network site use will be associated with greater increases in tie strength for ties who do not communicate frequently over other channels than for ties who do communicate frequently elsewhere.

However, for fledgling relationships, social network sites may be more important. SNS provide the means and opportunity to communicate (Haythornthwaite, 2002). They nicely complement uncertainty reduction

strategies of new or potential friends: Ties engage in covert observation and try to get the other to reveal more information about him or herself (Berger, 1979; Gibbs, Ellison, & Lai, 2011; Goffman, 1966), and SNS provide profiles full of personal detail and archives of their interactions with others. The profile is an exercise in impression management (Goffman, 1966): Because people have time to consider which elements to include and which to omit, they construct a polished version of themselves (Lampe, Ellison, & Steinfield, 2007; Walther & Parks, 2002). The self-portrait is not wildly inaccurate—concerns about meeting people in person and the permanent archiving of the content temper more flagrant self-improvement—but it does paint an idealized version of the self (Donath, 2008; Hancock, Toma, & Ellison, 2007). Profiles show a person's interests and background, providing viewers common ground for future conversation and showing ways in which the profile creator and viewer are similar. Empirical studies show that people feel good about themselves after viewing their own profile (Toma, 2010) and when strangers first meet, one person mentioning details gleaned from the other's profile increases liking (Hancock et al., 2008). Therefore, SNS reduce uncertainty in new relationships and provide fodder for future interaction, and may be the only channel through which they can learn about each other. Passively consuming a new tie's SNS profile, wall, photos, or other social news should be associated with greater relationship gains than consuming a more longstanding tie's news.

> *H9. Passive consumption will be associated with greater increases in tie strength for new ties than for longer-established ones.*

3.5. Methods

To analyze the relationship between SNS activity and changes in tie strength, I conducted a three-wave panel survey of Facebook users beginning in early June 2011, with follow-up waves in early July and August 2011. The survey contained questions about their relationships with up to eight ties on Facebook. Survey responses were matched to the server logs of the participants' activity on Facebook beginning one month prior to the first survey and concluding on the date of the last survey.

3.5.1. Participants

Participants (N = 11,701, 52% female) were recruited through a combination of Facebook ads and email invitations. The ad presentation and email message were targeted at English-speaking users around the world who had been active on the site in the previous 30 days, stratified by gender and Facebook use (number of login days in the past month). Participants who completed the relationship questions in at least two waves of the survey (n = 3649) were included in analysis. There are minor differences between dropouts and returnees in age (M = 41.2 and 43.4, respectively, $p < 0.001$) and gender (returnees were 8% more likely to be female, χ^2 =32.5, $p < 0.001$), but they were no different in friend count or number of days on the site in the week before

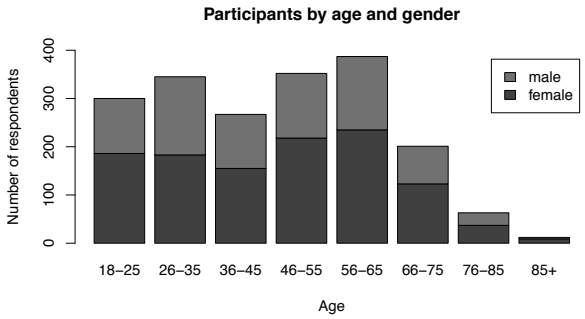

Figure 4. Survey participants by age and gender.

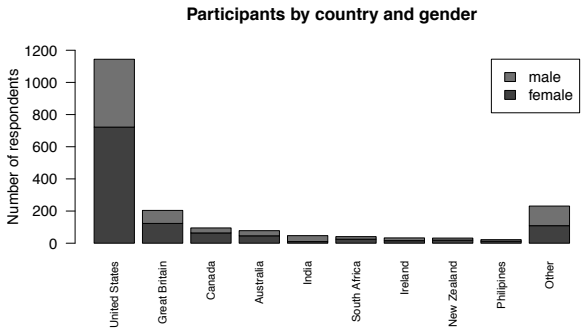

Figure 5. Survey participants were English speakers from 91 countries.

the survey. Compared to a random sample of Facebook users, survey takers were older (M =43.4 vs. 29.9, $p < 0.001$), and 11% more likely to be female ($\chi^2 = 108.1$, $p < 0.001$). They were heavier Facebook users with approximately 70 more friends than average and about twice the likelihood of logging in during the week prior to the survey. Figures 4 and 5 present participant demographics. Participants answered questions about 26,134 Facebook friends. In the following sections, the term "ego" refers to the person who took the survey and "alter" refers to one of the people the respondent rated, consistent with terminology from social network analysis literature (Easley & Kleinberg, 2010).

3.5.2. Survey content: Tie strength, communication frequency, and relationship type

Respondents completed an online survey about their relationships with a set of alters. See Appendix A for complete survey content. First, they were presented with a name generator question from (Marin & Hampton, 2007): "Who are the people you feel closest to? This might include people you discuss important matters with, really enjoy socializing with, or anyone else you feel especially close to. Select up to 6 people. It's also okay to select no one." They chose close friends from a typical Facebook friend selector box (the tool commonly used for event invitations and friend list creation). After participants chose up to 6 friends (M = 4.4), the system randomly selected 2 or more additional alters (totaling 8), and presented a list of ties to the participant. For each alter in the list in random order, the system presented a set of questions (see Figure 6). These included "How close do you feel to [tie name]?" and "Which of the following describe your relationship with [tie name]?" Additionally, respondents reported their frequency of communication with alters in person, over the phone, and through the internet (outside of Facebook).

This iteration through alters is similar to the approach taken by (Gilbert & Karahalios, 2009), with a few critical differences. Because strong ties form a much smaller percentage of one's social network than weak ties (Hill & Dunbar, 2003; Wellman & Gulia, 1999), respondents were encouraged to select strong ties first, rather than being presented with a totally random selection of ties. The system also includes questions about offline communication, allowing for comparisons between Facebook communication and other channels. Finally,

Figure 6. Survey questions about an alter.

the survey includes questions about tie type, e.g., professional colleague or romantic relationship, to allow modeling interaction effects between SNS use as tie types.

3.5.3. Behavioral log data: Independent variables

Site activity was collected for the respondents and ties beginning one month prior to the first survey through the date of the final survey, three months later. All data were anonymized. All behavioral variables follow heavy-tailed distributions and have different means, and so are log-transformed (base 2, after adding a start-value of 1) to control for skew and then standardized by centering at the mean and dividing by the standard deviation. Activity variables were divided into the three categories: directed communication, passive consumption, and broadcasting. Within each category variables are highly correlated with each other and so are collapsed into a single composite scale representing the entire category. Table 1 presents scale items and reliability metrics.

Directed communication (**inbound** and **outbound**) consists of targeted, one-on-one exchanges between ego and alter, such as a private message, a wall post, or a comment. Photo tagging (of ego by alter or vice-versa) is also included in this category because one user identifies a single friend in a photo and that friend is sent a notification about the event. Directed communication actions do not include any communication between ego and other alters, or alter with other alters, just activity within the dyad.

Directed communication is also separated into **"one-click"** interactions, which occur when someone presses a single button ("Like" or "Poke"), and "**composed"** interactions, in which someone composes original text, such as a message or comment. Finally, directed communication can be **private** (only the recipient can see the content, which is the case for messages), or **semi-public**, which for this study means that the action was viewable by people other than the recipient (e.g., comments, likes, and photo tags, which can be seen by other Facebook friends). Public, here, does not mean the general public, simply people other than the sender and receiver.

Passive consumption is comprised of viewing and reading other friends' content, including News Feed stories clicked on, profiles, and photos. This scale measures the extent to which a user consumes content, but does not communicate with the content owner about it.

Facebook activity scales and items	Explanation
Directed communication (by ego or alter) Likes† [a] Content (e.g., links) shared on tie's wall [a] Posts written on tie's wall‡ [a] Comments written‡ [a] Messages written‡ [b] Pokes† Photo tags	Targeted, one-on-one communication in which one person singles the other out for interaction. The target is notified. Scale alphas: Alter to ego = 0.66, Ego to alter = 0.65
Passive consumption Profile views News Feed story clicks Photo views	Discreet activity in which ego reads or views alter's content but does not directly engage/communicate with alter. Scale alpha = 0.51
Broadcasting (by ego or alter) Photos posted Content posted to own wall Status updates	One-to-many content production. Content is not aimed at any particular target. Scale alphas: By ego = 0.86, By alter = 0.84

† "One-click" communication ‡ "Composed" communication

[a] "Semi-public" communication [b] "Private" communication

Table 1. Classes of Facebook use. All activities are within dyads, e.g., "comments written" means comments written by ego to alter, or by alter to ego.

Broadcasting is the wider-audience posting a user performs, including photo uploads and status updates. This scale includes anything that is not targeted at a single friend. While some users have privacy settings enabled so that their broadcasts go to a limited number of Facebook friends, these actions are still counted as broadcasting to distinguish them from the single-friend focus of directed communication. In the present study, broadcasting by both ego and alter are included.

The three main classes of Facebook use (directed communication, passive consumption, and broadcasting) were divided based on a functional taxonomy—directed communication actions are one-on-one, and both parties are aware of the exchange, while broadcasting and consumption are one-to-many (or many-to-one), and neither party is certain whether a specific other viewed certain news. A confirmatory factor analysas (CFA) was performed to further confirm that these classes of activities are legitimately distinct. Overall, three models were tested and a set of goodness-of-fit indicators were compared (see Appendix C). The first model had a single factor with all variables (χ^2=3944.0). The second model had two factors, one for all production variables, such as messaging, status updates, and likes, and one for all consumption variables, such as photo and page views. This two-factor model performed better than the one-factor model (χ^2=2914.2, where lower is better; see (Roberts, 1999) for a discussion of CFA goodness-of-fit metrics). Finally, the three factor factor model (directed communication, passive consumption, and broadcasting) performs better than the two previous models (χ^2=2345.5). Though there may be many ways to distinguish classes of Facebook use, the three classes discussed here are empirically and theoretically distinct.

3.5.4. Method of analysis

To determine how site use relates to changes in tie strength, a multilevel linear model was created with created with ego's response to the "How close do you feel to [tie name]?" question as the dependent variable. The model includes a lagged dependent variable (reported tie strength last month) on the right side of the equation. So, the reported tie strength at time t is a linear combination of the reported tie strength 30 days prior (t -30) and communication activities during the intervening month, on Facebook and via other channels (e.g., email, face-to-face, or phone, as self-reported).

$$\textit{Ego-reported tie strength}_t = \alpha\,(\textit{Reported tie strength})_{t-30} + (\textit{General communication})_{(t-1\ldots t-30)} + (\textit{FB communication})_{(t-1\ldots t-30)} + \varepsilon_t$$

Where:

$$\textit{General communication} = \beta_0(\textit{In-person communication}) + \beta_1(\textit{Phone}) + \beta_2(\textit{Other online communication})$$

$$\textit{FB communication} = \beta_3(\textit{Directed communication ego to alter}) + \beta_4(\textit{Directed communication alter to ego}) + \beta_5(\textit{Passive consumption by ego}) + \beta_6(\textit{Broadcasts by ego}) + \beta_7(\textit{Broadcasts by alter})$$

The model therefore measures *changes* in tie strength associated with communication that took place in the month between surveys. This form of autoregressive distributed lag model is common in econometrics and appropriate when the dependent variable is stationary (the mean and variance do not change over time, as is the case with the tie strength measure) and model residuals are not highly autocorrelated. Lagged independent variables (site activity the previous month) are not included because they are highly collinear, and thus would produce biased estimates (Keele & Kelly, 2006). Static data about the dyad (e.g., ages, sexes, whether they live in the same city) are included as controls and noted in the appropriate tables.

Unlike cross-sectional models common in much of the prior research on the effects of online communication which simply measure correlation between the independent and dependent variables at a single point in time (e.g., (Ellison et al., 2007; Gilbert & Karahalios, 2009)), this is a far more conservative model, in effect controlling for a dyad's previous tie strength and all of the unmeasurable factors that contribute to it. This model then reveals the relationship between Facebook use and changes in tie strength. While it is impossible to truly determine a causal relationship between the independent and dependent variables without a randomized assignment of participants—e.g., assigning Facebook friends not to talk to each other for a month—this model is well suited for observational studies. By employing a three-wave survey, the study design also ensures that measured changes in the outcomes are not simply due to noise in the survey instrument, but rather due to meaningful changes in tie strength. Furthermore, the three-wave design means that there are more than two observations per participant, so measurements are more robust to exogenous events such as holidays which may increase both Facebook activity and feelings of closeness.

For each dyad, there are three observations of tie strength, and thus two observations of the lagged tie strength variable. Therefore, the multilevel model was grouped at the ego and alter levels to account for non-independence of the ego's responses, both about his or her alters and about the same alter on multiple occasions. Ego and alter were treated as random effects, not shown in the formula above.

3.6. Results and discussion

Recall that the overarching question driving this work is whether communication on social network sites is related to changes in tie strength over and above the effects of other relationship-maintenance channels, such as face-to-face communication, phone calls, and email. It is.

	1	2	3	4	5	6	7
1. In-person	1.00						
2. Phone	0.75	1.00					
3. Online (non-FB)	0.53	0.62	1.00				
4. Directed communication (alter to ego) on FB	0.24	0.25	0.26	1.00			
5. Directed communication (ego to alter) on FB	0.25	0.26	0.26	0.76	1.00		
6. Passive consumption by ego on FB	0.23	0.24	0.25	0.54	0.59	1.00	
7. Broadcasting by ego on FB	-0.02	-0.01	0.01	0.10	0.12	0.09	1.00
8. Broadcasting by alter on FB	-0.03	-0.02	0.00	0.11	0.11	0.13	0.55

Table 2. Correlation between communication media within a dyad.

We begin by considering how Facebook use compares with other channels. Friends who communicate regularly in person, on the phone, or online (outside of Facebook) also talk regularly on Facebook: There is a modest positive correlation between directed communication on Facebook and communication via other channels (r = 0.24 to 0.26, see Table 2). Similar correlations are found between passive consumption on Facebook and communication via other channels. (r = 0.24 to 0.26). Within-Facebook communication is more strongly correlated; egos who frequently communicate directly also frequently communicate via passive consumption, r = 0.59. This correlation is expected; reading news stories about one's friends may lead to comments on those stories, and writing on friends' walls may induce clicking on additional stories and photos. Broadcasting patterns are also correlated between ties (which can be thought about as a proxy for general chattiness or general level of Facebook sharing, since broadcasting is by definition not communication within the dyad): individuals who broadcast frequently on Facebook have ties who also broadcast frequently. That friends have similar behavioral patterns is well established, e.g., (Christakis & Fowler, 2007), though whether the similarity is due to homophily or social influence is outside the scope of the present study (Lyons, 2011; Noel & Nyhan, 2011). Instead, we'll move beyond these background correlations to analyses of tie strength.

3.6.1. Directed communication and changes in tie strength

Now we look at communication patterns that are associated with changes in tie strength month-to-month. Table 3 presents three models of changes in tie strength. The first model is a baseline with the lagged dependent variable (reported tie strength the previous month) and the control variables, the second model adds general communication variables, and the third model adds Facebook communication variables. The models get progressively better, with R^2=0.85, 0.86, and 0.87, respectively ($p < 0.001$). Notice that the first model explains most of the variance (because tie strength does not change much month-to-month), but the variables in Models 2 and 3 are still significantly associated with increases in tie strength. With only 15% of the remaining variance to explain, Model 2 explains 1/15, or 6.7% of it. Model 3 adds an additional 1/14th, or 7.1%. The following discussion focuses on Model 3, the model that contains all communication variables including those on Facebook.

The intercept (4.54) in Model 3 of Table 3 represents the tie strength of the average dyad—one in which all continuous variables are at their means and all binary variables are zero. Therefore, the intercept represents a dyad where both the ego and alter are 43 years old, ego is female and alter is male, they have the average number of friends, and are not family members, and not in a relationship together, etc. Recall that tie strength is measured on a 7-point Likert scale, so the average dyad is somewhat closer than the midpoint of the scale. (This intuitively makes sense, as more than half of the alters rated in the survey were close friends). For every one-point increase in an independent variable, the estimated tie strength increases by the coefficient in the Value column. So, for every one point higher their tie strength was the previous month, their current tie strength is 0.78 points higher. (This is expected; tie strength one month is highly correlated with tie

	Reported tie strength								
	Model 1: Baseline			Model 2: Communication			Model 3: Facebook Communication		
	Value	SE	*p*-value	Value	SE	*p*-value	Value	SE	*p*-value
(Intercept)	4.52	0.01	0.00 ***	4.56	0.01	0.00***	4.54	0.01	0.00 ***
Controls									
Reported tie strength last month	0.88	0.00	0.00 ***	0.78	0.00	0.00***	0.78	0.00	0.00 ***
Ego age (decades)	0.02	0.00	0.00 ***	0.03	0.00	0.00***	0.04	0.00	0.00 ***
Age difference (decades)	-0.01	0.00	0.00 **	-0.00	0.00	0.00**	-0.00	0.00	0.01 **
Ego is male	0.03	0.01	0.01	0.02	0.01	0.08	0.03	0.01	0.03 *
Same gender†	0.02	0.01	0.06	0.01	0.01	0.31	0.01	0.01	0.41
Ego's friend count‡	-0.01	0.03	0.68	-0.02	0.03	0.47	-0.02	0.03	0.46
Alter's friend count‡	-0.06	0.01	0.00 ***	-0.04	0.01	0.00***	-0.05	0.01	0.00 ***
Number of mutual friends	0.02	0.03	0.49	0.02	0.03	0.54	0.02	0.03	0.50
Family members†	0.24	0.02	0.00 ***	0.14	0.02	0.00***	0.13	0.02	0.00 ***
In a relationship together†	0.32	0.03	0.00 ***	-0.11	0.03	0.00***	-0.13	0.03	0.00 ***
Members of same work network†	0.01	0.03	0.83	-0.12	0.03	0.00***	-0.12	0.03	0.00 ***
Members of same school network†	-0.02	0.01	0.11	-0.01	0.01	0.51	-0.01	0.01	0.39
Live in the same city†	0.00	0.03	0.86	-0.07	0.03	0.01**	-0.08	0.03	0.00 ***
General communication									
Frequency of in-person contact				0.07	0.00	0.00***	0.07	0.00	0.00 ***
Frequency of phone contact				0.12	0.01	0.00***	0.12	0.01	0.00 ***
Frequency of online contact (not including Facebook)				0.11	0.00	0.00***	0.10	0.00	0.00 ***
Facebook communication									
Directed communication (alter to ego)							0.01	0.00	0.02 *
Directed communication (ego to alter)							0.01	0.00	0.01 **
Passive consumption by ego							0.02	0.00	0.00 ***
Ego broadcasting							-0.01	0.01	0.04 *
Alter broadcasting							-0.00	0.00	0.49
*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$	$R^2_{y,\hat{y}}$: 0.85 BIC=109449.3 N=42213 Egos=3674 Alters=26784			$R^2_{y,\hat{y}}$: 0.86 BIC=101798.8 N=40552 Egos=3649 Alters=26134			$R^2_{y,\hat{y}}$: 0.87 BIC=101759.0 N=40552 Egos=3649 Alters=26134		

† Binary variable
‡ Logged and standardized continuous variable
All continuous variables are centered at their means.

Table 3. Model of changes in ego-reported tie strength. Model 1 contains controls, Model 2 adds general communication variables, and Model 3 adds Facebook communication. Communicating on Facebook is related to changes in tie strength over and above changes attributable to other communication channels.

strength the previous month, $r = 0.91$.) After accounting for this lagged dependent variable, all of the other coefficients represent the change in tie strength month-to-month associated with the other independent variables. So, moving past the controls to the "General communication" section, we see that a one-point increase in frequency of in-person contact (e.g., going from talking a few times per month to a few times per week) is associated with a 0.07 point increase in tie strength. Phone and online contact (outside of Facebook) are also associated with increases in tie strength, consistent with previous research (Haythornthwaite & Wellman, 1998).

Now, we examine the Facebook communication variables. There are significant associations between several uses of Facebook and increases in tie strength. Hypothesis 1 is confirmed: Directed communication is associated with significant increases in tie strength over and above the effects of other communication channels. When alter sends a message to ego, or comments on ego's content, or writes on ego's wall, ego feels closer to alter. A one-unit increase in directed communication (approximately two extra comments received in a month) is associated with $\beta = 0.01$ increase in tie strength, $p = 0.02$). Notice this estimate is conservative because the model also includes directed communication initiated by ego, which may be a lead indicator of tie strength. When ego likes alter, ego comments and writes more on alter's wall ($\beta = 0.01$, $p = 0.01$). Therefore, we see that regardless of ego's level of communication toward alter, alter's communication toward ego affects ego's perception of tie strength. The magnitude of these coefficients can be compared to the coefficients for the general communication variables (e.g., frequency of in-person contact): Receiving approximately two comments from alter in a month is associated with about 1/7 or 14% of the increase in tie strength felt by partners that go from meeting in person a few times per month to a few times per week, and 1/12 or 8% of the increase in tie strength from increased phone communication. Considering that comments can be written regardless of geographic proximity, their association with increases in tie strength is remarkable. An analysis of the other kinds of Facebook activities —passive consumption and broadcasting—is suspended until Section 3.6.3.

> Research Question 1.
>
> SNS communication in a dyad is positively correlated ($r \sim 0.25$) with communication over other channels.
>
> Hypothesis 1: Confirmed.
>
> Directed communication is associated with increases in tie strength.

Survey respondents commented on the connection between directed communication on Facebook and feeling closer to ties.[3]

> *"Photos and comments and messaging allow us to be very close still even though we're 800 miles away."*

[3] Open-ended quotes are included for illustration, but have not been systematically analyzed in the present study. Quotes have been edited for length and names have been replaced, but are otherwise left as written. All are in response to the question, "Has Facebook affected your relationship with [tie name]?"

"Lucy is my very busy daughter-in-law. We don't get to talk often but I love her very much and am always delighted to chat back and forth by reading her posts and commenting and having her comment on my posts."

"We got to 'know' each other through FB. We knew that both of us existed (she is daughter of my favorite cousin) but it was communication/comments/photos etc via FB that brought us little closer. we have never me personally but now we will. Thanks, in part, to fB."

Like the phone and email, Facebook is a channel for providing emotional support, which brings people closer:

"We have sent messages either on our wall posts or messages. I originally sent her a long supportive message regarding her struggles with her sick father and other issues. She was very grateful and over time we struck up a more meaningful relationship. We have given each other support via phone, email, fb, and have found that we have much in common and are working towards something longer term."

"facebook has given my granddaughter and myself the opportunity to talk about her fears of her mothers cancer privately she is only 13, and needs all the support I can give her only between her and I"

And a lack of directed communication is a reason for concern:

"At least he could put in a comment or two making me realize that he's there."

Overall, the quantitative data confirm that talking one-on-one with ties on Facebook is associated with growing closer, and respondents' comments indicate a causal relationship, that talking on Facebook increases tie strength.

3.6.2. One-click versus composed directed communication

Next, we turn to Hypothesis 2, which compares the relative effects of "one-click" directed communication (likes and pokes) to more "composed" communication (comments, messages, wall posts). Table 4 presents a

	Reported tie strength		
	Value	SE	*p*-value
(Intercept)	4.54	0.01	0.00 ***
Facebook communication			
"Composed" directed communication (alter to ego)	**0.02**	**0.00**	**0.00 *****
"One-click" directed communication (alter to ego)	**0.00**	**0.00**	**0.65**
Directed communication (ego to alter)	0.01	0.00	0.08
Passive consumption by ego	0.02	0.00	0.00 ***
Ego broadcasting	-0.01	0.01	0.04 *
Alter broadcasting	-0.00	0.00	0.45

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$

Model includes all controls and general communication from Table 4, Model 2 (omitted)

$R^2_{y,\hat{y}}$: 0.85, BIC=101750.2 N=40552, Egos=3649, Alters=26134

Table 4. Model of "one-click" versus "composed" directed communication. Composed communication is associated with increases in tie strength while one-click communication is not.

regression similar to the ones from Table 3, this time breaking directed communication into these two types. (All controls and general communication variables from Table 3 are included in the model but omitted for space.) We see that the effect of directed communication is due to composed pieces—one-click actions are not associated with increases in tie strength ($p = 0.65$), while composed pieces are ($\beta = 0.02$, $p < 0.001$).

Hypothesis 2: Confirmed.

Receiving composed content from a tie is associated with greater increases in tie strength than is receiving one-click actions.

Comparing one-click to composed communication, one of the differences frequently mentioned by participants is humor: comments can be funny, while no one said that pokes or likes were funny.

> *"His comments are hilarious, we get to trade jabs online"*
>
> *"I like his funny posts."*

While respondents frequently mentioned learning about ties' "likes and dislikes" they rarely remarked on ties "liking" their content. One exception mentions a progression from likes to more meaningful interaction:

> *"my sister Theresa wasn't talking to me for 2 years...some falling out that was never forgiven...then one day she asked me to be her friend...slowly our conversation grew from her liking a few of my pics etc. to small comments to small messages and last week she messaged me to come and visit. So next week I will see her/speak with her for the first time in 2 years. I'm thankful for the non-threatening vibe of FB and hope we can communicate as easily in person...=)"*

Pokes were mentioned more often than likes, but typically with very close friends or spouses:

> *"We have been friends for over 20 years. She is married to my husbands best friend. They all live not close anymore. So this is great way to keep in touch. And not spend hours on the phone! We poke each other till we are black and blue!"*
>
> *"No, he just pokes me. He is my husband."*

Pokes are inherently ambiguous; the Facebook Help pages say "the poke feature can be used for a variety of things on Facebook. For instance, you can poke your friends to say hello"[4] and the popular press calls them "replete with sexual connotations" (Bartz & Ehrlich, 2010). Overall, communication actions in which a tie takes the time to write a brief piece of text are linked with increases in tie strength, while one-click actions are not.

3.6.3. Passive consumption and broadcasting

Now we consider the one-to-many and many-to-one modes of communication on Facebook: broadcasting and passive consumption. Recall that Hypothesis 3 predicts that passive consumption—reading a tie's social

[4] https://www.facebook.com/help?page=407

news, looking at her photos, looking at her profile—is predicted to be associated with increases in tie strength. It is. Return to Table 3, Model 3, where we can see the differences between different kinds of Facebook activities. Hypothesis 3 is confirmed: When ego passively consumes news about alter, ego feels closer to alter, ($\beta = 0.02$, $p < 0.001$). However, Hypothesis 4 is not confirmed: There is no difference between passively consuming a tie's news and receiving directed communication from that tie, confirmed by a post-hoc test, $p = 0.50$. Reading and writing are both associated with increases in tie strength.

Hypothesis 3: Confirmed.

Passively consuming a tie's news is associated with increases in tie strength.

Hypothesis 4: Not confirmed.

No difference is found between receiving directed communication from a tie and passively consuming the tie's news.

Why is passive consumption as effective as talking? Consistent with the theory that similarity increases attraction (Berscheid & Reis, 1998), respondents often mentioned that they learned through Facebook how similar they were to their ties.

> *"Very much! I had no idea how much we had in common!"*
>
> *"met on facebook through a freind and became friends due to similar ideas and interests."*

Learning of commonalities spurs directed communication:

> *"I saw, via Facebook, that Jennifer was using a business similar to one I'm starting. That resulted in me getting back in touch with her and soliciting some feedback. Wouldn't have saw her otherwise."*

Passive consumption also allowed friends and family members to learn about each others' lives without feeling like they were intruding:

> *"Josh is my son. I have been able to find out more about his friends and things he has been doing without having to feel like I am 'interogating or drilling' him about his personal life. He doesn't block me from his profile and I don't block him from mine."*
>
> *"It helps me to see things he's into without having to ask him and putting him on the defensive (he's my son)"*

Hypotheses 5a and 5b: Confirmed.

Receiving directed communication from a tie is associated with greater increases in tie strength than is the tie's broadcasting.

Sending directed communication to a tie is associated with greater increases in tie strength than broadcasting.

What about broadcasting? After accounting for directed communication and passive consumption, we see in Table 3, Model 3 that broadcasting does not make people feel closer. Egos who broadcast to their personal networks more than average (about one extra status update per month) became less close to individual ties in the network, $\beta = -0.01$, $p = 0.01$. It is not the case that broadcasting is displacing one-on-one communication; this model examines the effect of broadcasting while holding directed communication constant. And alter's broadcasting has no impact on ego's feeling of tie strength (though as we just saw, when ego passively consumes alter's broadcast content, ego feels closer to alter). A post-hoc test

confirms Hypotheses 5a and 5b: Receiving directed communication from alter is associated with greater increases in tie strength than alter's broadcasts, $\beta = 0.01$, $p = 0.04$, and ego's sending directed communication to alter is associated with greater increases than ego's broadcasting, $\beta = 0.03$, $p = 0.01$ (both p's corrected for multiple comparison). While broadcasting may be an efficient way to spread news to a large number of ties at once, merely having more information available about one's ties does not increase tie strength with any individual friend. The news must reach those ties (they need to passively consume it and/or directly communicate about it). The results speak to the importance of News Feed prioritization: An individual's stories have to make it in front of an audience, or they have little value.

3.6.4. Semi-public versus private directed communication

Consistent with Hypothesis 6, semi-public and private directed communication have different associations with changes in tie strength, as shown in Table 5. Semi-public communication, such as wall posts and comments, are associated with increases in tie strength, $\beta = 0.02$, $p < 0.001$, while private messages are not, $p = 0.16$. A post-hoc test confirms the difference, with semi-public communication associated with $\beta = 0.02$ greater increases in tie strength than private messages, $p < 0.001$. These results confirm the idea that a public declaration of a relationship, and enacting that relationship in the presence of others, is associated with increases in closeness. On the other hand, private messages, which would be expected to have greater amounts of disclosure, are not associated with changes in tie strength. This result is surprising. One possible explanation is private messaging on Facebook is redundant with other private channels,

Hypothesis 6: Confirmed.

Semi-public comments, likes, wall posts, and other Facebook activities visible to others are associated with increases in tie strength.

Private messages are not.

	Reported tie strength		
	Value	SE	p-value
(Intercept)	4.54	0.01	0.00 ***
Facebook communication			
Semi-public directed communication (alter to ego)	**0.02**	**0.00**	**0.00 *** **
Private directed communication (alter to ego)	**0.00**	**0.00**	**0.16**
Directed communication (ego to alter)	0.01	0.00	0.08
Passive consumption by ego	0.01	0.00	0.00 ***
Ego broadcasting	-0.01	0.01	0.04 *
Alter broadcasting	-0.00	0.00	0.36

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$

Model includes all controls and general communication from Table 3, Model 2 (omitted)

$R^2_{y,\hat{y}}$: 0.85, BIC=101738.4 N=40552, Egos=3649, Alters=26134

Table 5. Model of semi-public versus private directed communication (including same controls and general communication variables as Table 3, Model 3, but omitted here for space). Semi-public interactions are associated with increases in tie strength while private messages are not.

such as email and the phone. Within a specific dyad, participants rarely sent or received private messages, exchanging just $M = 1.3$ messages (both directions) per month. Therefore, there is little opportunity for those messages to affect closeness. Younger users—those who may have grown up using Facebook rather than email—do exchange more private messages, $M = 4.5$ for 21-year-olds and younger, though there are few of them in the sample (n = 275), and no interaction between age and private messaging is seen.

The data reveal that semi-public interactions are linked with increasing closeness, while private messaging is not. Enacting a relationship in the presence of others, especially mutual friends, has been shown to increase closeness and support (Heider, 1958; Newcomb, 1961; Putnam, 2001), and these theories hold up on Facebook. Other media commonly studied in HCI afford public display to some extent—mass emails, discussion groups—but social network sites are venues that embed communication in a network of mutual friendship and trust, one in which the actors are socially vetted and have profiles full of personal information. The benefits of this social context are evident in the present study, through semi-public interactions, which take advantage of that context.

> *"I love how [my husband] says sweet things about me, and how much he shows his love for our baby on his page."*

> *"We met on facebook right after I got my account, she friend requested me and I didn't know her and she didn't go to my HS but she was friends with over 10 of my friends so I accepted. We've been dating for over 3 years and got engaged in November."*

Participants rarely articulated these kinds of benefits from their own relationships being on display, but often referred to happiness at public displays by other friends.

> *"Last year, I was so excited to see she was getting married to a mutual friend! As far away as I live from our hometown, it is a warm feeling to see that my friends are happy!"*

> *"I was able to see a romance blooming with another friend purely through seeing them always commenting on each other"*

While communicating in front of an audience may strengthen relationships, the composition of the audience poses a problem of context collapse. Undifferentiated social circles collide on Facebook, and content appropriate for one may not be appropriate for another.

> *"[Facebook] sometimes creates problems, i.e. being friends with other girls, an ex, pics from long ago, etc. It hasn't done anything whereby the relationship would end, but as much utility as I get out of Facebook, sometimes I wish I could tailor it a bit more to make things easier."*

> *"I know more about what she's up to - probably more than appropriate, considering I used to be her boss"*

Social network site users are aware of their audience and of this conflict (Marwick & boyd, 2011; Papacharissi, 2002), and have two general responses. One is to post lowest-common-denominator content, to constrain their activities to those safe for all audiences, omitting emotional intimacy or controversial detail

(Donath & boyd, 2004; Hogan, 2010). The other is to become savvy with privacy controls in order to block unwanted eyes.

> *"I find that older family members (not my generation) who are on Facebook tend to overreact when I post things about my job/life etc.so I have blocked him from my statuses."*

> *"My mother has recently started getting used to using Facebook (and the internet in general) -- and as such, she is now able to do more things on it... Including seeing a lot of my status updates or things my friends post on my Wall, which means that I've had to put her on a private list so that she doesn't freak out about every little thing."*

As social network site features become more ubiquitous across the web and mobile devices (such as names of friends who liked the New York Times article you are reading, or push notifications when a Facebook friend has topped your high score in a game), these privacy concerns will only grow. Facebook recently introduced post-level privacy controls, and Google+ introduced the concept of "circles" to combat these problems. Despite problems of context collapse, the present study affirms the value of communicating semi-publicly.

3.6.5. Facebook communication with different kinds of ties: Family, frequent contacts, and new ties

Family versus non-family. Now we examine whether the effect size of Facebook communication differs by the type of tie. It does. Hypothesis 7 predicts that Facebook communication is less important for kin than non-kin, as family members have institutional, structural ties promoting their success. A regression including interaction effects between Facebook activities and a binary variable representing family status bears this out (see Table 6). Family members are less affected by directed communication and passive consumption on Facebook than are non-family members; family status basically wipes out the gains from either activity. In Figure 7, the top, solid line represents family members, and the bottom dashed line represents non-family. The *x*-axis is split, showing directed communication one standard deviation below the mean and one standard deviation above the mean. Regardless of the amount of directed communication ego does with his family member, his feelings of tie strength do not change. For non-family members, tie strength increases with directed communication (as shown by the upward slope of the dashed line).

> Hypothesis 7: Confirmed.
>
> Social network site use is associated with greater increases in tie strength for non-family than family members.

Though neither directed communication nor passive consumption were associated with increases in tie strength for family members, respondents frequently remarked that Facebook allowed them to see other sides of their family members, revealing personalities they do not get to see as a sibling or child.

> *"Yes, I get to see how she wants to present herself to her social world, which is different from how I get to interact with her in person as her cousin."*

> *"Bob's my brother. And while we're close, facebook helps me know the things he doesn't tell me. hehe."*

	Reported tie strength		
	Value	SE	*p*-value
(Intercept)	4.46	0.01	0.01 ***
Family members (1=family, 0=non-family)	0.32	0.01	0.00 ***
Facebook communication			
Directed communication (either direction)	0.05	0.01	0.00 ***
Passive consumption by ego	0.03	0.00	0.00 ***
Ego broadcasting	-0.01	0.01	0.06
Alter broadcasting	-0.00	0.00	0.47
Interactions between FB communication and family status			
Family members X Directed communication	-0.05	0.01	0.00 ***
Family members X Passive consumption	-0.03	0.01	0.00 ***

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$
Model includes all controls and general communication from Table 3, Model 2 (omitted)

$R^2_{y,\hat{y}}$: 0.85, AIC=100902.5 N=40552, Egos=3649, Alters=26134

Table 6. Facebook communication is less valuable for family members than for non-family members.

"[My dad] is only on Facebook to see and share pictures of his grandkids, but it is interesting to read posts from his friends and see my dad as a social person rather than dad/grandpa."

"My younger sister is the main reason why I continue to use Facebook, since we live in different states and a cool young 16 year old does not have the time write emails or talk on the phone with her older sister. Through facebook I am able to keep up with the happenings in her life with school, boyfriends and what is going on with the family. The ability to follow her and keep up to speed with the busy life of a teenage sibling on Facebook has actually done wonders for our relationship, as I am more aware and therfore more able to support her life's ventures in a way that I

Figure 7. Different effects of Facebook on family and non-family relationships. For non-family members (dashed blue lines), increased Facebook use is associated with increases in tie strength. This holds for both directed communication and passive consumption on Facebook. Neither activity significantly affects tie strength with family members (solid red lines).

hadn't been able to do since I was living at home in the room down the hall before I moved across the country for college over five years ago."

These quotes center on passive consumption rather than directed communication—perhaps one's closest relationships don't require Facebook for one-on-one communication; they have other channels for that. Instead the site's value is in revealing the tie's wider interests and interactions with others, providing another lens on the friend's life.

Frequent versus infrequent contacts. Hypothesis 8 asks this very question: Do ties who frequently communicate in person, on the phone, or over email see the same benefits from Facebook use as ties who rarely communicate through other channels? The results are similar to those for kin: Frequent contacts are not as affected by Facebook use. Table 7 and Figure 8 show the differences. In Table 7, participants are divided into two categories: "frequent contacts" includes ties who are in a romantic relationship, live together, or report talking a few times per week or more via the phone, email, or in person, and "less frequent contacts" are all other ties. Table 7 shows that there are main effects on tie strength for both directed communication and passive consumption, but there are also interaction effects, such that frequent contacts do not benefit as much. Figure 8 shows this graphically. The top, solid line represents frequent contacts, and the bottom dashed line represents less frequent contacts. The slopes of the

Hypothesis 8: Confirmed.

Social network site use is associated with greater increases in tie strength for ties not frequently contacted via other channels.

	Reported tie strength		
	Value	SE	*p*-value
(Intercept)	4.47	0.01	0.01 ***
Frequent contacts elsewhere (1=yes, 0=no)	0.32	0.01	0.00 ***
Facebook communication			
Directed communication (either direction)	0.05	0.01	0.00 ***
Passive consumption by ego	0.03	0.00	0.00 ***
Ego broadcasting	-0.02	0.01	0.01
Alter broadcasting	-0.00	0.00	0.06
Interactions between FB communication and family status			
Freq contact X Directed communication	-0.04	0.01	0.00 ***
Freq contact X Passive consumption	-0.02	0.01	0.18 ***

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$
Model includes all controls and general communication from Table 3, Model 2 (omitted)

$R^2_{y,\hat{y}}$: 0.85, AIC=104301.8 N=40552, Egos=3649, Alters=26134

Table 7. Facebook communication is less valuable for ties maintained frequently over other channels (face to face, phone, email).

Figure 8. Different effects of Facebook on ties with whom ego is in frequent contact via other channels (red line) and less-frequent contacts (dashed blue line). For ties not maintained on other channels, Facebook is associated with increases in tie strength. It has no effect on ties maintained elsewhere.

lines are different; frequent contacts are not affected by Facebook use (the lines are basically horizontal), but less frequent contacts do see increases in tie strength through Facebook. This is true for both directed communication and passive consumption.

When strong ties who have regular face-to-face interaction do directly communicate on Facebook, they often do it because the site affords media sharing and game playing.

> *"We see each other almost everyday so we do not use Facebook to chat or keep up to date, but we are able to share pictures of our adventures and it is an easy way to share links, websites, and videos."*
>
> *"Facebook has made it easier to reminisce over pictures and share trivia that brighten our days. However, we use email to communicate more substantially when we're not living together or on the same schedules."*
>
> *"Not a lot. We are married, so we have a great relationship. I can send him love notes or game coins."*
>
> *"even when not in town together, we use fb for scrabble, poker, games."*

So, for strong ties, Facebook's value may be for rich media and gaming, and in revealing other sides of loved ones. Additionally, many participants, in selecting their closest ties for the survey, commented that after meeting their spouse for the first time, they used Facebook for the next step, even if Facebook is not an important part of their relationship anymore.

> *"It's part of the reason we got together and ultimately got married. She found me on Facebook in college and sent a message, and we connected from there to begin our romantic relationship."*

"Actually, it's how he got my phone number. We met through a friend and he didn't get my number, so he sent me a facebook message the next day. We now have been dating for over a year. But since then, no. We're not big on using FB to communicate."

"Charles and I were partners on many projects in college. We always meant to become better friends (e.g., 'We should go out to coffee sometime.' But, we never did. Ergo, we found each other on FB a few years later and started messaging each other. When I moved near him in recent years, we have become very close friends. It all started with Facebook."

New ties versus older ties. Though respondents mentioned using Facebook for the early steps in relationships, the quantitative data do not show different effects of Facebook use for new ties versus long-established ones. For ties the respondents marked as "someone I just met" (approximately 2% of ties, n = 1480), or for ties "friended" on Facebook in the last two months (approximately 9% of ties, n = 7366), the effect of Facebook use on tie strength is no different than for ties that have been connected longer, $\beta = 0.04$, SE=0.03, $p = 0.14$. Hypothesis 9 is not confirmed. However, the present study does not include tie strength reports for extremely nascent ties—people with whom the respondents had not yet created a Facebook friendship. Therefore, it is possible that Facebook plays a role in uncertainty reduction with new ties, facilitating discreet lookups of each others' profiles and mutual friends, but this stage happens before one person initiates the friend request. After the tie is articulated on Facebook, use of the site is associated with increased tie strength, but the effects are no larger for these new friends.

Hypothesis 9: Not confirmed.

No difference is found in the effect of social network site use on new ties versus longer-standing ties.

3.7. Conclusion

Like other forms of computer-mediated communication at their earliest stages, social network sites have been lambasted by the popular press as forums for inconsequential interaction (Copeland, 2011; Pullella, 2011), or as competitors with richer, more meaningful venues, such as family gatherings or visits with the neighbors (McPherson et al., 2006). However, it is clear that social network sites are a meaningful component in a portfolio of communication channels, and that the sites have value that sets them apart. Reading and writing on social network sites strengthen relationships.

This study examines the types of interaction on Facebook that are associated with increasing closeness over time. Table 8 summarizes the findings. Directed communication, especially composed and semi-public pieces, are linked with increases in tie strength. This work demonstrates how social network sites fit into the ecology of communication media, showing increases in tie strength associated with Facebook use over and above other channels. In this way, Facebook activity is both a reflection of tie strength as it is maintained elsewhere and a tool for nurturing that relationship. Furthermore, the study unpacks different classes of communication common on social network sites. One surprising finding is that passive consumption—reading about ties

	Feature	Prediction	Confirmed
1	Directed communication (both directions)	Increases in tie strength	Y
2	"Composed" vs. "one-click" directed communication (in)	Composed > one-click	Y
3	Passive consumption	Increases in tie strength	Y
4	Directed communication (in) vs. passive consumption	Directed > passive	N
5a.	Directed communication (in) vs. alter broadcasting	Directed > alter broadcast	Y
5	Directed communication (out) vs. broadcasting	Directed > broadcast	Y
6	Semi-public vs. private directed communication (in)	Semi-public != private	Y
7	Kin vs. non-kin	Greater increases in tie strength for non-kin	Y
8	Frequent contacts (elsewhere) vs. less frequent contacts	Greater increases in tie strength for less frequent contact	Y
9	New ties vs. longer-established ties	Greater increases in tie strength for new ties	N

Table 8. Summary of hypotheses and results

without actually contacting them—is equally effective in increasing closeness as actually receiving messages from those ties. Even though interpersonal communication literature indicates frequency of interaction and communication exchanges are the building blocks of relationships, the present study shows that two people may not have to synchronously interact or direct messages at each other to grow closer. Quietly taking in the mundane details of another's life works. Certainly directed communication actions are important, but this study shows that reading is as good as writing.

Consistent with media multiplexity arguments—that strong ties have many channels over which they communicate (Haythornthwaite & Wellman, 1998)—the present study confirms Facebook as a venue for relationship maintenance, and shows that its influence is smaller for ties that interact in person or on the phone frequently. Similarly, kin ties are less affected by Facebook activity than non-kin. However, the present study surfaces interesting details about the role of Facebook in family relationships. Siblings, children, and parents appreciate that the site reveals a different side of their family members. They see cousins talking candidly about politics, children interacting with peers, and grandparents as "social people" rather than simply fulfilling a grandparent role. Many parents valued that they could learn about their teens' lives without intruding. While people don't think that Facebook brings them closer to their family, they do gain a different perspective on their kin.

3.7.1. Limitations and future work

This study is limited by having just one side of the picture—we see how one half of a pair rates the relationship. Relationships may be asymmetric, and the study does not take this into account in modeling changes in tie strength over time. However, unlike many previous survey-based studies, behavioral data from both sides of the dyad are included strengthening the claims made here.

The timeframe in the present study is short. Relationships take years to develop, and changes in tie strength may happen gradually over months or years, rather than the month-to-month window used here. However, despite the short window and the infrequent communication within dyads on Facebook, we do see substantial increases in tie strength, over and above those expected from numerous baselines, such as living together or talking on the phone.

Furthermore, like Chapter 2, this study is agnostic to communication content. A thorough, automated analysis of both semi-public and private exchanges may reveal linguistic markers of closeness missed in the present study. For example, private messages were not associated with increased closeness, but all private messages are not created equal. Some are event notifications while others are lengthy missives full of emotional support. The relative impact of small talk is an open question in the literature, and the present study does not distinguish between chatty, mundane news and weightier discussions; it simply distinguishes between those carried out in the presence of others and those in private. Inconsistencies in the logging of synchronous chat data during the study period caused chat interactions to be omitted from the present study, so we do not know whether synchronous, private communication would lead to increases in tie strength. Had chat been included, it may have been revealed as an equally powerful mechanism for maintaining close relationships as semi-public communication, at which point, an analysis of the differences in language between semi-public and private communication would be enlightening. Similarly, "composed" pieces differ in length and content, and it may be the case that shorter, more generic composed pieces (such as writing "happy birthday") are comparable to one-click actions: less powerful in eliciting feelings of closeness than longer, more meaningful messages.

Like all observational studies, this work is limited in its ability to infer causality. Participants were surveyed over a short time period, two months, and we cannot determine whether their communication patterns cause their relationships grow closer, or if other underlying variables cause people to grow closer and to talk more. By unpacking different kinds of relationships, including kin and non-kin, frequent contacts and less frequent contacts, and new ties, as well as controlling for communication via other channels, I am accounting for many other possible causal factors, but the study design cannot completely demonstrate causality.

This study focuses on tie strength at the dyad level, and raises questions about the downstream consequences of interactions with these dyads. How are individual well-being outcomes, such as social support, happiness,

and loneliness related to Facebook communication patterns? Does passive consumption of a large social circle's content increase feelings of social support just as it is linked to increases in tie strength with specific friends here? Or does directed communication become more important to maintaining many relationships and their aggregate benefits? In the next study I explore these issues.

4. Who, what, where: Individual well-being and dimensions of Facebook use

4.1. Introduction

The social web has emerged in the midst of a decline in Americans' community involvement and number of close friendships (McPherson et al., 2006; Putnam, 2001). Hundreds of millions of people connect online, but they appear to have fewer confidants and trust each other less than did previous generations. This puzzle has been explained in part by the rise of television as the predominant form of entertainment (Putnam, 2001), but several studies implicate the internet. Declines in social resources are greatest among those with higher educations and incomes, namely, the technology adopters (Hampton et al., 2009; McPherson et al., 2006; Nie, 2001). More extensive use of the internet has been associated with declines in off-line communication with friends and family (Kraut, Rice, Cool, & Fish, 1998a; Shklovski et al., 2004), reductions in self-reported social capital, and increases in levels of stress, depression, and loneliness (Bessière et al., 2008). Wellman and colleagues describe "post-familial families" who interact with their devices more than each other (Wellman & Hogan, 2006). Other research, however, has shown that internet users have better social integration than do non-users (Hampton et al., 2011; Valenzuela, Park, & Kee, 2009) and that online interaction promotes prosocial behavior, including a sense of community (Ellison et al., 2007; Steinfield, Ellison, & Lampe, 2008), emotional support (Galegher, Sproull, & Kiesler, 1998; Shaw, Mctavish, Hawkins, Gustafson, & Pingree, 2000), even voting turnout (Bond et al., 2011). The connection between the internet and social well-being is complicated, and is only beginning to be understood.

One of the reasons for conflicting accounts of social technology's impact on well-being is that the social web is often treated as a monolith: All the time people spend online interacting with people is considered "social" and is simply compared to "non-social" online activities like watching videos, reading the news, or playing solitaire. However, the "social" category encompasses a wide variety of activities, and each may have a different effect on well-being (Burke et al., 2011; Burke, Marlow, & Lento, 2010b). Gossiping with close friends over chat, posting photos from a family reunion, and reading about acquaintances' enviable new jobs and love lives are performed through the same basic technology, but may induce intimate bonds or jealousy and loneliness.

Therefore, a much more detailed examination of social technology use is called for, particularly one of social network sites, which support a variety of uses and users. This study focuses on three dimensions of social network site use and the interaction between these dimensions and individual well-being outcomes, such as social support, happiness, bridging social capital, loneliness, and health. The first dimension of SNS use is

what people are doing on the site, including talking one-on-one with friends, passively consuming many ties' news, and broadcasting updates to a wide audience. The second dimension is with whom they're interacting: strong and weak ties provide different benefits. The third dimension shaping the effect of SNS use on well-being is individual differences in users, such as personality traits, social skills, or exogenous events such as losing a job. All of these dimensions color the effectiveness of a social platform for supporting its users' happiness and social support.

In this chapter, "well-being" refers to a portfolio of outcomes, including perceived social support, bridging social capital, happiness, loneliness, depression, positive and negative affect, stress management, and health. Though the outcomes have different antecedents and consequences, for the purpose of this research they share a common component: they are all bellwethers of individual well-being. The focus of the present chapter is social capital and social support, but the other outcomes are singled out where theory predicts different effects and are generally included as robustness checks. Section 4.4.2 describes these measures in more detail.

4.2. Social capital and social support

When individuals form relationships with others, networks of mutual trust and reciprocity are generated, and these networks facilitate benefits that would not otherwise be possible, a phenomenon known as social capital (Bourdieu, 1986; Coleman, 1988; Lin, 2002; Putnam, 2001). Social capital derives from one's position in a social network and the number and character of the ties one maintains (Burt, 1995; Wellman & Wortley, 1990). One's connections comprise a spectrum of closeness from parents to near-strangers, and Granovetter defined this closeness as tie strength, the "combination of the amount of time, the emotional intensity, the intimacy (mutual confiding), and the reciprocal services which characterize the tie" (Granovetter, 1973).

Subsequent empirical work has demonstrated benefits to both "weak" and "strong" ties. Having a large network of diverse, weakly connected ties provides access to novel information about jobs and other topics, because one's closest friends are likely to have only redundant information (Granovetter, 1973). Strong ties tend to be similar to each other, get their news from the same sources, and share that information with each other (Marsden, 1987), so having weak ties who travel in different social circles exposes us to new ideas and opportunities. Information gain is particularly likely when an individual is the sole bridge between different communities (Burt, 1995). In *Bowling Alone*, Putnam (2000) refers to this dimension of relationships as "bridging social capital" and pointed to its ability to generate broad, community-based identities and generalized reciprocity, or a willingness to help someone with the expectation that someone else will return the favor in the future. Examples of settings in which bridging social capital is generated include bowling leagues, local parks where regular dog walkers recognize each other, and churches that cross class lines.

Bridging social capital is developed through our relations with acquaintances, and through them we are exposed to diverse perspectives, new possibilities, and access to external assets. These weak ties are the connective tissue of networks: removing them causes the whole network to collapse (Onnela et al., 2007), leaving individuals in small, narrow-minded (but tightly knit) clusters with no external exposure.

In contrast, strong ties such as family members and good friends provide what Putnam terms bonding social capital (Putnam, 2001), and is more generally referred to as social support. Social support is the provision of psychological and tangible resources by others in the network, including instrumental, informational, and emotional support (Cohen et al., 2004), with different relationships providing different resources (Wellman & Wortley, 1990). Instrumental support encompasses financial aid or help with tasks, such as parents providing a car loan to their child or a neighbor providing a ride to a medical appointment. Informational support refers to guidance with personal problems, such as medical advice between members of a cancer support group, or exposure to new ideas, such as when workers from one organization learn new techniques by visiting another plant. Emotional support includes expressing empathy and providing opportunities to vent with trusted friends. Strong-tie relationships generate social support and companionship as well as specific reciprocity, an expectation that each will help the other (Wellman & Wortley, 1990).

Numerous studies have documented the relationship between these dimensions of social support and health outcomes, both psychological and physical (e.g., (Cohen et al., 2004; House & Landis, 1988; Schaefer, Coyne, & Lazarus, 1981)). People with more diverse ties get fewer colds (possibly because their immune systems are more robust from exposure to a variety of people), recover faster after a stroke, and are generally in better physical health, even after controlling for socioeconomic status, demographics, and level of medical care (Putnam, 2001). Social support is often seen as a buffer, allowing an individual to cope with stress (Cassel, 1976; Cobb, 1976; House, Kahn, McLeod, & Williams, 1985), through the perception that others—even one close tie—will provide aid when needed (Cohen, 2004). Perceived social support, particularly emotional support, is associated with lower levels of anxiety, distress, and depression (Cohen & Wills, 1985). Social support is also believed to have a direct effect on health outcomes, not just serve as a buffer of stress, because it promotes positive psychological states such as positive self-esteem and satisfaction with life (Bargh, McKenna, & Fitzsimons, 2002; Diener, 2000), and this positive affect triggers positive physiological responses such as enhanced immune function or suppressed neuroendocrine response (Cohen et al., 2004; Uchino, Cacioppo, & Kiecolt-Glaser, 1996). Putnam summarizes the health benefits of social relationships: "if you belong to no groups but decide to join one, you cut your risk of dying in half. If you smoke and belong to no groups, it's a toss-up statistically whether you should stop smoking or start joining" (Putnam, 2000, p. 331).

Social support is often divided into two forms: perceived and received (Barrera, 1986). Perceived support refers to the potential access to support from a network of ties, and is a more abstract and subjective concept, while received support is the receipt of tangible and informational resources, typically in response to stress

and over a specific timeframe (Barrera, 1986; Cohen, Mermelstein, Kamarck, & Hoberman, 1985; Uchino et al., 1996). They are statistically interrelated but conceptually different processes, with different antecedents and outcomes (Uchino et al., 1996). In particular, perceptions of support are more strongly predictive of well-being and improved health, including cardiovascular health and lower mortality rates (Cohen et al., 2004; House et al., 1985), while received support is not, with some received support linked to negative outcomes, such as resentment and increased stress arising from "unhelpful" support (Wortman & Lehman, 1985). Some scholars point to early childhood experiences as the source of perceived social support—that parental warmth and early trust in the familial safety net casts "long shadows" into a person's adulthood, creating a disposition to believe that others are supportive and accessible (Sarason, Sarason, & Shearin, 1986; Uchino et al., 1996). Perceived support may be more closely tied to an individual's optimism or trusting nature, rather than being an accurate measure of one's resources. We will return to these differences.

Different kinds of ties provide different kinds of support. As Wellman and Gulia (1999) put it, "kith and kin are not relics from a pastoral past, but are active arrangements for helping individuals and households deal with stresses and opportunities." Neighbors are helpful for babysitting and lifting heavy furniture, but they don't necessarily like each other and are not committed for the long term (Litwak & Szelenyi, 1969; Wellman & Wortley, 1990). Extended kin are committed for life, but may live far away and cannot provide a ride to the airport at 5am. However, they can provide emotional support over the phone and help discuss major life decisions. Friends impart companionship and advice. Rather than having a uniform network of support-givers, people have specialized ties, and they must invest energy in maintaining these different relationships (Wellman & Wortley, 1990). This energy takes the form of communication with the tie. Communication is the "stuff" of relationships—it holds them together and causes them to grow stronger (Berscheid & Reis, 1998; Duck, 2007). People prefer to talk to those they like, and that interaction increases familiarity and positive affect, leading to further liking and interaction (Homans, 1973). People reveal more personal information about themselves in emotionally close relationships, and giving or receiving disclosure increases relationship closeness (Collins & Miller, 1994). They share day-to-day details of their lives and pass time (Duck et al., 1991; Parigi & Bearman, 2005).

An open question in communication research is whether communication requires action by both parties for the generation of social capital and other well-being outcomes like happiness. Frequency and intimacy of communication exchanges are classic markers of tie strength (Granovetter, 1973), but do people actually have to talk for the exchange to be effective? Is it enough to simply keep track of what others are up to, without directly engaging them? People can come to like others simply by seeing them multiple times (Moreland & Zajonc, 1982; Zajonc, 1968), and they can feel good about themselves by simply reflecting on meaningful relationships (Steele, 1988), so it is possible that simply monitoring others' lives can increase feelings of self-worth and social connection. One of the key outcomes of bridging social capital, exposure to novel information, may not require directly engaging the providers of that information, just keeping track of what

they make public. However, people routinely overestimate others' happiness (Jordan et al., 2011), and passively following ties may lead to negative social comparison, in which individuals evaluate themselves relative to their friends (Festinger, 1954). Feeling that one's friends are happier or have more fulfilling lives could stimulate feelings of loneliness or reduced self-worth. To determine whether passively tracking friends' lives is sufficient for stimulating a sense of connectedness and well-being, the present study compares the well-being experienced by individuals doing different amounts of active communication with friends and passive consumption of their friends' social news.

> *Research Question 1: How do active communication and passive consumption compare in their association with individual well-being? Is passive consumption sufficient to maintain social capital and social support, or is more active communication required?*

Before delving into the question of the relative effects of active communication and passive consumption, we will first consider the platform on which these activities take place: modern social networking sites.

4.3. The role of social technology

The research just reviewed identifies gaps in the basic research literature on how communication influences social support. Research conclusions on the impact of internet communication are much less clear. The next sections summarize important open issues relating to internet use, social capital, and well-being.

Much early research agued that computer-mediated communication was less rich than phone and in-person communication (Sproull & Kiesler, 1986), required more effort to produce (Brennan & Ohaeri, 1999; Clark & Brennan, 1991), and was subject to misunderstanding (Kiesler & Sproull, 1992; Kruger et al., 2005). Therefore users should have difficulties maintaining social ties over the medium. Empirical research shows that on average, ties developed online are indeed slower to develop than those developed in person (Walther & Parks, 2002) and are weaker (Parks & Roberts, 1998). If people used the internet primarily to support the superficial relationships suggested by this story, then heavy internet users would become less involved with others in person and would lose social capital. Accruing large networks of virtual friends could undermine connections to real ones (Nie, 2001). Like television, the internet could drive people indoors, away from the casual, face-to-face interactions that build social capital (Putnam, 2001).

However, these findings do not tell the whole story, because people typically combine off-line and online communication. People most frequently use the internet to communicate with those whom they have existing off-line relationships and talk to them using a variety of media, not just the internet (Boneva et al., 2001; Haythornthwaite & Wellman, 1998; Williams, 2006). Internet communication is especially useful to social relationships that are threatened by distance (Shklovski, Kraut, & Cummings, 2006; 2008). American Facebook users have approximately 229 friends, 22% of whom are from old high schools, "dormant"

relationships revived through the site (Hampton et al., 2011). Even among relationships initiated entirely online, there is clear evidence that people can develop very strong ties, with the route often migrating to phone calls and in-person meetings (McKenna, Green, & Gleason, 2002).

Wellman and colleagues crystallized the debate with the paper, "Does the internet increase, decrease, or supplement social capital?" (Wellman, Haase, Witte, & Hampton, 2001). Cross-sectional research shows that compared to light users, people who use the internet heavily, especially for social purposes, have better social integration. For example, heavier users participate more in organizations and are in more frequent contact with friends and relatives (Wellman et al., 2001). Teenagers who use instant messaging heavily spend more time off-line with existing friends and have better quality friendships (Valkenburg & Peter, 2007). Bloggers are 95% more likely to have discussion partners of other races, and those who use online photo-sharing sites are 61% more likely to have a friend from a different political party (Hampton et al., 2009). However, some internet users exhibit pathologies similar to gambling addiction, resulting in lack of sleep and disrupted personal relationships (Young, 1998). Lonely and depressed individuals who prefer to express themselves online feel increased psychosocial distress (Caplan, 2003).

Many of the contradictions that arise from this line of research are due simple changes in the internet over time. In the early days of the internet, people were using desktop machines to talk with strangers and offline social norms constrained its use (Kraut et al., 1998b). However, "an Internet year is like a dog year, changing approximately seven times faster than normal human time" (Wellman, 2001). Now, a social layer pervades the web and two-thirds of smartphone owners access the internet on their phones daily (Smith, 2011). New technology is often met with the cries of social scientists questioning its repercussions (Baym, 2009), so the discussion here is not a new one. However, I argue that social network sites are different because they are based on an underlying network of mutual obligation and trust. They blend the benefits of both worlds—online and offline—and change the ways in which we interact with close friends, acquaintances, and strangers.

4.3.1. Social network sites

Social network sites (SNS) like Facebook, Google+, and MySpace play a different role than the social media that came before them. They are microcosms of the internet and all its services, embedded in a network of mutual trust and obligation. SNS users can send private messages (like email), chat synchronously (like instant messenger), share photos (like Flickr, Picasa), post news (like Twitter), meet people with similar interests (like Google Groups), read social news (like blogs and news sites), and play games. Unlike the general web, however, all of these interactions take place within a layer of relationships, in which user's friends serve as tacit enforcers of good behavior and honesty (Donath & boyd, 2004). Unlike discussion groups where strangers with shared interests interact under aliases, or email, which is private to the sender and receiver, SNS communication is largely visible to others on the site, and these others know the communicators in an offline context. Facebook and Google+ require real names on user accounts, so profiles

are linked to permanent, authentic identities. Anonymity and pseudonymity have been linked with social disinhibition, such as trolling and flaming (Lea, O'Shea, Fung, & Spears, 1992), though the effects are often small, e.g. (Hiltz, Turoff, & Johnson, 1989), and the real-name policy has been controversial among users who prefer to keep their online personalities separate from their offline lives (Carmody, 2011). The connection between online and offline identities, as well as the variety of communication modes available through SNS set them apart from previously studied forms of computer-mediated communication.

The Pew Internet and American Life Project documents the rapid growth of SNS from 8% of American adults in 2005 to 65% in 2011 (Madden & Zickuhr, 2011). Facebook is not just for weak ties, either; Pew reports that 40% of SNS users have all of their close confidants as Facebook friends, up from 29% in 2008 (Hampton et al., 2011). More than 800 million people actively use Facebook, half of whom log on to Facebook on any given day, and the site is read in 70 languages (Facebook, 2011). While the skyrocketing adoption rates strongly indicate the importance of research on SNS, the sites also have features that set them apart from the majority of sites studied in the past, and there is both theoretical and empirical evidence to suggest these features affect interpersonal relationships and aggregate social capital.

One key feature of SNS is the personal profile, which contains carefully curated information about the self alongside a list of friends and less controllable artifacts of one's interactions with those friends. Figure 1 shows a typical profile. The profile is an act of impression management; when presenting ourselves to others, we seek to emphasize some aspects and downplay others (Goffman, 1966). In his hyperpersonal model, Walther (1996) describes "[computer-mediated communication] that is more socially desirable than we tend to experience in parallel [face-to-face] interaction." SNS provide users with time to select which pieces of themselves they want to display, such as their current thoughts, flattering portraits, and favorite books, and the display is editable at any time. Privacy settings allow users to craft different versions of themselves for different audiences, so parents see their child's book list and friends get the party photos. This selective packaging of self is no surprise to SNS users; they are aware of their multiple audiences and cater to them (Marwick & boyd, 2011). Profile elements that require real-world validation and effort to acquire, such as a large number of friends, a university email address, or an attractive photo, are considered more credible than elements that can be filled in with little effort, such as a favorite book or band (Donath, 2008; Walther & Parks, 2002). In the early days of Facebook, Lampe and colleagues (Lampe et al., 2007) demonstrated that college students who included verifiable real-world information in their Facebook profiles, such as their hometown or high school, had more friends, and argued that the fields aided people in finding their existing friends and trusting new acquaintances. Lab studies confirm that strangers are more likely to initiate friendships with individuals with attractive profile photos, and that having no photo is better than an unflattering one (Wang, Moon, Kwon, Evans, & Stefanone, 2010). Like users of SNS, online daters construct improved versions of themselves in their dating profile, though expectations of in-person interaction keep profile creators from egregious lies about their weight, height, or age (Hancock et al., 2007). Instead, they

Figure 1. Facebook profile.

portray themselves as they could be with a quick diet or heels. Many individuals who feel hindered by physical appearance or social skills when interacting face-to-face use their online profiles express the "real me" and are better able to form close relationships online (Amichai-Hamburger, Wainapel, & Fox, 2002; McKenna et al., 2002). Online profiles are expressions of selective self-presentation.

In addition to being intentionally composed, static representations of oneself, SNS profiles are archives of interactions with others. Relationship confirmations, appearances in others' photos, and comments from friends comprise the majority of the profile, in a region known on Facebook as the Wall (or Timeline). Because they come from other people, these signals are inherently more trustworthy indicators of one's identity and social worth (Donath, 2008; Donath & boyd, 2004). Looking at one's own Facebook profile stimulates feelings of self-worth, positive affect toward the self and others, and reduces defensiveness, by reinforcing important attributes of the self and important social relationships (Toma, 2010). However, the information deposited on one's profile by others is less controllable. As Walther and colleagues write, "This makes participative social networking technologies different from Web pages, e-mail, or online chat because all those technologies allow the initiator complete control over what appears in association with his- or herself. The possibility that individuals may be judged on the basis of others' behaviors in such spaces prompts this question: Are we known by the company we keep?" (Walther, Van Der Heide, Kim, Westerman, & Tong, 2008). The answer is yes; profile owners are judged to be more physically attractive when their friends' photos are attractive, and more competent and socially attractive when friends leave complementary, pro-social comments on the profile (Walther et al., 2008).

Another key feature of social network sites is an aggregated stream of social news about all of one's ties, known as the News Feed on Facebook (see Figure 2). The stream contains a constantly updated list of ties' recent activity, including their photos, favorite links, and conversations with other friends. These short updates allow individuals to keep tabs on many ties at once, without the greater effort and imposition of an email or phone call. Facebook users take advantage of the News Feed to observe much larger numbers of ties than the small cluster they actively communicate with (Backstrom et al., 2011; Kluth, 2009; Marlow, 2009). Similar "social awareness feeds" (Kivran-Swaine & Naaman, 2011; Naaman et al., 2010) exist elsewhere on the web, notably Twitter. However, Facebook's feed is unique in that its contents are from ties with whom a relationship has been mutually agreed upon, and those ties come from a larger user base more likely to contain one's closest friends and family. By contrast, other microblogging platforms like Twitter allow pseudonymity and promote a celebrity-follower norm (in which many ties are one-sided). Both Twitter and Facebook have been credited with catalyzing information flow during the "Arab Spring" of early 2011 (Pollock, 2011), promoting one form of bridging social capital: information diffusion. However, it's unclear whether streams of social news (even news from one's close friends) are sufficient to generate bonding social capital or social support, and so the present research addresses this issue.

Figure 2. News Feed with stories about one's Facebook friends.

Researchers at Michigan State University began the first investigations into the relationship between social networking sites and social capital (Ellison et al., 2007; Steinfield et al., 2008). Surveying undergraduates about their Facebook use and social capital, they found that students who use the site more heavily have higher levels of social capital. General internet use did not show these effects. Burke and colleagues followed these analyses by pairing behavioral data from Facebook's servers with social capital surveys, this time identifying different types of Facebook activity associated with social capital (Burke et al., 2011; Burke, Marlow, & Lento, 2010b). They found that Facebook users generally have high levels of both bridging and bonding social capital, but that bonding does not appear to change with Facebook use, and bridging requires active maintenance of one's social network—people have to talk to each other to feel that they can take advantage of their ties' resources (Burke, Marlow, & Lento, 2010b).

The present work expands on this line of research in several ways, discussed below. It is a more detailed approach that takes into account the type of communication, the communication partner, and individual differences in users.

4.3.2. Communication type

A central focus of this dissertation is the difference between targeted, one-on-one exchanges, wider broadcasts with larger circles of friends, and more passive "monitoring" of ties' news. The first activity, **directed communication with individual ties** consists of personal, one-on-one exchanges, such as private messaging or "liking" a tie's update. In each of these actions, one person singles out another and performs a communication action that gets the other's attention. Drawing on Lin's (2001) resource-based theories of social capital, Ellison and colleagues (Ellison, Vitak, Grey, & Lampe, 2011b) refer to these kinds of activities as "signals of relational investment." Each action increases the sender's expectations of future reciprocal actions: If I press the "Like" button by your cute cat video today, you may invite me to a party next week or leave a message on my wall next month. These one-on-one actions also signal relationship value to the recipient: it takes more effort to send a personalized message to a tie than to post a generic message to a wide audience, and so directed communication indicates that the recipient is worth the effort. Therefore, both sending and receiving directed communication should be associated with increases in well-being, and receiving should have an effect over and above that of sending.

> *H1a. Directed communication predicts increases in well-being.*
>
> *H1b. Receiving directed communication predicts greater increases in well-being than does sending directed communication.*

Directed communication itself takes many forms, which vary in their effort and content, and thus may differentially affect well-being. The social web provides "one click" interaction, such as Facebook's "Like" button or Google's "+1" button to indicate positive feedback, "favoriting" a tweet, or sending an emoticon

on an online dating site. Such actions may reduce the cost associated with maintaining social capital because they require little premeditated thought and allow users to "ping" many ties quickly and efficiently. Yet because they require less effort, they may not signal relationship value as clearly as a longer, more "composed" communication such as a private message or wall post, which takes more time to write. One-click communication is a one-size-fits-all approach to tie maintenance, and because it is content-less, it cannot contain the language associated with strong-tie relationships and social support. By being focused on a single recipient, composed content is tailored for the recipient and the context of her relationship with the sender. Simply because it has content, "composed" communication is more likely than "one-click" actions to have personal disclosure and supportive language, characteristics of close relationships and social support (Berscheid & Reis, 1998; Collins & Miller, 1994). The "like" button does not disclose anything (aside from an interest which may be revealing, but not in the way a longer message would be). By virtue of having content, receiving "composed" pieces should be associated with greater increases in well-being than "one-click" communication.

H2. Receiving "composed" directed communication is associated with greater increases in well-being than is receiving "one-click" directed communication.

Interactions on Facebook take place in two general venues: the private inbox, and the semi-public wall. (Here, "public" simply means viewable to multiple people, typically all of one's Facebook "friends," though the exact number depends on one's privacy settings. Wall posts across individuals are then aggregated and displayed as a stream in the News Feed, to be viewed by many other friends. Public exchanges signal the reliability of one's claims because they are made in front of a network of friends who implicitly enforce truthfulness and good behavior through the threat of reputation loss (Donath & boyd, 2004). Writing on a friend's wall, then, is a public declaration of friendship, while private inbox messages lack this avowal. Recall that social capital is not a dyadic phenomenon; capital is generated by networks of mutual trust and responsibility (Coleman, 1988; Putnam, 2001). Therefore, communication exchanges that take place publicly may be more likely to activate networks of relationships necessary for social capital growth. Semi-public exchanges such as wall posts are displayed to a wide audience of ties on Facebook via the News Feed, where those ties can then comment on the original post. In this way, semi-public interactions draw in a wider circle of ties. Though they did not explicitly test semi-public and private communication, Ellison and colleagues find that perceived bridging social capital gains on Facebook are greatest for individuals with fewest actual friends on the site, and surmise that the benefits may come from visibility to friends-of-friends (Ellison, Vitak, Grey, & Lampe, 2011b).

Yet semi-public exchanges may be susceptible to the least-common-denominator phenomenon: Posters often water-down their semi-public exchanges so that they are appropriate for all audiences (Donath & boyd, 2004; Hogan, 2010). Public messages therefore may lack the emotional support or personal disclosure that could be

revealed in a private message. Therefore, it is not clear whether communicating semi-publicly or privately would be better, but they should have different associations with well-being.

H3. Semi-public and private directed communication will have different associations with well-being.

In contrast to the directed communication actions previously described, Facebook users participate in two other classes of activities: **broadcasting** of personal social news, such as status updates and photo sharing, and **passive consumption** of others' broadcasts, profiles, and the stories of their activities with others. These classes of activities are not focused between a single sender and receiver, and so are less likely to be rich in relationship-maintaining behaviors that characterize directed communication. However, they may still be valuable for maintaining a large network of relationships. Broadcasts require little effort to produce (per capita readership), and the News Feed facilitates keeping track of a large number of friends. Skimming a new tie's profile provides material for conversational grounding and information about mutual interests, which increases liking (Hancock et al., 2008). For these reasons, it is plausible that creating and consuming undirected messages, allowing users to keep in touch, will lead to improvements in social capital and other well-being outcomes like loneliness.

On the other hand, passively consuming others' social news may lead to social comparison, in which individuals evaluate themselves relative to their friends (Festinger, 1954). The popular press decries Facebook "status envy," or feeling lonely by comparison (Armstrong Moore, 2010, Copeland, 2011), and researchers have found empirical evidence that people routinely overestimate others' happiness (Jordan et al., 2011). Therefore, the consequences of passive consumption and its flip-side, broadcasting, are less clear.

RQ2. Over and above the effects of directed communication, how do passive consumption and broadcasting relate to well-being?

4.3.3. Communication partner

Facebook enables communication with a myriad of friends. Communication type and partner are often intertwined; sending frequent, personalized messages is a characteristic of close-tie relationships (Gilbert & Karahalios, 2009), while generic broadcasts are a way to keep up with a large network of acquaintances (Ellison, et al., 2007). However, communication type and partner can be examined separately.

Communicating online with strong ties can lead to improvements in well-being (e.g., declines in depression symptoms) typically associated with emotional support, while communicating with strangers online does not deliver this benefit (Bessière et al., 2008; Bessière, Kiesler, Kraut, & Boneva, 2004). Adolescents who communicate with strangers online have lower levels of life satisfaction while those who talk to strong ties are much happier (Valkenburg & Peter, 2007). Strong ties provide significantly more emotional aid, minor services, and companionship, as well as a broader array of social support than weak ties (Wellman & Wortley,

1990), and so interacting with strong ties should be associated with greater increases in social support than talking with weak ties.

> *H4. Receiving directed communication from strong ties will predict greater increases in well-being than will receiving directed communication from weak ties.*

In contrast, weak ties on the internet seem to be especially valuable for getting informational support, for example on how to deal with a disease (Eysenbach, Powell, Englesakis, Rizo, & Stern, 2004) or to find resources before moving to a new location (Hiller & Franz, 2004), just as people do offline (Cummings, 2004). Though direct messages may most frequently be exchanged between strong ties, the impact of an occasional direct message to a weak tie may be crucial for maintaining a distant friendship long-term (Burke et al., 2011). Weak ties provide novel information, connections to more diverse perspectives, and reminders of connections to a wider community (Granovetter, 1973). Interacting with them should be linked with increases in bridging social capital (Putnam, 2001). Strong ties, with their redundant information and mutual friendships, should not provide this bridging benefit.

> *H5. Receiving directed communication from weak ties will predict greater increases in bridging social capital than will receiving directed communication from strong ties.*

4.3.4. Individual differences in users

Individual differences in users affect both well-being and their choice of activities online. While there are numerous differences between people, including personality, socioeconomic status, and cultural background, in this study, two exemplars of individual differences are considered. The first is a relatively stable individual characteristic: one's social communication skill. The second is an exogenous event: losing a job. Whether long-term or temporary, both factors may influence feelings of self-worth and social support and may drive people to use communication tools differently and moderate the impact of those tools on their well-being. The two differences are discussed in turn.

Social communication skill. When considering how people differ along inherent traits, research by Mikami and colleagues is instructive (Mikami, Szwedo, Allen, Evans, & Hare, 2010). They show that adolescents' social disposition at age 13–their peer status, positivity and negativity when interacting with classmates, and any delinquent behavior—predicts their online behavior on social networking sites nine years later. For example, those who were liked more by friends in adolescence had more friends on social networking sites, communicated with more friends and had more supportive messages from those friends nine years later. Rather than internet use influencing these young adults' social capital, this research clearly shows that stable social dispositions can account for the association between internet use and social capital.

Less socially skilled individuals may gravitate toward computer-mediated communication because it reduces social boundaries, and thus they might have more to gain from new media than their more socially connected

peers (Bargh et al., 2002). Social skill is a combination of verbal and nonverbal fluency with emotional control, expressivity, and sensitivity (Riggio, 1986). Each of these dimensions is likely to influence an individual's preference for different communication media and success using it. One dimension, social control—particularly perceived difficulty with self-presentation—has been linked to a preference for online social interaction, in which one believes that "one is safer, more efficacious, more confident, and more comfortable with online interpersonal interactions and relationships than with traditional [face-to-face] activities" (Caplan, 2005). Online channels allow greater control over self-presentation (Walther, 1996), and so individuals with social-control deficits manage their anxiety over social interactions by going online. However, Caplan suggests that this preference for interacting online fosters compulsive internet use that leads to negative outcomes, including missing work or getting in trouble at school (Caplan, 2005). On the other hand, studies of college students using Facebook indicate that those with lower self-esteem—which has a correlation of 0.57 with social skill (Riggio, Throckmorton, & DePaola, 1990)—gain more social capital than their peers with higher self-esteem (Ellison et al., 2007).

One explanation for the different outcomes experienced by social technology users with lower social skills is that it depends on what they are doing. Burke and colleagues find that adults with low social skills—those on the high-functioning end of the autism spectrum—have difficulty maintaining fledgling relationships developed online, in part because they have trouble deciding whom to trust, how much personal detail to disclose, and what social rules to apply (Burke, Kraut, & Williams, 2010a). They lack social capital because they are unclear how their own communication timing and content is perceived by potential friends. As a result, they are uncomfortable initiating interactions with others (performing "directed communication"). Instead, they prefer one-click actions (such as the "like" or "poke" buttons, or "smilies" in online dating sites) because those actions do not require thinking of what to say. Burke and colleagues also find that when individuals with low social communication skills spend time reading about ties on Facebook, and looking through those ties' photos and profiles, they feel increased bridging social capital, while individuals with higher communication skills are not affected by passive consumption (Burke et al., 2011). The differential effect of passive consumption on those with lower social skills may be because those who are uncomfortable in face-to-face social situations may have interacted less with friends and so are less aware of the friends' resources, or the information they glean online may catalyze future interactions.

The social challenges characteristic of autism and the social challenges of neurotypical adults may be caused by very different mechanisms (e.g. for autism, focus on details rather than the big picture, the need for additional processing time), but everyone, not just those with formal diagnoses of autism, falls somewhere on a range of social communication skill. Social communication skill gauges comfort with social "chitchat" and ability to recognize nonverbal signals (such as when a partner is getting bored) (Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001). The present study focuses on this trait because computer-mediated

communication levels the playing field, allowing people who are uncomfortable communicating face-to-face to have time to craft their self-presentation and their message.

An open question in this line of research is whether individuals with lower social communication skills do more of the "one-click" actions that don't require thinking of what to say, and whether they benefit more from one-click actions than do those with higher social communication skills. If compositions are fraught with social complexity for those with low social skills, one-click actions may have additional benefits for them:

> *H6. Individuals with lower social communication skills will experience greater benefits from one-click interactions than those with higher social communication skills do.*

Job loss. The second difference between individuals considered in the present study is job loss. Unlike social communication skill, job loss is caused by an exogenous shock, often involuntary, and causes major readjustment in a short period. Unemployment is linked to a multitude of psychological and physical problems including stress, depression, headaches, and suicide (Wanberg, 2011), and is one of the most intense life events requiring much time to accommodate (Holmes & Rahe, 1967). Beyond the financial hardship imposed by losing a job, individuals also lose daily structure, social contact, and shared goals with coworkers (Jahoda, 1938). These changes make job loss an acute stressor that can overtax one's coping abilities leading to psychological distress (Thoits, 1995). The current prevalence of unemployment also makes the issue timely. Unemployment in the United States and European Union are greater than 9% (Central Intelligence Agency, 2011). The focus of the present study is recent job loss rather than long-term unemployment, when the shock is still fresh and individuals are struggling to accommodate the change.

As previously reviewed, one's social network plays a critical role in the job search. Strong ties are less helpful because their leads are generally redundant. Instead, weak ties traveling in more diverse social circles are more likely to know of new job opportunities (Granovetter, 1973). Weak ties provide greater access to external resources, such as an "in" with a human resources department at a company that's hiring, and when individuals are connected to multiple disparate clusters, they are especially likely to gain from those connections (Burt, 1995; Lin, 2002). Motivated job seekers who put more time and effort into the networking aspect of their job search—tapping their informal connections for information—are more likely to find a job and receive more offers (Wanberg, 2011). Many job leads arise from "serendipity," simply talking to the right acquaintance at the right time (McDonald, 2010). Therefore, a tool like Facebook, which displays photos and news snippets from assorted acquaintances, may promote the serendipity and bridging social capital that facilitate reemployment. Recall that in Hypothesis 5, using Facebook to talk with weak ties is predicted to increase bridging social capital. There may also be an interaction between job loss status and talking with weak ties on Facebook, such that these weak-tie conversations may differentially increase bridging social capital for the newly unemployed.

H7. Individuals who recently lost a job will experience greater bridging social capital from talking with weak ties than will individuals who did not recently lose a job.

In addition to finding new employment opportunities, those who recently lost a job may be suffering higher levels of psychological distress and may be in need of additional support from loved ones. Social support alleviates perceptions of deprivation and economic anxiety about "getting by" and reduces the severity of many psychological and physical responses to unemployment (Gore, 1978; Wanberg, 2011). This form of emotional support typically comes from strong ties, including family and spouses (Wellman & Wortley, 1990). Strong ties provide financial support, assist with moving, and lend a shoulder to cry on. However, much research suggest that these ties are inept at providing the right kind of support in a personal crisis such as losing a job. Family members, who themselves haven't been affected by the crisis, make unhelpful statements pushing for recovery too quickly or become overly "helpful" with unwanted advice that elicits resentment from the receiver (Lehman, Ellard, & Wortman, 1986; Wortman & Lehman, 1985). Gender differences in coping strategies cause mismatches in spouses, where husbands tend to hide problems, give unwanted advice, and be bothered by their wives' emotional expressivity (Thoits, 1995). Furthermore, strong ties may push a person to move on too quickly because they themselves are inconvenienced by their friend's distress (Lehman et al., 1986). Though strong ties are typically the providers of emotional support, it is unclear how they will affect individuals who recently lost a job. These conflicting finding motivate the following research question:

RQ3. How does talking with strong ties affect those who have recently lost a job? How does their well-being change with strong-tie interactions?

In summary, this study examines the relationship between Facebook use and well-being, taking into account different uses of the site, different communication partners, and the individual differences in users, including social communication skill and job loss.

4.4. Method

To analyze the relationship between SNS activity and well-being, I conducted a three-wave panel survey of Facebook users beginning in early June 2011, with follow-up waves in early July and August 2011. The survey contained standard scales measuring indicators of well-being and questions about their relationships with a set of eight Facebook friends. Survey responses were matched to the server logs of the participants' activity on Facebook beginning one month prior to the first survey and concluding on the date of the last survey.

4.4.1. Participants

Participants (N = 10,557, 52% female) were recruited through a combination of Facebook ads and email invitations. The ad presentation and email message were targeted at English-speaking users around the world who had been active on the site in the previous 30 days, stratified by gender and Facebook use (number of

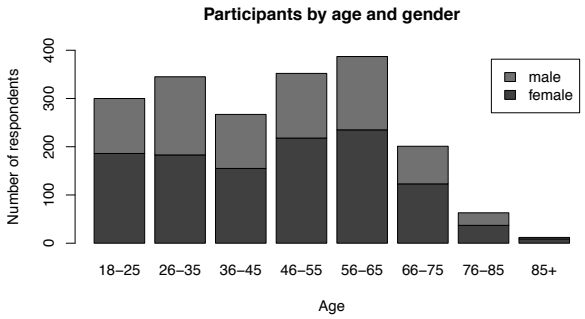

Figure 3. Survey participants by age and gender.

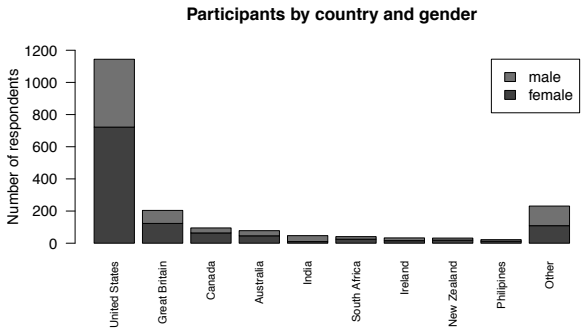

Figure 4. Survey participants were English speakers from 91 countries.

login days in the past month). A subset of participants, (n = 1927, 59% female), completed all three waves of the study. There are minor differences between dropouts and returnees in age (M = 41.2 and 46.2, respectively, $p < 0.001$) and gender (returnees were 8% more likely to be female, (χ^2 =32.5, $p < 0.001$), but they were no different in friend count, number of days on the site in the week before the survey, directed communication, passive consumption, or communication skill, so only participants who responded at all three time points are included in the analysis. Compared to a random sample of Facebook users, survey takers were older (M =46.2 vs. 29.9, $p < 0.001$), and 11% more likely to be female (χ^2 = 108.1, $p < 0.001$). They were heavier Facebook users, with approximately 70 more friends than the average user, about twice the likelihood of logging in during the week prior to the survey. Figures 3 and 4 presents participant demographics.

4.4.2. Survey content: Dependent variables

Participants completed an online survey of validated scales measuring aspects of well-being and social communication skill, described below. The constructs measured by each scale have different antecedents and consequences, but for the purposes of the present study they are treated as multiple indicators of well-being. All measures were scored using the mean of a 5-pt Likert scale, unless otherwise noted. These scales are generally referred to as "well-being variables" throughout this text. Table 1 presents the correlation between scales and the complete survey can be found in Appendix A.

Social support (ISEL) (12 items, scale alpha = 0.88, test-retest reliability = 0.76) is measured with the Interpersonal Support Evaluation List, assessing the functional components of social support (Cohen et al., 1985). The scale includes items such as "When I need suggestions on how to deal with a personal problem, I know someone I can turn to" and "If I needed some help in moving to a new house or apartment, I would have a hard time finding someone to help me." This scale is comparable to Putnam's concept of bonding social capital, and has been called that in previous work (Burke et al., 2011; Burke, Marlow, & Lento, 2010b;

Ellison et al., 2007; Williams, 2006). ISEL gauges perceived social support—the idea that support is available from one's network, rather than received support, reports of instances of support obtained in the past.

Bridging social capital (10 items, scale alpha = 0.87, test-retest reliability = 0.69) measures the extent to which an individual is connected to a wide variety of people and feels part of a greater community (Williams, 2006). Sample items include "Based on the people I interact with, it is easy for me to hear about new job opportunities" and "Interacting with people makes me interested in what people unlike me are thinking."

Happiness (SWL) (5 items, scale alpha = 0.86, test-retest reliability = 0.79) is measured with the Satisfaction with Life scale (Diener, Emmons, Larsen, & Griffin, 1985), and evaluates global life satisfaction, a component of subjective well-being. Sample items include "In most ways my life is close to my ideal" and "The conditions of my life are excellent."

Depression (CES-D) (10 items, scale alpha = 0.87, test-retest reliability = 0.78) measures current levels of depressive symptomology, particularly depressed mood (Radloff, 1977). Participants report how often in the last month "I felt depressed" or "I felt that everything I did was an effort."

Loneliness (8 items, scale alpha = 0.87, test-retest reliability = 0.80) measures the difference between a participant's desired levels of social connection and those she feels she actually has (Russell, 1996). Sample items include "I often feel isolated from others" and "I often feel that my relationships with others are not meaningful."

Positive and negative affect (PANAS) (5 items each, positive scale alpha = 0.82, test-retest reliability = 0.68, negative scale alpha =0.81, test-retest reliability = 0.71) taps a participant's mood on two independent scales (Watson, Clark, & Tellegen, 1988). Participants reported how often they felt "active," "inspired," (positive) or "hostile," "nervous" (negative) (among other items) in the past month.

Stress (PSS) (10 items, scale alpha = 0.87, test-retest reliability = 0.77) measures the degree to which situations in one's life are perceived as stressful (Cohen, Kamarck, & Mermelstein, 1983). Participants report

	Support	Bridge	Happy	Dep.	Lonely	Positive Affect	Negative Affect	Stress	Health	Social Comm.
1. Social support	1.00									
2. Bridging social capital	0.40	1.00								
3. Happiness	0.48	0.31	1.00							
4. Depression	-0.52	-0.26	-0.58	1.00						
5. Loneliness	-0.77	-0.44	-0.53	0.63	1.00					
6. Positive affect	0.44	0.44	0.45	-0.53	-0.51	1.00				
7. Negative affect	-0.39	-0.16	-0.43	0.73	0.49	-0.34	1.00			
8. Stress	-0.49	-0.26	-0.58	0.83	0.58	-0.55	0.76	1.00		
9. Health	0.27	0.17	0.39	-0.41	-0.28	0.34	-0.28	-0.37	1.00	
10. Social communication skill	0.46	0.35	0.28	-0.36	-0.51	0.34	-0.32	-0.38	0.18	1.00

Table 1. Correlation between well-being and social communication skill variables.

how often they felt in the last month "Unable to control the important things in my life" and "Difficulties were piling up so high that I could not overcome them."

General health (2 independent items) (SF-36) asks participants "In general, how would you describe your health" at two time periods: "Overall" (test-retest reliability = 0.79) and "In the past month" (test-retest reliability = 0.55) on a scale ranging from 1 (*poor*) to 5 (*excellent*). The monthly health reports are used in the present study.

4.4.3. Survey content: Independent variables

In addition to these dependent well-being measures, the survey included some independent variables measuring individual differences in participants, major life events, and questions about relationships with a small set of friends.

Social communication skill (10 items, scale alpha = 0.72) measures participants' comfort communicating in social situations. The items are one subscale of the Autism Spectrum Quotient (AQ) (Baron-Cohen et al., 2001). Sample items include "I frequently find that I don't know how to keep a conversation going" and "I find it easy to 'read between the lines' when someone is talking to me." Respondents answered on a 5-pt scale for consistency with the other scales, with 1 point was given to *agree* or *strongly agree*, 0.5 to *neither agree nor disagre*e, and 0 for *disagree* or *strongly disagree* (inverted for reverse-worded items). Scores were summed across the 10 items, so range from 0-10.

Tie Strength for a small set of ties was collected (full details can be read in Chapter 2). Briefly, participants were asked to select up to six Facebook friends that they feel closest to (with participants selecting a mean of 4.4 friends). "This might include people you discuss important matters with, really enjoy socializing with, or anyone else you feel especially close to." Hampton and colleagues (Marin & Hampton, 2007) have demonstrated these "name generators" successfully elicit one's closest ties. After participants selected close friends, the system randomly selected additional Facebook friends to bring the set total to eight. For each of the eight friends, participants then answered questions like "How close do you feel to X" and "Which of the following describe your relationship with X: Professional colleague / Romantic partner / Family / etc." (See Appendix A.) Though participants may have very strong ties who are not Facebook members, on a 7-point Likert scale ranging from 1 (*not close at all)* to 7 (*extremely close),* the median rating for the user-selected friends was 7, and the mean was 6.0, indicating that they were able to identify very strong ties among their existing Facebook friends. These ratings were used to train a model of tie strength across all participants' Facebook friends; see Section 4.5.5.

Major life events. Participants also reported whether any major life events had occurred in the previous month, as major life events have the potential to affect well-being (Holmes & Rahe, 1967). Major life events

were derived from the Social Readjustment Rating Scale (Holmes & Rahe, 1967), and included pregnancy or a new family member, a move to a new city, personal injury or illness, losing a job, getting a new job, marriage or a relationship reconciliation, a divorce or relationship breakup, and the death of a close friend or family member. Each was measured with a single binary value indicating whether the event occurred between survey waves. Surveys were identical across waves.

4.4.4. Behavioral log data: Independent variables

Site activity was collected for the participants beginning one month prior to the first survey through the date of the final survey, three months later. All variables were aggregated from server logs and were anonymized. These data are referred to as "activity variables" or "behavioral variables" throughout this text.

All activity variables follow heavy-tailed distributions and have variances larger than their means (see Table 2), and so are log-transformed (base 2, after adding a start-value of 1) to control for skew and then standardized by centering at the mean and dividing by the standard deviation. Activity variables were divided into four conceptual categories based on the nature of the interaction, described below. Within each category variables are highly correlated with each other and so are collapsed into a single composite scale representing the entire category. See Appendix C for correlations between activity variables.

Directed communication (**inbound** and **outbound**) consists of targeted, one-on-one exchanges between a user and a friend, such as a private message, a wall post, or a comment (see Table 2 for complete list). Photo tagging (in both directions) is also included in this category because a user identifies a single friend in a photo and that friend is sent a notification about the event. Directed communication is also separated into **"one-click"**" interactions, which occur when a friend presses a single button, such as "Like" or "Poke," and "**composed"** interactions, in which the friend composed some original text, e.g., a message or comment. Finally, directed communication can be **private** (only the recipient can see the content, which is the case for messages), or **semi-public**, which for this study means that the action was viewable by people other than the recipient (e.g., comments, likes, and wall posts, which can be seen by other Facebook friends). Public, here, does not mean the general public, simply people other than the sender and receiver.

Passive consumption is viewing and reading other friends' content, including News Feed stories clicked on, profiles, and photos. This scale measures the extent to which a user consumes content, but does not communicate with the friend about it.

Broadcasting is the wider-audience posting a user performs, including photo uploads and status updates. This scale includes anything that is not targeted at a single friend. While some users have privacy settings enabled so that their broadcasts go to a limited number of Facebook friends, these actions are still counted as broadcasting to distinguish them from the single-friend focus of directed communication.

Facebook activity scales and items	Median	Mean	Std. Dev.	Correlation with scale
Directed communication (out) (scale alpha = 0.70)				
Comments written‡ [a]	17.0	51.2	110.3	0.84
Likes† [a]	11.0	62.1	181.1	0.87
Messages written‡ [b]	4.0	22.4	81.2	0.59
Pokes†	0.0	7.0	46.8	0.42
Content (e.g., links) shared on friends' walls	0.0	1.4	7.9	0.29
Posts written on friends' walls‡ [a]	3.0	7.0	12.9	0.60
Photos tagged	0.0	8.6	36.3	0.30
Distinct people user sent direct communication to	26.0	45.3	62.5	0.80
Directed communication (in) (scale alpha = 0.72)				
Comments received‡ [a]	12.0	47.8	104.3	0.83
Likes received† [a]	14.0	53.6	127.1	0.83
Messages received‡ [b]	7.0	22.8	69.5	0.65
Pokes received†	0.0	8.1	51.4	0.42
Content friends saved on wall	0.0	0.8	2.7	0.39
Wall posts received‡ [a]	1.0	5.4	17.3	0.46
Photos tagged in	1.0	12.0	41.8	0.40
Distinct people user received direct communication from	24.0	40.4	57.5	0.78
Passive consumption (scale alpha = 0.58)				
Profiles viewed	130.0	333.9	657.6	0.91
News feed stories clicked on	22.0	75.9	284.6	0.53
Photos viewed	0.0	73.4	302.8	0.55
Distinct people whose content user consumed	58.0	112.8	168.2	0.83
Broadcasting (scale alpha = 0.51)				
Photos posted	0.0	2.0	4.5	0.49
Content posted to own wall	1.0	6.6	21.3	0.83
Status updates	2.0	7.8	20.0	0.83

† "One-click" communication ‡ "Composed" communication

[a] "Semi-public" communication [b] "Private" communication

Table 2. Descriptive statistics for participant activity variables for one month, averaged across three months' data. Composite scales were created for each section (e.g., "passive consumption") using log-transformed, standardized versions of these variables. Cronbach's alpha for composite variables and item-scale agreement (with transformed items) are listed.

The three main classes of Facebook use (directed communication, passive consumption, and broadcasting) were divided based on a functional taxonomy—directed communication actions are one-on-one, and both parties are aware of the exchange, while broadcasting and consumption are one-to-many (or many-to-one), and neither party is certain whether a specific other viewed certain news. A confirmatory factor analysas (CFA) was performed to further confirm that these classes of activities are legitimately distinct. Overall, three models were tested and a set of goodness-of-fit indicators were compared (see Appendix C). The first model had a single factor with all variables (χ^2=3944.0). The second model had two factors, one for all production

variables, such as messaging, status updates, and likes, and one for all consumption variables, such as photo and page views. This two-factor model performed better than the one-factor model (χ^2=2914.2, where lower is better; see (Roberts, 1999) for a discussion of CFA goodness-of-fit metrics). Finally, the three factor factor model (directed communication, passive consumption, and broadcasting) performs better than the two previous models (χ^2=2345.5). Though there may be many ways to distinguish classes of Facebook use, the three classes discussed here are empirically and theoretically distinct.

4.4.5. Method of analysis

To determine how site use relates to changes in well-being, a linear multilevel model with a lagged dependent variable was used with the following form:

$$Support_t = \alpha Support_{t-30} + \beta_0 DirectedComm_{(t-1\ldots t-30)} + \beta_1 Passive_{(t-1\ldots t-30)} + \beta_2 Broadcast_{(t-1\ldots t-30)} + \varepsilon_t$$

The model therefore measures *changes* in social support associated with the activity variables (directed communication, passive consumption, and broadcasting) that took place in the month between surveys. This form of autoregressive distributed lag model is common in econometrics and appropriate when the dependent variable is stationary (the mean and variance do not change over time, as is the case with the well-being measures) and model residuals are not highly autocorrelated. Lagged independent variables (site activity the previous month) are not included because they are highly collinear, and thus would produce biased estimates (Keele & Kelly, 2006). All continuous independent variables are centered at their means and standardized.

Unlike cross-sectional models common in survey research which simply measure correlation between the independent and dependent variables at a single point in time (e.g., (Ellison et al., 2007; Gilbert & Karahalios, 2009)), this is a far more conservative model, in effect controlling for an individual's previous level of social support and all of the unmeasurable factors that contribute to it. This model then reveals the relationship between the activity variables in the past month and changes in social support. While it is impossible to truly determine a causal relationship between the independent and dependent variables without a randomized assignment of participants—e.g., assigning a Facebook user's friends to not talk to her for a month, an obviously untenable option—this model is well suited for observational studies. By employing a three-wave survey, the study design also ensures that measured changes in the outcomes are not simply due to noise in the survey instrument, but rather due to meaningful changes in well-being.

For each participant, there are three observations of social support, and thus two observations of the "lagged" social support (the participant's social support value at the previous month). As observations from a single participant are not independent of each other, the model was grouped at the individual level, treating

participant as a random effect (not shown in the model above)[5]. Age and gender were included as controls. Country was not a significant predictor and so has been excluded from the models.

Each well-being variable (e.g., social support, bridging social capital, happiness) was regressed in a separate equation, and results are only considered significant if the pattern was observed in more than one well-being variable. The different well-being variables serve as robustness checks. For simplicity, only the results for social support are presented, but it is noted when others are also significant.

4.5. Results and discussion

Recall that the questions driving this work center on the effect of Facebook use on individual well-being. How do the different types of communication, different communication partners, and differences in individuals doing the communicating come into play?

4.5.1. Type of Facebook activity: Directed communication

First we examine different types of communication on the site, including directed communication (targeted, one-on-one exchanges), passive consumption (viewing without interacting), and broadcasting (posting news to a wide audience) and their associations with changes in social support. Table 3 presents two regressions with social support as the outcome. Both models control for age, gender, and social support the previous month, so the coefficients represent increases in social support. Model 1 includes three Facebook activities: directed communication, passive consumption, and broadcasting. Model 2 divides directed communication

	Model 1 Social support			**Model 2 Social support**		
	Value	SE	*p*-value	Value	SE	*p*-value
(Intercept)	3.80	0.01	0.00 ***	3.80	0.01	0.00 ***
Social support last month	0.74	0.01	0.00 ***	0.83	0.01	0.00 ***
Age (decades)	0.01	0.01	0.02 *	0.01	0.01	0.01 *
Male	-0.01	0.02	0.46	-0.00	0.01	0.68
Facebook activities						
Directed communication (both directions)	0.05	0.02	0.01 *			
Directed communication (in)				0.04	0.02	0.04 *
Directed communication (out)				-0.01	0.02	0.80
Passive consumption	-0.02	0.01	0.27	-0.01	0.01	0.42
Broadcasting	-0.01	0.01	0.32	-0.01	0.01	0.23
*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$	$R^2_{y,\hat{y}}$: 0.58			$R^2_{y,\hat{y}}$: 0.58		

Number of observations: 3854, Number of groups: 1927

Table 3. Model showing changes in social support associated with different Facebook activities. Model 1 shows that directed communication is associated with increases in perceived social support, while passive consumption and broadcasting are not. Model 2 separates directed communication into inbound and outbound, and shows that receiving has an effect in addition to the effect attributable to sending.

into its two directions: inbound and outbound, to determine the effect of them separately.

> Hypothesis 1a: Confirmed.
>
> Sending and receiving likes, pokes, messages, and other one-on-one actions on Facebook is linked to improvements in:
>
> - social support
> - bridging social capital
> - depression
> - loneliness
> - happiness (marginally)

Talking one-on-one with ties on Facebook is associated with improvements in social support and four other well-being measures. Beginning with Model 1, we see that directed communication (in both directions) is associated with increases in social support. The intercept value of 3.80 is the social support level (out of 5) for the average person in the sample (a 46 year-old woman who felt the mean amount of social support last month and who did the mean amount of directed communication, passive consumption, and broadcasting between surveys). Coefficients are additive. So, the coefficient on the lagged social support variable ($\beta = 0.74$) indicates that an otherwise identical woman whose social support last month was one point higher than average would have a current social support level of 4.54 (3.80 + 0.74). For every standard deviation increase in directed communication she participated in (approximately 60 additional comments and/or likes in the past month), her current social support level would be $\beta = 0.05$ points higher ($p = 0.01$). Significant results of similar magnitude were found for other well-being outcomes, including bridging social capital, depression (reductions), loneliness (reductions), and marginally for happiness[6]. Hypothesis 1a is confirmed. Appendix B contains the full statistical details. Discussion of the effects of passive consumption and broadcasting is postponed to Section 4.5.4.

Participants frequently mentioned feeling greater social connectedness and support when they received messages, comments, likes, and other kinds of directed communication.[7]

> *"he frequently comments on my stuff and I feel loved".*
>
> *"Better, definitely better. The support from close friends aswell as those not so close isjust fantastic. It is great to know that there are people who do TRULY care about you."*
>
> *"We have a shared interest. In response to a resource I mentioned, Dana has responded on a group thanking me and praising me for my help. I liked that. Don't know if it affects our relationship.... but it gave me increased street cred with the rest of that group."*

Respondents also initiate directed communication to let others know they care.

---

[6] Results for other listed well-being outcomes are statistically significant at $p < 0.05$ or better level unless noted. See Appendix B for complete tables with these outcomes.

[7] Open-ended quotes are included for illustration, but have not been systematically analyzed in the present study. Quotes have been edited for length but are otherwise in their original form. All quotes are in response to the question "Has Facebook affected your relationship with [tie name]?" or "Has using Facebook made you feel better or worse about any of these events?" after selecting major life events from the past month.

"my cousin who i adore but don't have alot of time for. for me time is always an issue and with fb it is always good to leave a quick post on her wall to let her know that i'm there for her."

"A poke...is very useful, saves me time to let him know that am mindful of him though far away"

Inbound versus outbound directed communication. Now turning to the right side of Table 3, we examine the two directions of directed communication separately: inbound and outbound. As seen in Table 4, inbound and outbound communication are highly correlated ($r = 0.91$). Sending a message to someone evokes norms of reciprocity (Sacks, Schegloff, & Jefferson, 1974), so outbound communication is likely to elicit inbound communication. Conversely, someone who does not initiate much conversation is less likely to be on the receiving end often. So this analysis is very conservative, examining the effect of receiving communication while holding outbound communication constant. We see that even holding outbound directed communication constant, inbound directed communication is associated with increases in happiness of $\beta = 0.04$, $p = 0.04$, confirming Hypothesis 1b. A post-hoc comparison shows no difference between the effects of inbound and outbound directed communication on social support ($p = 0.23$). So, put another way, it's likely that both sending and receiving messages, likes, and comments on Facebook are linked with feeling greater social support, and yet we see that being on the receiving end of those exchanges has additional benefits, over and above any effects attributed to a user's sending behavior. Facebook users who post content on their friends' walls every day will certainly elicit responses from their friends (comments, likes, reciprocal posts), and they will feel increased social support from receiving that attention over and above the feelings attributable to their own outbound posting behavior.

Hypothesis 1b: Confirmed.

Receiving likes, pokes, messages, and other one-on-one actions on Facebook is linked to improvements in:

- social support
- happiness
- bridging social capital (m)

regardless of sending behavior.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Directed communication (both)	1.00															
2. Directed communication (in)	0.98	1.00														
3. Directed communication (out)	0.98	0.91	1.00													
4. Passive consumption	0.76	0.72	0.76	1.00												
5. Broadcasting	0.78	0.75	0.77	0.65	1.00											
6. One-click (in)	0.86	0.85	0.83	0.60	0.67	1.00										
7. Composed (in)	0.91	0.94	0.84	0.69	0.72	0.73	1.00									
8. One-click (out)	0.81	0.76	0.83	0.60	0.61	0.91	0.64	1.00								
9. Composed (out)	0.91	0.86	0.93	0.74	0.72	0.73	0.87	0.69	1.00							
10. Semi-public (in)	0.90	0.92	0.83	0.68	0.77	0.78	0.95	0.66	0.83	1.00						
11. Private (in)	0.80	0.80	0.77	0.64	0.58	0.63	0.84	0.58	0.81	0.69	1.00					
12. Semi-public (out)	0.90	0.83	0.92	0.74	0.75	0.75	0.81	0.77	0.94	0.85	0.68	1.00				
13. Private (out)	0.78	0.74	0.78	0.62	0.56	0.61	0.77	0.57	0.85	0.65	0.89	0.67	1.00			
14. Dir. comm. (in) from strong ties	0.84	0.85	0.79	0.62	0.65	0.71	0.81	0.66	0.75	0.80	0.67	0.74	0.63	1.00		
15. Dir. comm. (in) from weak ties	0.92	0.94	0.86	0.69	0.73	0.81	0.90	0.71	0.82	0.89	0.76	0.79	0.71	0.67	1.00	
16. Dir. comm. (out) to strong ties	0.82	0.77	0.84	0.64	0.65	0.69	0.71	0.70	0.79	0.71	0.63	0.79	0.64	0.89	0.61	1.00
17. Dir. comm. (out) to weak ties	0.93	0.87	0.94	0.73	0.75	0.78	0.81	0.77	0.89	0.80	0.74	0.88	0.75	0.65	0.89	0.70

Table 4. Correlation between composite Facebook activity variables

Interpreting effect size. How should the magnitude of the coefficients be interpreted? They are small, but of practical and statistical significance. The well-being variables do not change much month-to-month, and so the vast majority of the variance in the model is explained by the lagged outcome variable. Social support, for example, is correlated across waves at $r = 0.76$. Therefore, only a small amount of variance is available to be explained by the time-varying activities.

In fact, the effect size of the Facebook activities is comparable to major life changes, as shown in Figure 5. Consider a participant who got married between surveys. Her social support score increased on average by only 0.02 points (which was not statistically significantly different from 0)[8]. A participant who experienced the death of a close friend or family member felt increases in social support of 0.04 points, $p = 0.05$, likely through the outpouring of emotional support from other friends of the deceased. Therefore, an increase in social support of 0.04 points—the amount explained by talking one-on-one with friends on Facebook—is substantial, and roughly equivalent in effect size to the impact of a death in the family or divorce.

Figure 5. Marginal changes in social support associated with Facebook activities compared to major life changes. Boxes represent the regression coefficient for that activity +/- SE.

[8] Controlling for major life changes did not improve any of the models like the one in Table 3, and so they are excluded from analyses except where noted.

4.5.2. Clicked versus composed

Hypothesis 2: Confirmed.

Receiving composed interactions such as messages and comments is linked to improvements in:

- social support
- bridging social capital
- happiness
- positive affect
- loneliness

And the effects are greater than for one-click interactions, such as likes and pokes.

Next, factors specific to directed communication are examined, including its amount of content and whether it was done semi-publicly or privately. "One-click" directed communication is inferior to "composed" communication, confirming Hypothesis 2. Likes and pokes are not equivalent to longer communication actions in their associations with well-being. Table 5 shows three models comparing one-click and composed actions on increases in social support and four other well-being variables. All three models control for social support the previous month, the age and sex of the participant, and other Facebook activities (passive consumption and broadcasting, for consistency across models). The first model examines composed actions, the second model examines one-click actions, and the third contains both. We'll focus on the third model. We see that individuals who receive "composed" directed communication, such as messages, wall posts, and comments, feel increases in social support ($\beta = 0.04$, $p = 0.01$), while one-click interactions such as likes and pokes are not associated with changes in support ($\beta = -0.02$, $p = 0.18$). A post-hoc comparison confirms that they have different effects; receiving composed interactions is better than receiving one-click interactions ($\beta = 0.06$, $p = 0.01$). Since the interpretation of pokes is ambiguous, a similar analysis was performed using only likes as the one-click variable (instead of the composite variable consisting of both likes and pokes), and results are qualitatively similar (with likes not statistically significant, $\beta = -0.02$, SE=0.01, $p = 0.21$). Composed actions, such as wall posts, messages, and comments are linked to greater

	Model 1 Social support			**Model 2 Social support**			**Model 3 Social support**		
	Value	SE	*p*-value	Value	SE	*p*-value	Value	SE	*p*-value
(Intercept)	3.80	0.01	0.00 ***	3.81	0.01	0.00 ***	3.80	0.01	0.00 ***
Social support last month	0.74	0.01	0.00 ***	0.74	0.01	0.00 ***	0.74	0.01	0.00 ***
Age (decades)	0.01	0.00	0.01 *	0.01	0.00	0.04 *	0.01	0.01	0.01 *
Male	-0.01	0.01	0.45	-0.02	0.01	0.27	-0.01	0.02	0.45
Facebook activities									
"Composed" directed communication (in)	0.03	0.01	0.01 **				0.04	0.02	0.00 **
"One-click" directed communication (in)				-0.00	0.01	0.85	-0.02	0.01	0.18
Passive consumption	-0.01	0.01	0.42	0.00	0.01	0.92	-0.01	0.01	0.53
Broadcasting	-0.01	0.01	0.44	0.01	0.01	0.54	-0.01	0.01	0.69
*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$	$R^2_{y,\hat{y}}$: 0.58			$R^2_{y,\hat{y}}$: 0.58			$R^2_{y,\hat{y}}$: 0.58		

Number of observations: 3854
Number of groups: 1927

Table 5. Models showing changes in social support associated with receiving one-click (e.g., likes and pokes) versus composed directed communication (e.g., messages, comments).

improvements in well-being than are one-click actions. Similar results are found for improvements in bridging social capital, happiness, loneliness, and positive affect. Respondents did not bring up differences between one-click and composed activities, with one exception:

> *"We don't speak as much. Facebook is detrimental to maintaining meaningful long-distance friendships by the ease of which it allows you to reduce what would ordinarily be the springboards of conversation to instead just clicking 'like'."*

These findings are consistent with resource-based theories of social capital (Lin, 2002), in that composed content takes more time to generate, and thus signals to the recipient that there are senders in her network that care enough to invest effort and attention to the communication act, and would thus be available to call upon in the future. Furthermore, composed content has the potential to be highly tailored for the recipient and may contain personal disclosure by the senders, features unavailable in the contentless clicks of the "Like" and "Poke" buttons. The differences are somewhat analogous to a hand-written postal letter and a blank postcard: both convey a "wish you were here" sentiment, but one took more effort and may be valued more. The length of the composed pieces is not included in the present analysis, so a comparison of longer and shorter composed pieces is left to future work. However, receiving many long, handwritten letters may increase one's perceived social support more than receiving empty postcards—the former suggests that there are strong ties in the network available to supply help when needed because they're willing to expend effort writing now.

4.5.3. Semi-public versus private

Now we compare directed communication that takes place semi-publicly (in front of other ties on Facebook, such as wall posts and likes) and those that are private (messages). The results are mixed. Semi-public and private exchanges do not differ in their relationship to social support. However, different effects of semi-public and private exchanges can be seen for happiness and bridging social capital, with opposite results. Table 6 shows that individuals who receive directed communication that is semi-publicly visible feel increases in happiness ($\beta = 0.08, p < 0.001$), while private messages are marginally associated with reductions in happiness ($\beta = -0.02, p = 0.08$). A post-hoc test confirms that the gains are greater for semi-public exchanges than for private ones ($\beta = 0.10, p < 0.001$). On the other hand, for bridging social capital, the opposite effect is seen: private messages are linked with increases in bridging social capital ($\beta = 0.02, p = 0.03$, see Table 7), while semi-public exchanges are not. Loneliness and positive affect show marginal trends, as well, with semi-public exchanges linked with reduced loneliness, but private exchanges linked to increased positive affect.

> Hypothesis 3: Confirmed.
>
> Semi-public and private exchanges are different from each other. Semi-public exchanges are linked to improvements in:
>
> - happiness
> - loneliness (m)
>
> While private exchanges are linked to improvements in:
>
> - bridging social capital
> - positive affect (m)

	Happiness		
	Value	SE	*p*-value
(Intercept)	3.47	0.01	0.00 ***
Happiness last month	0.79	0.01	0.00 ***
Age (decades)	0.01	0.01	0.06 ·
Male	0.02	0.02	0.36
Facebook activities			
Semi-public directed communication (in)	0.08	0.02	0.00 ***
Private directed communication (in)	-0.02	0.01	0.08 ·
Passive consumption	0.01	0.02	0.46
Broadcasting	-0.05	0.02	0.01 **

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.63

Number of observations: 3854
Number of groups: 1927

Table 6. Semi-public directed communication is associated with increases in happiness. Private directed communication is not, and is marginally associated with decreases in happiness.

These findings are inconclusive: They suggest that semi-publicly visible communication actions do differ from private messages in some circumstances, but the difference is not uniform and more research is needed to clarify their differences. Happiness and loneliness both improve with semi-public communication. These two outcomes are both cognitive evaluations of life. In the case of happiness, the scale measures global satisfaction with life (Diener, 2000), and for loneliness, a disconnect between the social relationships one desires to have and those he or she actually has. Therefore, one interpretation of these results is that communication enacted in the presence of others reminds individuals of their self-worth and meaningful relationships, consistent with the self-affirmation effect found when individuals look at their own profiles

	Bridging social capital		
	Value	SE	*p*-value
(Intercept)	3.77	0.01	0.00 ***
Bridging social capital last month	0.67	0.01	0.00 ***
Age (decades)	0.00	0.00	0.35
Male	-0.03	0.01	0.04 *
Facebook activities			
Semi-public directed communication (in)	0.02	0.01	0.23
Private directed communication (in)	0.03	0.01	0.01 *
Passive consumption	-0.02	0.01	0.05
Broadcasting	0.02	0.01	0.22

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.48

Number of observations: 3854
Number of groups: 1927

Table 7. Private directed communication (messaging) is associated with increases in bridging social capital. Semi-public directed communication is not.

(which contain all of their semi-public interactions) (Toma, 2010). Public exchanges are tacitly reinforced by an audience of mutual friends (Donath & boyd, 2004), and so may be more globally satisfying. However, it is surprising, then, that social support and bridging social capital do not increase with semi-public communication. Both trend upward, but the results are not statistically significant, $\beta = 0.02$, $p = 0.13$ (social support), and $\beta = 0.02$, $p = 0.23$ (bridging social capital).

On the other hand, bridging social capital is enacted through weak ties, dissimilar people with whom an individual may not regularly interact. Survey respondents frequently mentioned using private messaging as a substitute for email when they did not have a tie's email address, so perhaps the private messaging variable is really capturing inactive connections being activated for the first time. An analysis of the percentage of message recipients who are being contacted for the first time is outside the scope of this study, but strong ties infrequently communicate over private messaging (see Chapter 3).

> *"I interviewed him for a job once and used Facebook to reach out to him, since I didn't have his email address."*

> *"Actually, it's how he got my phone number. We met through a friend and he didn't get my number, so he sent me a facebook message the next day."*

Another interpretation for the increases in bridging social capital with private messaging is that weaker ties may be more likely to passively consume each other's content but not directly communicate, and so perhaps a private message—which contains some original, composed content—may be especially valuable in demonstrating that the relationship is actionable, that the recipient can count on the sender to serve as a bridge in the future. Previous studies have confirmed that bridging social capital is not directly a factor of the number of ties in one's Facebook network, but rather the number of "actual" friends (Ellison, Steinfield, & Lampe, 2011a) or communication partners (Burke, Marlow, & Lento, 2010b). Additionally, Facebook events, such as parties and political gatherings employ the private messaging feature—event organizers can contact guests with news, and the typical channel for these updates is private messaging (in addition to untargeted (broadcast) posts on the event wall). Events naturally bridge social circles, so perhaps these event messages are largely accountable for increases in bridging social capital.

4.5.4. Directed communication versus passive consumption and broadcasting

The previous analyses have all focused on directed, one-on-one communication between Facebook friends. Now we turn to one of the fundamental research questions driving this work: Do people have to talk to each other to feel connected, or is passively keeping track of each others' lives sufficient? So, we now explore the differences between directed communication and passive consumption. Recall that passive consumption consists of viewing and reading activities (e.g., looking at someone's profile or pictures) without communicating with the target. Targets do not know that anyone was looking at their content. Broadcasting is

also considered in the following discussion, as it is an efficient way to maintain a wide social circle by disseminating status updates and photos, and broadcast content is then passively consumed.

Passive consumption and broadcasting have little additional relationship to well-being, over and above the directed communication actions they evoke. Return to Table 3, Model 1, which considers the changes in social support with directed communication (both directions), passive consumption, and broadcasting. While directed communication is significantly associated with increases in social support, neither passive consumption nor broadcasting affect social support. Broadcasting has no significant relationship to any well-being variable (see Appendix B for regressions of all well-being outcomes), and in most cases, neither does passive consumption. When passive consumption does predict changes in well-being, it predicts worsening. For example, as Table 8 shows, passive consumption is linked to a β = -0.03 change in bridging social capital, $p = 0.04$, and the results are similar for depression, showing marginally significant increases in depression (β = 0.03, $p = 0.06$).

Research Questions 1 and 2:

Broadcasting has no effect over and above directed communication.

Passive consumption is linked to worsening of:

- bridging social capital
- depression (m)

The results indicate the importance of activating ties through directed communication. Consider two people, Alice and Brenda, who are identical in every way, including the amount of one-on-one conversation they have with friends on Facebook each month. Brenda, however, spends additional time looking at friends' profiles, photos, and status updates, but does not write to those friends. Despite viewing social news about a wide circle, Brenda does not feel additional social support from this passive consumption; in some cases she feels even less connected. The

	Bridging social capital		
	Value	SE	*p*-value
(Intercept)	3.77	0.01	0.00 ***
Bridging social capital last month	0.67	0.01	0.00 ***
Age (decades)	0.00	0.00	0.44
Male	-0.03	0.01	0.05
Facebook activities			
Directed communication (both directions)	0.05	0.02	0.00 **
Passive consumption	-0.03	0.01	0.04*
Broadcasting	0.01	0.01	0.38

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.48

Number of observations: 3854
Number of groups: 1927

Table 8. Passive consumption is associated with reductions in bridging social capital when controlling for directed communication and broadcasting.

decreases in bridging social capital suggest that to gain the bridging benefits from ties, one must keep them active through communication.

Another interpretation is that the content of the passive consumption matters, as does the relative state of the viewer—when individuals see news of their ties succeeding and they themselves do not feel successful, it increases depression and makes them feel less a part of a greater community. Several participants remarked on a negative social comparison:

> *"no one really shares sad or distressing stuff. They must have some concerns, but most of my contacts act as if they do not. So in comparison, I feel worse."*
>
> *"I'd say that when we have troubles at home, FB seems kinda like fantasy, like I'm supposed to only say nice or funny things in my status updates."*
>
> *"not much. I dont write or do much. just look at others and sometimes I do feel like I'm missing out when I dont get invited to events and I see pictures of them, but I choose to do other things. I'm just getting older and missing my youth."*

These quotes are consistent with empirical work showing that people routinely assume their peers are having more fun than they are (Jordan et al., 2011). The detail in the final quote is telling: This woman is not writing to others on the site and feels like she's missing out when she reads about others. Passive consumption without directed communication may increase feelings of disconnectedness. Passive consumption is not uniformly negative, however. In Chapter 3 we see that passively consuming a tie's news is associated with feeling closer to that particular tie. Here, we see problems associated with passively consuming across many ties without talking to them. These findings are consistent with upward social comparison (Festinger, 1954). Yet reading about others can also be inspiring:

> *"Regarding heath and career, sometimes it pushes me to make more of my life, when I see the updates of my friends who are lawyers or doctors, or who live abroad, but then I realize I have things very good when I see my friends who are unemployed, struggling with their health or are posting status updates related to struggles they are having in their lives."*
>
> *"Facebook can help putting things in proportion, it gives you a chance to bounce of ideas and experiences to individuals & groups, it gives you a chance to see where their priorities lie. It made me realise that I would like to volunteer more and be more politically active and more creative - seeing other people do things and discuss things gave me food for thought and inspiration to do things. So Facebook can help channel information the right way but it is up to the individual to act."*

Consumption and broadcasting are highly correlated with directed communication (r = 0.76 for passive consumption, and r = 0.78 for broadcasting, see Table 4), and so after the variance explained by directed communication, these other two types of communication do not provide additional explanatory power. Yet, it is likely that broadcasting and consumption cause future directed communication in shorter-term intervals than the month windows in the present study. The News Feed, through which much passive consumption takes place (and which streams much broadcast content), allows inline commenting so that people can give

direct feedback to the content creators. In this way, both passive consumption and broadcasting are powerful tools for spurring directed communication. At monthly intervals, we see that consumption and broadcasting to not directly improve well-being, but rather the well-being improvements are associated with directed communication. Where consumption and broadcasting are higher than average but directed communication is no higher, individual well-being is not affected (or is worse, in the case of bridging social capital). Therefore, it's not enough to consume and broadcast—to take advantage of the social network, you must actively communicate one-on-one with network members. A fine-grained model of the path from consumption or broadcasting to directed communication to wellbeing improvements is outside the scope of this study, but participants often mentioned passive consumption and broadcasting leading to directed communication actions. They comment on others' broadcast status updates and posts, and like it when others do the same.

> *"Yes as an author who's work I love to read, I am able to keep updated on her writing and give encouragment and feedback when she asks for it in real time."*
>
> *"definitely she travels a lot and posts lots of photos on facebook and i love commenting on them"*
>
> *Yes...he gives comment on my every status which makes me feel special*
>
> *"She posts a lot and I enjoy keeping up with what is happening in her life. Occasionally, I comment on her posts or pictures."*

To summarize the results so far, the connection between Facebook and a person's well-being depends on what that person and his or her ties do. Directed, one-on-one communication is associated with a host of well-being improvements, while passive consumption and broadcasting have at best indirect effects on well-being. One-click exchanges, such as likes and pokes are not associated with well-being gains, but longer pieces in which the sender took time to compose some original content are. Communication taking place in front of other mutual ties is associated with improvements in happiness and loneliness, but not bridging social capital, as expected. Instead, private messages are associated with gains in bridging social capital.

4.5.5. Communication partner: strong versus weak ties

To test Hypotheses 4 and 5 on directed communication from strong and weak ties, we first need an estimate of tie strength across communicators. Chapter 2 explains the tie strength model fully, but I briefly summarize it here. Participants rated their tie strength with eight Facebook friends, including up to six very close friends that they selected, and these ratings were used to train a model of tie strength across all of their Facebook friends. The model was a multilevel linear regression at the dyad level, with independent variables coming from Facebook's server logs and users' profiles. For each dyad (whose members are referred to as 'ego' and 'alter'), tie strength is a linear combination of directed communication within the dyad (e.g., number of messages ego sent alter, number of comments alter left for ego), passive consumption by ego (e.g., ego's views of alter's profile or photos), static information about each person (e.g., age, gender) and static

information about each dyad (e.g., number of days since the Facebook friendship was initiated, whether they live in the same city, whether they've stated that they're "in a relationship" together, number of mutual friends). Chapter 2 presents model validation details. In a held-out sample, predicted and self-reported tie strength were highly correlated ($r = 0.66$). The model was then applied to the participants in the present study, generating a tie strength rating for each of their Facebook friendships.

For the following analyses, tie strength was converted to a binary (strong versus weak tie) for each friend, with an estimate of 5 (out of the 7-point scale) as the strong-tie cutoff (inclusive). The cutoff was the average (both mean and median) estimated tie strength score for the ties participants selected as their very close friends. With this threshold, 39.4% of participants' ties were considered "strong" and the median user had 38 strong ties ($M = 47$). Directed communication actions were then counted separately, depending on whether the tie was strong or weak. Counts were logged and standardized like all other activity variables, as described in Section 4.4.4. Users received approximately half of their directed communication from strong ties, according to this metric ($M = 52.2\%$).

Hypothesis 4: Confirmed.

Receiving directed communication from strong ties is linked to improvements in:

- social support
- happiness
- depression
- loneliness
- positive affect
- negative affect
- health
- stress (m)

while directed communication from weak ties is not.

Communicating with strong ties is linked with many improvements in well-being, and Hypothesis 4 is confirmed. Receiving directed communication from strong ties significantly predicts increases in social support, happiness, depression, loneliness, positive affect, negative affect and health, and marginally predicts improvements in stress. Table 9 shows

	Social support		
	Value	SE	*p*-value
(Intercept)	3.80	0.01	0.00 ***
Social support last month	0.73	0.01	0.00 ***
Age (decades)	0.01	0.01	0.02 *
Male	-0.01	0.02	0.53
Facebook activities			
Directed communication (in) from strong ties	0.05	0.02	0.00 ***
Directed communication (in) from weak ties	0.00	0.02	0.85
Passive consumption	-0.01	0.01	0.32
Broadcasting	-0.02	0.01	0.29

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.58

Number of observations: 3854
Number of groups: 1927

Table 9. Receiving directed communication from strong ties is associated with increases in social support, while communication from weak ties is not.

that as messages, comments, likes, and other forms of directed communication from strong ties increases, social support scores increase ($\beta = 0.05$, $p < 0.001$), while a roughly equal volume of these actions from weak ties shows no impact ($p = 0.85$). Communication from strong and weak partners is correlated at $r = 0.67$, and so including them in the same model is conservative, but even so, strong tie communications have a profound effect. In the case of monthly health, receiving a standard deviation more than average strong-tie communication is linked to a β=0.07 point increase in health, $p = 0.01$, while weak-tie communication does not affect health ($p = 0.15$, see Table 10). A post-hoc test confirms that strong ties are significantly better than weak ties for health, ($\beta = 0.11$, $p = 0.03$). Table 10 presents the relationship between strong tie communication and health, with an added control of whether the person reported having a personal injury or illness since the last survey. To understand the magnitude of the effect size of strong-tie communication on health, consider people who had a major illness or injury between surveys. As Table 10 shows, they were β = -0.58 less healthy this month, $p < 0.001$. One additional standard deviation of directed communication from strong ties (approximately 60 comments or likes) offsets about 1/7 the health losses due to illness. Participants who reported being ill between surveys described how the site affected them, and many brought up strong ties, both on- and offline:

> *"As I got very sick ,I had a lot of help from my friends and I must say the minute one knew, it went like an Indian tam-tam and people started to show up at my house; it was nice and helped a lot in my recovery."*

> *"I've been able to reach out and share what I've been going through and have my friends support me. It's increased my support network and help me feel not so alone in what I'm facing. It also has given me an outlet to say what's on my mind and 'yell' at the universe lol"*

	Health this month		
	Value	SE	*p*-value
(Intercept)	3.51	0.03	0.00 ***
Health last month	0.02	0.01	0.14
Had a major injury or illness between surveys	-0.58	0.03	0.00 ***
Age (decades)	-0.06	0.01	0.00 ***
Male	0.03	0.04	0.47
Facebook activities			
Directed communication (in) from strong ties	0.07	0.03	0.00 **
Directed communication (in) from weak ties	-0.03	0.03	0.38
Passive consumption	0.02	0.03	0.58
Broadcasting	-0.04	0.03	0.13

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$ $R^2_{y,\hat{y}}$: 0.32

Number of observations: 3854
Number of groups: 1927

Table 10. Receiving directed communication from strong ties is associated with increases in monthly health.

"It is nice to see people who have meant something to you. I helps you realize what is important in life - Relationships."

These quotes suggest a causal relationship between Facebook and health improvements: the site reflects, reinforces and facilitates offline social support. People get perceived and actual support through their relationships, and unlike many online communities studied over the past decade, those relationships exist both online and off. That support leads to health improvements, or at least a perception that things are getting better. Much of that support is unmeasurable in the present study; Facebook is only one of many channels through which strong ties communicate. As participants commented,

"The people that gave me encouragment on Facebook would have been in contact with me in one way or another during difficult times in my life"

"Always look to facebook for good news from my family. If that isn't the case, I usually get a phone call to explain the problem."

These results contradict previous findings indicating that received support does not influence health (Uchino, 2009; Uchino et al., 1996). Though we do not know the content of strong-tie communication on Facebook, the communication exchanges themselves are a form of received support—informational or emotional provision, or simple companionship. We see modest health improvements associated with these communication exchanges.

Although improvements in social support and seven other well-being measures were associated with receiving directed communication from strong ties, this was not the case for bridging social capital. Recall that bridging social capital is generated by being connected to a wide variety of people, who expose us to new information and instill a sense of community and generalized reciprocity. As expected, bridging social capital is not moved by messages from strong ties ($p = 0.71$), but instead, is related to communication with weak ties. Hypothesis 5 is confirmed. Table 11 shows that every standard deviation increase in directed communication from weak ties is linked with a $\beta = 0.06$ point increase in bridging social capital, $p < 0.001$. A post-hoc test confirms that strong and weak ties differ by $\beta = 0.07$ points, $p = 0.01$.

Hypothesis 5: Confirmed.

Receiving directed communication from weak ties is linked to improvements in:

- bridging social capital

while directed communication from strong ties is not.

These results provide strong evidence that communication partners on Facebook are varied, just as they are in offline communication, and that different types of partners provide different benefits. Consistent with Granovetter's "strength of weak ties" argument, Facebook facilitates connections with diverse others, and when Facebook users act on those weak-tie connections, they feel the bridging benefits of those ties. They feel exposed to new information and part of a larger community. These bridges are not built through close friends, however. Close friends have redundant information and overlapping networks, and thus cannot provide the community-linking functions

	Bridging social capital		
	Value	SE	*p*-value
(Intercept)	3.76	0.01	0.00 ***
Bridging social capital last month	0.67	0.01	0.00 ***
Age (decades)	0.01	0.01	0.29
Male	-0.03	0.01	0.03 *
Facebook activities			
Directed communication (in) from strong ties	-0.01	0.02	0.49
Directed communication (in) from weak ties	0.06	0.02	0.00 ***
Passive consumption	-0.02	0.01	0.06 ·
Broadcasting	0.02	0.01	0.21

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.48

Number of observations: 3854
Number of groups: 1927

Table 11. Receiving directed communication from weak ties is associated with increases in bridging social capital.

of weak ties (Granovetter, 1973), and the data clearly show this: bridging social capital only increases with weak-tie communication.

On the other hand, strong ties provide strong benefits. While much research treats Facebook as a resource for easily maintaining a large network of weak ties (Burke, Marlow, & Lento, 2010b; Ellison et al., 2007; Hogan, 2010), researchers rarely measure it for emotionally close relationships (excepting (Gilbert & Karahalios, 2009)). The present study clearly confirms that strong ties are present on Facebook, and interacting with them is linked to a host of well-being gains, most notably health improvements.

4.5.6. Individual differences in users: social communication skill

Next, we turn to individual differences in Facebook users that may influence their overall well-being, their choice of activities on the site, and the effect that those activities has on their well-being. We first examine an inherent trait in individuals: social communication skill. Overall, participants had high levels of social skills, as shown in Figure 6, with the average user having a score of $M = 7.9$ out of 10.

Communication skill and well-being. First, as a baseline, we examine the relationship between social communication skill and well-being, and find results consistent with previous work: Individuals with higher social communication skills have better levels of all well-being variables. Table 12 presents a model of social support showing a main effect for social communication skill: Those with one point higher social communication skill feel $\beta = 0.08$ increases in social support, $p < 0.001$. The results are similar for all well-being outcomes in the present study: Those with higher social communication skills feel greater social

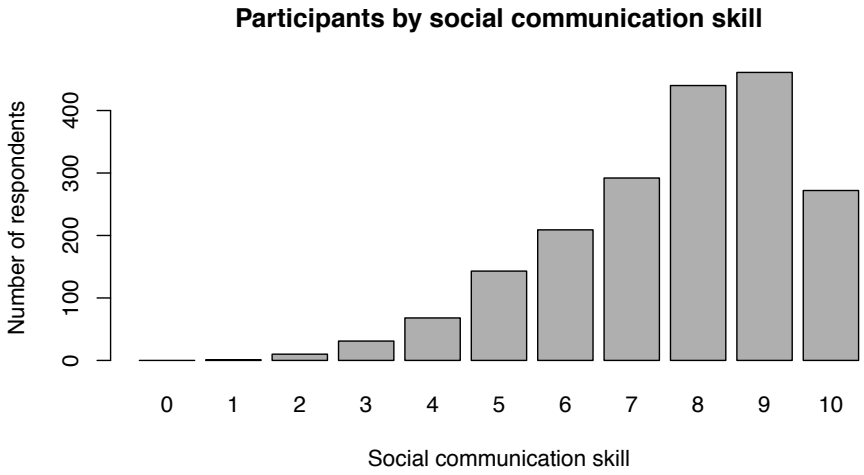

Figure 6. Social communication skill of participants.

support, bridging social capital, happiness, depression, loneliness, positive and negative affect, stress, and health. (See Appendix B for all tables.) Those who are more comfortable socially are able to use their social connections for emotional support and reduced stress (House & Landis, 1988), and have higher levels of wellbeing.

Communication skill and Facebook use. Next we analyze the relationship between social communication skill and Facebook use. Are people who are comfortable with face-to-face conversations more talkative online, as well? Communication skill is correlated with levels of Facebook activity, with more socially skilled communicators receiving and sending more directed communication ($p < 0.001$ and $p = 0.02$, respectively), and sending more "composed" pieces ($p = 0.01$), see Table 13. There is no difference, however, between those with high and low social skill in the amount of one-click communications sent, passive consumption, or broadcasting ($p > .23$ for all). Some of these results are intuitive: Those with higher social communication skills are more comfortable with social "chitchat" and exercise it on Facebook through messages, comments,

	Social support		
	Value	SE	*p*-value
(Intercept)	3.81	0.01	0.00 ***
Social support last month	0.67	0.01	0.00 ***
Age (decades)	0.00	0.00	0.35
Male	-0.01	0.01	0.63
Social communication skill	0.08	0.00	0.00 ***

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.61

Number of observations: 3854
Number of groups: 1927

Table 12. Social communication skill is associated with increases in social support.

	Directed comm. (in)			Directed comm. (out)			Passive consumption			Broadcasting		
	Value	SE	*p*-value	Value	SE	*p*-value	Value	SE	*p*-value	Value	SE	*p*-value
(Intercept)	0.18	0.02	0.00***	0.18	0.02	0.00***	0.15	0.02	0.00***	0.15	0.02	0.00***
Age (decades)	-0.02	0.00	0.00***	-0.02	0.00	0.00***	-0.02	0.00	0.00***	-0.02	0.00	0.00***
Male	-0.22	0.03	0.00***	-0.25	0.03	0.00***	-0.12	0.03	0.00***	-0.18	0.03	0.00***
Social communication skill	0.01	0.00	0.00***	0.01	0.00	0.02*	0.01	0.00	0.23	0.00	0.00	0.39

	Composed directed comm. (out)			One-click directed comm. (out)		
	Value	SE	*p*-value	Value	SE	*p*-value
(Intercept)	0.21	0.02	0.00***	0.15	0.02	0.00***
Age (decades)	-0.02	0.00	0.00***	-0.01	0.00	0.00***
Male	-0.31	0.03	0.00***	-0.22	0.04	0.00***
Social communication skill	0.01	0.00	0.01*	0.00	0.00	0.33

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$

Number of observations: 5781
Number of groups: 1927

Table 13. Social communication skill is associated with different amounts of directed communication and composed communication.

and wall posts, just as they would be more comfortable striking up a conversation with someone offline. Those with lower communication skills perform these composed actions less often. One-click actions, such as liking and poking, with their one-size-fits-all aspect, are used by high and low communicators equally. Consistent with the findings of (Burke, Kraut, & Williams, 2010a), one-click actions are accessible to those with lower communications skills as a lightweight way to initiate a conversation without having to think of something to say, and so we see that everyone uses them the same (on average) regardless of communication skill.

Hypothesis 6: Not confirmed.

Sending one-click communication is not associated in well-being gains for individuals with lower social skills.

Interactions between communication skill and Facebook use on well-being. Now we examine whether those one-click actions provide differential benefits to individuals with lower social communication skills. When they send one-click actions, do they feel greater social support and bridging social capital because they are reaching out to their networks in the best way they can? The answer is no. While there are positive main effects for sending composed communication, there are no main effects for sending one-click communication, and no interactions between communication skill and one-click interaction. Hypothesis 6 is not confirmed. Table 14 presents the results for social support. First the main effects: Sending one standard deviation more composed directed communication actions than average is associated with a $\beta = 0.03$ increase in social support, $p = 0.04$, while sending one-click actions is not, $p =$

	Social support		
	Value	SE	*p*-value
(Intercept)	3.81	0.01	0.00 ***
Social support last month	0.70	0.01	0.00 ***
Age (decades)	0.01	0.01	0.15
Male	-0.01	0.02	0.62
Social communication skill	0.04	0.01	0.00***
Facebook activities			
Composed directed communication (out)	0.03	0.02	0.04 *
One-click directed communication (out)	-0.02	0.01	0.18
Passive consumption	-0.01	0.01	0.50
Broadcasting	-0.00	0.01	0.87
Social communication skill x Composed (out)	0.01	0.01	0.47
Social communication skill x One-click (out)	0.00	0.01	0.80

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.58

Number of observations: 3854
Number of groups: 1927

Table 14. Sending composed communication is associated with increases in social support, while sending one-click communication is not. The relationship between these communication actions and social support does not vary by communication skill.

0.18. A post-hoc test confirms the two actions are different, with composed actions associated with $\beta = 0.05$ greater increases in social support than one-click actions, $p = 0.03$. The effect of sending composed communication is similar to that of receiving it: feelings of social support increase. However, there are no significant interactions between social communication skill and composed or one-click communication. Everyone benefits equally from sending composed communication, and no one benefits from sending one-click communication.

Though the specific features tested here did not show additional benefits for individuals with lower social skills, the general benefits of computer-mediated communication still apply. The site allows for asynchronous communication and the crafting of a more ideal self. As participants with lower social skills commented:

> *"I am not socially adept in real life, but I can use fb to send condolences and well wishes with out feeling weird and anxious. Face book has made me able to keep friends and be social. Before I was on fb I was very reclusive and alone. Last month i used it to plan a b-day party that went great! That is the first time I ever threw and participated in a party."* (social communication skill = 5.5 out of 10)

> *"Facebook helps me feel connected without having to get dressed"* (social communication skill = 3)

> *"Facebook brings both me and my friends closer and lets me express who I really am inside."* (social communication skill = 4.5)

However, many participants with lower social skills mentioned passive consumption and social comparison—saying that the site reinforces the social difficulties they're already feeling.

> *"worse because i see my former friends on facebook succeeding in life when I'm degrading. I dont want to see what other people are up to. i dont want to see their successes. unfortuntaly, because of the invention of facebook, these things are blasted on the internet and theres no way of avoiding it. i get stress, nerves, and aniexty over what ill see next on my news page. its addicting even though i dont want to see it."* (social communication skill = 2.5)

> *"Learning about my friends new relationships has kinda made me feel worse about myself and my social awkwardness but it's life."* (social communication skill = 2.5)

4.5.7. Individual differences in users: job loss

Beyond relatively unchanging individual characteristics such as social communication skill, people are also susceptible to exogenous events that affect their well-being, such as losing a job. In the current sample, 5.2% of participants (N = 101) reported losing a job in the last month on at least one survey.

Job loss and well-being. First, as a baseline, we examine the relationship between job loss and well-being, and find results consistent with previous work: Individuals who have recently lost a job feel reductions in happiness, and increases in depression, negative affect, stress. However, they do not feel changes in social support, bridging social capital, positive affect, loneliness, or health. Table 15 shows that individuals who lost a job in the past month feel β=0.21 increases in stress, $p < 0.001$, and Appendix B contains tables for all well-being variables.

Job loss and Facebook use. Next we analyze the relationship between job loss and Facebook use. People who have recently lost their jobs do not use Facebook differently from those who haven't recently lost a job. Table 16 shows that there are no significant differences in directed communication in or out, passive consumption, broadcasting, or composed communication sent. They do send β = 0.07 more one-click directed communication, p = 0.04. If these individuals have more discretionary time, they are not spending it on Facebook.

	Stress		
	Value	SE	p-value
(Intercept)	2.36	0.01	0.00 ***
Stress last month	0.78	0.01	0.00 ***
Age (decades)	-0.02	0.00	0.00 ***
Male	-0.01	0.02	0.45
Lost job in past month	0.21	0.06	0.00 ***

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.59

Number of observations: 3854
Number of groups: 1927

Table 15. Losing a job is associated with increases in stress.

	Directed comm. (in)			Directed comm. (out)			Passive consumption			Broadcasting		
	Value	SE	*p*-value	Value	SE	*p*-value	Value	SE	*p*-value	Value	SE	*p*-value
(Intercept)	0.18	0.02	0.00	0.18	0.02	0.00	0.15	0.02	0.00	0.15	0.02	0.00
Age (decades)	-0.19	0.01	0.00	-0.17	0.01	0.00	-0.22	0.01	0.00	-0.16	0.01	0.00
Male	-0.23	0.03	0.00	-0.25	0.03	0.00	-0.12	0.03	0.00	-0.18	0.03	0.00
Lost job in past month	0.05	0.04	0.18	0.02	0.03	0.59	-0.03	0.04	0.49	-0.01	0.04	0.73

	Composed directed comm. (out)			One-click directed comm. (out)		
	Value	SE	*p*-value	Value	SE	*p*-value
(Intercept)	0.21	0.02	0.00	0.15	0.02	0.00
Age (decades)	-0.18	0.01	0.00	-0.14	0.01	0.00
Male	-0.32	0.03	0.00	-0.22	0.04	0.00
Lost job in past month	0.03	0.05	0.49	0.07	0.04	0.04*

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$

Number of observations: 5781
Number of groups: 1927

Table 16. Losing a job is not associated with different uses of Facebook except for increases in one-click communication.

	Bridging social capital		
	Value	SE	*p*-value
(Intercept)	3.76	0.01	0.00 ***
Bridging social capital last month	0.67	0.01	0.00 ***
Age (decades)	0.01	0.01	0.21
Male	-0.03	0.01	0.03 *
Lost job in last month	0.01	0.06	0.86
Facebook activities			
Directed communication (in) from strong ties	-0.00	0.02	0.82
Directed communication (in) from weak ties	0.06	0.02	0.00 ***
Passive consumption	-0.02	0.01	0.09 ·
Broadcasting	0.01	0.01	0.32
Lost job x Directed comm (in) from strong ties	-0.19	0.13	0.13
Lost job x Directed comm (in) from weak ties	0.19	0.11	0.09 ·

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.48

Number of observations: 3854
Number of groups: 1927

Table 17. Individuals who recently lost a job gain (marginally) greater increases in bridging social capital when talking with weak ties on Facebook.

Interactions between job loss and Facebook use on well-being. Now we examine whether job loss status moderates the effect of Facebook use on well-being. Through the News Feed, Facebook has the potential to generate the serendipity and bridging social capital most needed by those who have recently lost a job. It may also be a tool for close friends to provide emotional support during the personal crisis. Therefore we'll focus on communication with strong and weak ties on the site.

First, we examine weak ties and bridging social capital. Recall that receiving directed communication from weak ties is associated with increases in bridging social capital. Now we examine whether those who have recently lost a job benefit even more from talking to their weak ties. They do, marginally. Table 17 presents a model of bridging social capital with main and interaction effects for strong and weak tie communication and job loss. We again see a strong main effect for talking with weak ties, with a one standard-deviation increase in weak-tie communication associated with a $\beta = 0.06$ increase in bridging social capital, $p < 0.001$. There is no main effect for job loss on bridging social capital (perhaps because the loss was recent and the lost connections aren't yet felt). There is a marginally significant interaction between job loss and receiving communication from weak ties, $\beta = 0.19$, $p = 0.09$, such that those who lost a job feel greater increases in bridging social capital than do people who have not lost a job when talking to weak ties. The coefficient for the interaction effect is approximately three times the magnitude of the main effect ($\beta = 0.19$ vs. 0.06), indicating that the benefits for those who have lost a job are large and of practical significance, though the high standard error (SE = 0.11) makes it only marginally statistically significant. Losing a job is a highly unpredictable event, and personal experiences vary, and so it is not surprising that standard errors are higher.

Survey respondents also mention using Facebook to tap their weak ties for job opportunities:

> *"probably better; I can stay in contact with people back home & ask about jobs from people I know in my new city."*
>
> *"We have kept in contact and she has helped me with some job leads."*
>
> *"By keeping in touch with former work colleague, for future job references and reunions."*
>
> *"Margaret was an extern in our office last year. I am interested in her enough to see that she does well and finds a good job"*

Building this bridging capital is important to reemployment. Table 18 shows that bridging social capital is a strong predictor of the likelihood of finding a new job. The model in Table 18 is a logistic regression predicting the likelihood of finding a new job based on one's age, gender, and bridging social capital the previous month. The intercept represents the average person in the sample, who has a log odds of finding a job of $\beta = -2.86$ (which translates to a 5.4% probability of finding a new job). Someone with one standard deviation greater than average bridging social social capital has approximately one and a half times the probability of finding a new job: $\beta = -2.86+0.48 = -2.38$ (or 8.5% probability).

Research Question 3:

Losing a job moderates the impact of Facebook on well-being.

Hypothesis 7: Confirmed.

Those who recently lost a job feel marginally greater increases in bridging social capital when talking with weak ties than do people who haven't lost a job.

Those who recently lost a job also feel increased stress, depression, and decreased positive affect when talking with strong ties than do people who haven't lost a job.

Now we examine the role of strong ties after losing a job. Recall that talking with strong ties is generally associated with a host of benefits, including improvements in social support, happiness, stress, and depression. Now we examine whether those who have lost a job experience anything different when talking with strong ties. They do. Though there are no interaction effects between job loss and strong-tie communication on social support, there are significant interactions on depression, stress, and positive affect: Talking with strong ties on Facebook is associated with poorer well-being for those who have lost a job. Table 19 shows the magnitude of the effect: One standard deviation increase in communication from one's strong ties is associated with a β = 0.27 increase in stress, p =0.04, which is as stressful as the actual event of losing a job (β = 0.21). Why is talking to strong ties so bad in this case? Strong ties often make the psychological distress of job loss worse by offering unhelpful advice and pushing for recovery too quickly (Wortman & Lehman, 1985). Individuals may feel greater embarrassment or imposition with their strong ties (who know of the job loss and may be providing financial support offline) than weak ties (who are more peripheral, so are less likely to know), and so perhaps receiving contact from strong ties heightens that embarrassment and pressure to get a new job. Support-receivers may feel their independence threatened, increasing resentment rather than relief (Bolger, Zuckerman, & Kessler, 2000). Strong ties also experience anxiety about doing anything upsetting, which may cause them to switch to more "automatic" or "casual" modes of help-giving, making them less supportive (Lehman et al., 1986). As participants remarked,

> *"Worse, probably. Everyone wants to know if I got a job already!"*
>
> *"I feel worse about losing my job when using Facebook. I find it really hard to connect with people who care about me/my life. I get a lot of pity comments on Facebook"*

	Finding a new job		
	Value	SE	*p*-value
(Intercept)	-2.86	0.14	0.000 ***
Age (decades)	-0.58	0.07	0.000 ***
Male	-0.02	0.20	0.931
Bridging social capital last month	0.48	0.17	0.004 **

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$

Number of observations: 1927

Table 18. Bridging social capital last month is a strong predictor of finding a new job this month.

	Stress		
	Value	SE	*p*-value
(Intercept)	2.36	0.01	0.00 ***
Stress last month	0.78	0.01	0.00 ***
Age (decades)	-0.02	0.01	0.00 **
Male	-0.01	0.02	0.46
Lost job in last month	0.21	0.06	0.00 ***
Facebook activities			
Directed communication (in) from strong ties	-0.02	0.02	0.19
Directed communication (in) from weak ties	-0.00	0.02	0.87
Passive consumption	0.00	0.01	0.75
Broadcasting	0.02	0.01	0.17
Lost job x Directed comm (in) from strong ties	0.27	0.13	0.04 *
Lost job x Directed comm (in) from weak ties	-0.10	0.12	0.38

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.59

Number of observations: 3854
Number of groups: 1927

Table 19. Individuals who recently lost a job feel more stressed when receiving messages from strong ties.

As previously described, some people feel that negative news does not belong in status updates—that they should be artificially cheery—and so those who have lost a job may feel constrained from sharing their true feelings. Wortman and colleagues (1985) find that one of the most helpful responses to personal crises is providing people the ability to express their emotions. As previously discussed, people may feel that emotional expression is stunted by the site (at least in their semi-public communication) with strong ties, and so communication with them is additionally burdensome. Survey responses confirm that Facebook reinforces negative feelings surrounding unemployment, particularly when comparing oneself to others.

> *"I have to remind myself more NOT to compare my life to others, NOT to feel like a failure in the face of friends' successes, NOT to let the highly filtered updates of Facebook make me feel any differently about myself."*

> *"Facebook has not made me feel better or worse about my new job. It did, however, make me feel worse when I was unemployed and I would regularly read newsfeed status updates celebrating personal successes. I have a life philosophy that it's a downward spiral to compare yourself to your peers; Facebook makes this philosophy very difficult to uphold."*

> *"about the same. sometimes not so good when you read how well everyone else is doing. And it seems I am going nowhere fast. Still looking for work."*

At the same time, respondents did feel support from ties on Facebook, especially when they did find new jobs and posted the news:

> *"Felt a little better with supporting comments about losing my job. My friends gave me a better outlook on the situation."*

"Better, I posted my new job (and upcoming move) on FB and I got so many nice comments"

Being able to connect with others in similar circumstances is a source of comfort after a crisis (Lehman et al., 1986), and respondents frequently mentioned commiserating through the site.

"Yes, am able to commiserate with other colleagues on losing our jobs (due to Bank failure) and getting prospects for new opportunities."

"Been able to share my worries, get help on Cvs, job hunting and general chit chat about whats happening to others."

"Much better it is way easier to stay connected when looking for employment t see what others found. If someone finds a lead they cannot use they pass it on in case anyone else can use it. We are finding jobs"

"It has made me feel a whole lot better - I have been able to share the ups and downs of my life with others who are in similar circumstances - and we have all been able to support each other emotionally."

In summary, for those who have lost their jobs, Facebook is a source of relief and frustration. Consistent with offline findings, weak ties are useful for increasing bridging social capital—sharing résumés, learning about job openings, meeting friends-of-friends who are in the same field—and this bridging social capital is highly predictive of finding a new job. The site also allows people to commiserate with others who are in the same situation. However, consistent with previous research, strong ties are not always helpful in a crisis, and they exacerbate the stress and anxiety surrounding job loss. The News Feed both generates bridging social capital and fosters negative social comparison. As one participant remarks, the effects depend on your focus:

"Facebook allows me to see how all of my friends/acquaintances are doing. Getting a new job or having some other self-assessed success/failure can be put in perspective (whether realistic or skewed) by viewing the glimpses of others' lives through Facebook. If things aren't going well (ex. fired/lost a job), being able to read about the success of so many other people so quickly/easily can exaggerate depression. On the other hand, reading about the struggles of others can also put your own issues in perspective, making you feel better about what you're going through. I suppose, then, that these two options cancel each other out and it all comes down to what catches your attention (what is it you focus on) when you read through your 'news feed' that day."

4.5.8. Analysis of specific Facebook activities

The previous analyses have examined gross categories of Facebook use: directed communication, passive consumption, and broadcasting. Using these composite variables is important both for statistical validity and generalizability. The composite variables reduce multicollinearity in the models which would otherwise be evident, given that variables within a category are highly correlated (e.g., comments written and likes given are correlated at $r = 0.65$). The composite variables also allow generalizability to other platforms and abstract away from Facebook interface details: directed communication is like email; passive consumption is like reading blogs, tweets, and photo albums; and broadcasting is like blogging, tweeting, and photo sharing.

However, system designers are often interested in the relationship between specific features and well-being. How much happiness is associated with wall posts? How does that compare to pokes? To compare individual activity variables, a series of multilevel linear regressions was run, each regressing a single activity (e.g., a

comment) on a well-being outcome (e.g. social support), controlling for the lagged outcome (social support last month), age, and gender. Activity variables were transformed as described in Section 4.4.4 (logged base 2 after adding a start value of 1, centered at the mean, and divided by the standard deviation). Table 20 shows the resulting coefficients for three well-being outcomes: social support, bridging social capital and happiness. For interpretability, activity variables are presented in raw units. So, a person who was one standard deviation higher in comments written on the log-transformed scale wrote approximately 66 more comments in the original scale.

Table 20 reveals differences among the activity variables as well as the outcomes themselves. First, note that all three outcomes are mainly related to directed communication actions, with a only a few passive consumption and broadcasting actions being related to well-being. However, the differences between the outcomes and the variables are noteworthy. Bridging social capital is associated with more Facebook activities than the other two outcomes, suggesting that Facebook is the platform where bridging social capital is exercised; social support and happiness are due to interactions across many channels—family dinners, long-distance phone calls—but many weak ties may not communicate anywhere other than Facebook. Therefore, it's not surprising that the bridging social capital elicited from weak ties is more closely tied to Facebook activities than any other aspect of well-being. Bridging social capital is most swayed by the number of distinct people one interacts with (as seen from the large coefficients, $\beta = 0.060$ and 0.075). The greater weights given to distinct people suggests that for the bridging relationships to be most effective, there need to be a lot of them, rather than just a few maintained more vigorously. If just a few relationships were heavily maintained through communication, they might pass the strong-tie threshold and begin to lose their bridging value. Compare this to social support, which is not related to interacting with a large number of distinct people. Consistent with the vast body of research on interpersonal support (e.g., (Cohen et al., 1985)), social support comes from a smaller core of strong ties. Next, notice the power of photo tagging (both being the tagger and taggee). It has a significant and relatively large effect size across all three outcomes. Tagging and being tagged in a photo is a strong indicator of well-being, because it reflects offline social connectedness. Pokes, with their sadly ambiguous interpretation, fall to the bottom of the list, not contributing to any aspect of well-being.

4.6. Conclusion

The present study provides strong evidence that the relationship between Facebook and well-being is conditional; it depends on what you're doing, with whom you're doing it, and who you are. Table 21 summarizes the findings. Generally, directed, one-on-one communication between individuals is linked with the greatest increases in well-being, while passive consumption of social news and broadcasts to a wider circle of friends have no additional impact over and above the directed communication they elicit. Facebook users

Facebook activities	Social support	Bridging social capital	Happiness
Directed communication (out)			
66 Comments written	0.011	0.029 *	0.022*
62 Likes	0.009	0.031 *	0.022*
21 Messages written	0.016	0.046 ***	0.011
3 Pokes	-0.006	0.010	-0.007
1 Piece of content (e.g., a link) shared on friends' walls	0.007	0.025 *	-0.011
8 Posts written on friends' walls	0.026*	0.047 ***	0.016
5 Photos tagged	0.029**	0.034 **	0.024*
59 Distinct people user sent direct communication to	0.010	0.060 ***	0.023*
Directed communication (in)			
60 Comments received	0.018	0.045 ***	0.032**
63 Likes received	0.008	0.042 ***	0.024*
23 Messages received	0.019	0.054 ***	0.006
4 Pokes received	-0.001	0.009	-0.005
1 piece of content friends saved on wall	0.023*	0.029 *	0.001
5 Wall posts received	0.028*	0.039 **	0.032**
11 Photos tagged in	0.032**	0.046 ***	0.034**
50 Distinct people user received direct communication from	0.016	0.075 ***	0.023*
Passive consumption			
441 Profiles viewed	0.010	0.020	0.012
88 News feed stories clicked on	-0.002	0.019	0.017
43 Photos viewed	0.007	0.007	0.008
139 Distinct people whose content user consumed	0.012	0.034 *	0.015
Broadcasting			
2 Photos posted	0.015	0.027 *	0.012
6 pieces posted to own wall	0.002	0.050 ***	-0.001
9 Status updates	0.003	0.022	0.001

*** $p < 0.001$ ** $p < 0.01$ * $p < .05$

Table 20. Coefficients for individual Facebook activities regressed on social support, bridging social capital, and happiness. Activity units (e.g., 66 comments written) represent one standard deviation on a logged scale.

who spend more time talking one-on-one reap the benefits of their social networks, while those who simply keep track of their friends or blast updates to the crowd do not see those gains.

Even within directed communication, different factors influence the effectiveness of the communication. One-click interactions, such as likes and pokes generally do not influence well-being, compared to communication in which the sender composed some original content. The latter is associated with a host of benefits. The case for semi-public and private interactions is less clear, with semi-public interactions linked to happiness and private interactions linked to bridging social capital.

	Feature	Prediction	Confirmed
1a	Directed communication (both directions)	Improvements in well-being	Y
1b	Directed communication (inbound)	Improvements in well-being	Y
2	'Composed' vs. 'one-click' directed communication (in)	Composed better than one-click.	Y
3	Semi-public vs. private directed communication (in)	Different relationships to well-being	Y
4	Strong- vs. weak-tie directed communication (in)	Strong-tie better than weak-tie.	Y
5	Weak-tie directed communication (in)	Improvements in bridging social capital	Y
6	'One-click' directed communication (out) by individuals with lower communication skills	Improvements in well-being	N
7	Weak-tie communication by individuals who have recently lost a job	Improvements in bridging social capital	Y

Table 21. Summary of hypotheses and results.

The communication partner matters. Communicating with strong ties matters. This study demonstrates that strong ties do exist on Facebook, and when people receive messages from these close friends, they feel more social support, happier, less lonely, less depressed, and most profoundly, healthier. The present study does not examine the path by which strong-tie communication on the site is linked to health improvements, but given the connection between strong-tie communication and the emotional well-being outcomes, these other outcomes are likely mediators, and further study is needed. For those seeking to increase bridging social capital, such as job-seekers, weak ties bring those bridging benefits, as predicted by theory. However, weak ties do not impact other kinds of wellbeing, and for job-seekers, talking with strong ties is associated with poorer well-being.

The study also demonstrates that social communication skill is strongly related to all well-being outcomes, as expected, but the data do not reveal communication actions on the site that are preferentially beneficial to those who are less comfortable communicating face-to-face. Though some adults with lower social skills prefer one-click communication actions as a way to avoid coming up with something original to say (Burke, Kraut, & Williams, 2010a), the present study fails to show these actions make the senders feel more socially connected or less lonely, and as seen in Section 4.5.2, the recipients don't gain much from them, either.

4.6.1. Limitations and future work

The present study does not take into account the content of communication exchanges, merely counts and the 'composed' and 'one-click' proxies. This was done intentionally as both a privacy-preserving approach and to determine what can be modeled with simple counts. The results are excellent, but could be improved while still preserving participants' privacy with automatic linguistic feature generation, such as message length and word counts from psychosocial categories (e.g., the "positive emotion" dictionary in LIWC (Pennebaker et al., 2001)). Such an approach could determine language associated with social support, such as positive and negative emotion words or religious terms, and how that differs from the language associated with increases in bridging social capital (possibly more centered on interests, sports, or politics). Furthermore, as participants report pessimistic social comparison when passively consuming others' content, a linguistic approach could further identify content that makes viewers feel particularly bad. This content may be global across users, but more likely is an interaction between the state of the viewer and that of the poster. Perhaps the News Feed algorithm could weight more content-neutral pieces to show to individuals who do inordinate amounts of passive consumption.

"Composed" and "one-click" actions are dichotomized in the present study, but really, they're a continuum from the Like button to a short comment to a lengthy personal message. Even within the composed category there are some actions not requiring any forethought, such as "happy birthday" and "congratulations" messages. Further work is needed to determine whether these rote messages are more comparable to push-buttons in their effect on social support and social capital.

Like many studies of large, thriving online communities, the study cannot completely determine causality because participants were not randomly assigned to conditions. Many exogenous events impact an individual's well-being, and Facebook use may be both a contributing factor and a reflection of one's feelings. Moreover, the data are analyzed at the monthly level, so conversational features like turntaking and chronemics are lost in the aggregation. However, this study is far stronger than the many cross-sectional analyses popular in HCI because it takes into account lagged versions of the outcomes, which control for many of the unseen factors related to well-being. With a three-wave deployment, the study design also ensures that change over time is really that, not simply noise in an instrument only deployed twice.

Finally, the study is centered on a single platform, with a single self-selected sample of users. The results generalize to the extent that other platforms share Facebook's features, such as an aggregated feed of social news (shared by Twitter), strong and weak ties (email, instant messaging), and broadcasting (blogging, Twitter, and photo-sharing sites). The participants in the study, though self-selected, came from 91 countries and widely varied in age, increasing the generalizability of these findings. Self-selected samples of internet users are generally comparable to participants in traditional paper-and-pencil studies (Gosling, Vazire, Srivastava, & John, 2004), and this sample is larger and more representative than many offline samples.

This study examines the well-being an individual develops through social interactions with a wide variety of people. The results show that well-being depends on many factors, including the type of communication, the individual initiating the conversation, and the person on the other side.

5. Conclusion

Scholars and the popular press have long questioned the impact of the internet on the well-being of its users, and this dissertation presents a rich, highly detailed answer. Social network sites (SNS) are just platforms; the net consequences depend on how people use them, with whom they interact, and any personal differences they bring to the table. By using a methodology that combines a longitudinal design and the pairing of self-reports with server logs, this research reveals details that fill longstanding gaps in communication theory and inform social network site design. One consistent finding is that talking one-on-one is critical. SNS make it easy to consume the news of hundreds of ties with a few scrolls and clicks, and to reach a wide audience with a single status update, but to keep those relationships thriving and extract the most support and happiness from them, they need individual grooming.

The work makes significant contributions to theory and practice, as described below.

5.1. Theoretical contributions

Directed, one-on-one communication versus passively monitoring friends. This work adds to our understanding of relationship maintenance and social support by clarifying the circumstances in which it is necessary to engage friends and when it is sufficient to simply keep track of their lives. Close friends do both, and both are associated with increases in tie strength over time. However, passive consumption does not scale to the level of one's personal network—keeping track of many ties does not increase feelings of social support or connectedness. To develop a network that is a valuable source of support, one must regularly interact with those ties, not simply know what is happening in their lives. Similarly, this work demonstrates that generic, one-to-many broadcasts do not bring people closer or increase well-being except indirectly, through the directed communication they elicit.

Different kinds of ties. This work examines communication partners in depth, unpacking the benefits derived from strong and weak ties and the conditions under which they are most helpful. It confirms the literature linking social support to health benefits but places it in the new context of social network sites. This work shows that interacting with strong ties is associated with increases in social support, happiness, and perceived health, among other outcomes. Granovetter's (1973) "strength of weak ties" argument is reinforced, as well, with weak ties providing bridging social capital, which is demonstrated here to be associated with 1.5 times the likelihood of finding a job the following month. However, this work adds to our understanding of situations that color the effectiveness of talking with strong and weak ties. Though

strong ties are typically providers of support and companionship, to individuals who have recently lost a job, strong ties are toxic, and communicating with them is differentially associated with increased stress and depression and reduced positive affect. Strong ties may be providing unhelpful advice and pushing for recovery too soon, and so weak-tie communication is better for these individuals.

SNS compared to other communication channels. Consistent with media multiplexity theory (Haythornthwaite & Wellman, 1998), close friends communicate through a variety of channels including SNS, and SNS provide benefits beyond those expected from the other channels. Ties grow closer the more they directly communicate on Facebook, and site use is associated with increases in well-being of similar magnitude to that from major life changes, such as the outpouring of support after a loved one dies. For family members and ties that frequently communicate in person or on the phone, Facebook is less important as a tool for keeping the relationship close. However, family members learn about different sides of their kin by seeing them interact with other friends on the site. Dad becomes a "social" person, rather than just "Dad."

Tie strength distributions in personal networks. This work adds to the voluminous literature on personal network composition but illuminates a dimension rarely studied—the distribution of tie strengths. This work establishes that when individuals accrue very large personal networks, the majority of the ties are acquaintances, but those weak ties do not crowd out strong ties. People with very large networks also have more strong ties. More ties is not a bad thing.

Level of effort in communication exchanges. This work demonstrates that communication partners who take more effort in composing messages (rather than simply pushing the "Like" button) are considered closer ties, worthy of maintaining, and that receiving many of these composed communication actions is better than receiving many one-click actions. People feel greater social support, happiness, and less lonely when their ties take the time to write an original comment or message. These findings are consistent with signaling theory, that ties who take more effort signal that a relationship is more valuable to them, and thus are worth paying attention to. The present work cannot distinguish between the value of longer communication actions as signaling effort or as vehicles for the language of support and disclosure, but provides the groundwork for future explorations.

Semi-public and private exchanges. Social network sites transform interpersonal communication by layering it over a network of mutual friends and making most interactions visible to them. Though one would expect these semi-public interactions would be sources of bridging social capital, we find instead that private messages form this connective tissue for weak ties. Semi-public interactions are instead associated with increases in tie strength and happiness.

Different kinds of users. Finally, this work upholds previous findings that individual differences shape the way that individuals use computer-mediated communication and the benefits they receive from them. Here

we see that individuals with low social communication skills in person perform less communication on SNS, as well. However, they are no different in their use of one-click communication actions such as "liking" others' content; one-click communication allows those who are uncomfortable face-to-face to reach out in a more accessible format. However, these one-click actions do not make others feel closer to them, and do not increase the sender's feelings of connectedness or support. Personal crises such as losing a job also affect the value that users derive from a social platform; though they use the site no differently they have dramatically different stress responses when talking with certain kinds of ties.

5.2. Practical contributions

Demonstration of the value users gain from SNS use. Designers of social network sites want to create a platform that makes its users' lives better. This work demonstrates that Facebook accomplishes that, and that the benefits derived from it are in addition to benefits from other communication channels, such as email and the phone. Use of the site with particular people in particular ways is associated with increases in relationship closeness, social support, happiness, perceived health, and positive affect, and decreases in depression, loneliness, stress, and negative affect.

Details on SNS features and classes of features that improve relationships and well-being. This work presents evidence of types of SNS use that improve users' lives at both the general and feature levels. All three studies present classes of SNS use: directed communication, passive consumption, and broadcasting, and demonstrate the circumstances in which each is beneficial. Understanding how these classes of activities work is critical to designing new suites of features. The strong findings for directed communication indicate that any new passive consumption and broadcasting features should include direct feedback mechanisms (such as comment boxes). As Facebook spreads to more devices, allowing people to keep track of their friends on the go, interface designers need to ensure that comments, likes, and other targeted posting are easily accessible so that passive browsing doesn't become the only activity on mobile devices. Commenting should be a first-class citizen in all interfaces.

Comparison of one-click and composed actions. The "Like" button is now a ubiquitous hook for social sharing across the web. While this may be an ideal device for letting users share their interests and connecting content across the web, it is less useful for interpersonal connectedness. "Liking" a friends' content does not provide the friend with the same satisfaction and support as a comment, wall post, or message. For user-to-user interactions, the opportunity to compose original content should have as little friction in the interface as possible.

Model of tie strength. The model of tie strength in Chapter 2 is theoretically driven but less computationally complex than Gilbert and Karahalios's (2009), so it could be computed daily at Facebook

scale. Tie strength is highly correlated in the present study with wanting to hear about a tie's news ($r = 0.71$), and so accurately modeling tie strength goes a long way toward identifying the highest quality content for the News Feed. This becomes increasingly critical as users' personal networks grow, filling their feeds with massive content that needs prioritization. Site designers attempt to optimize many goals in these social awareness streams—providing relevant content (i.e., from one's closest friends), fresh and novel stories (from interesting, funny, or popular weaker ties), and ensuring that the users and product pages broadcasting the content reach the right audience. This work informs the first goal and can be combined with further user modeling to optimize all three. Furthermore, this work forms a piece that can be used in the growing body of research on social influence. Strong ties are more influential in spreading information (Bakshy et al., 2011) (though more content overall is spread through more abundant weak ties). Therefore, advertisers who have identified users who like or endorse their brands may want to place ads in front of the strong ties of those users with those endorsements. And though it was not a focus of the present work, the data from 80,000 dyads in these studies can be used to model other kinds of relationships, such as ties that interact frequently offline but not on the site (such as spouses or roommates), family members, professional contacts, romantic and former romantic partners, and childhood friends, allowing better content targeting across these social roles (e.g., reducing the likelihood that one's boss sees party photos, or recommending that a former romantic partner "friend" a current one).

Examination of SNS on those who have lost a job. Unemployment is nearing 10% across much of the United States and the European Union, and those who have recently lost a job are using social network sites just as much as their employed peers. Yet they experience different outcomes from the same kinds of actions, and the tool that can be so powerful for generating the bridging social capital they need to find a new job also causes them grief. Strong ties use it to provide unhelpful advice and the unemployed report feeling greater distress when reading about others' enviable jobs and lives in their feeds. Literature on personal crises suggests that the most advantageous forms of support are connecting people with others who are in similar circumstances and allowing emotional expression (Wanberg, 2011; Wortman & Lehman, 1985). Social network sites are perfect venues for that, and some users are taking advantage, such as the coworkers in Chapter 4 who were all laid off together, who use Facebook to commiserate and share CVs. Yet many of those who have recently lost a job do not know others in their network who are in the same situation, as people feel compelled to hold back negative personal news. If users had a way to discreetly identify that they were looking for work (such as a private setting in their profiles that was not visible to others), the site could automatically re-prioritize content that would be more beneficial to them. Their news could be distributed more widely among their weak ties (and should provide opportunities for those ties to comment and provide other direct communication). Weak ties who work for local companies that are hiring might be ideal targets for the unemployed's news, increasing the likelihood of a fruitful match. Additionally, those who have recently lost a job could be demoted in the interface among strong ties (e.g., downgrading their news in the

News Feed and their photo in the list of "friends online"), so that those strong ties are less likely to write to them. The site could recommend resources such as online groups for the recently unemployed, or more targeted groups based on geographic region and educational background, so that individuals could sympathize with similar others and share job leads. Advertisements for local industries that are hiring could be targeted at the people who would be most likely to be a good match.

5.3. Concluding remarks

The Pew Internet and American Life project recently documented that 65% of adults with internet access in the United States use social network sites (Madden & Zickuhr, 2011), and Facebook is nearing a billion users (Facebook, 2011). This dissertation paints a rich picture of social network sites and changes in the lives of their users, and how those changes depend greatly on what people are doing, whom they're doing it with, and who they are. Social media have aided in the unexpected ouster of repressive regimes in North Africa and the Middle East, and they are only in their infancy. This thesis forms the foundation for an increasingly momentous line of research on social media on our lives.

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Appendix A: Survey content

Participants completed an online survey with two parts. Part 1 began on Facebook, asking users to select friends they felt closest to, and then asking them questions about their relationships with those friends and additional randomly-selected ones. Part 2 contains questions about individual well-being.

Introduction screen:

Name generator screen:

Friend selector pop-up from name generator screen. They can select up to 6 close friends. Friend selector allows searching by name, friend list, network.

After selecting close friends, participants see their selected friends plus 2 or more randomly-chosen friends.

Sample friend question page. Participants completed one of these for each of the eight friends.

After answering questions about eight friends, participants transitioned to Surveymonkey for Part 2.

Beginning of Part 2.

Appendix B. Models and additional tables

Chapter 2: Full model of tie strength

Variables are presented in order of absolute value of coefficient size.

	Value	SE	*p*-value	Class†	Initiated by
(Intercept)	2.77	0.03	0.000 ***		
In a relationship together	1.21	0.04	0.000 ***	S	
Family members	1.00	0.02	0.000 ***	S	
Appeared in same photo (past 90 days)	0.59	0.03	0.000 ***	C	
Alter initiated interaction at least once (past 90 days)	0.59	0.02	0.000 ***	DC	Alter
Country: Great Britain	-0.48	0.04	0.000 ***	S	
Alter's friend count	-0.47	0.01	0.000 ***	S	
Days since they became Facebook friends	0.47	0.01	0.000 ***	S	
Country: Ireland	-0.45	0.07	0.000 ***	S	
Checked in to same location (past 90 days)	0.45	0.05	0.000 ***	C	
Ego viewed alter's profile (past 90 days)	0.37	0.02	0.000 ***	P	Ego
Ego initiated interaction at least once (past 90 days)	0.33	0.02	0.000 ***	DC	Ego
Ego wrote message to alter (past 90 days)	0.32	0.02	0.000 ***	DC	Ego
Country: Philippines	0.30	0.07	0.000 ***	S	
Ego commented on alter's content (past 90 days)	0.27	0.02	0.000 ***	DC	Ego
Who initiated Facebook friendship: alter	-0.25	0.01	0.000 ***	S	
Country: Australia	-0.24	0.06	0.000 ***	S	
Country: India	0.23	0.04	0.000 ***	S	
Ego liked alter's content (past 90 days)	0.22	0.02	0.000 ***	DC	Ego
Ego poked alter (past 90 days)	0.20	0.04	0.000 ***	DC	Ego
Ego wrote on alter's wall (past 90 days)	0.20	0.02	0.000 ***	DC	Ego
Attended same event (past 90 days)	0.17	0.08	0.030 *	C	
Appeared in same thread (past 90 days)	0.16	0.02	0.000 ***	C	
Alter viewed ego's photos (past 90 days)	0.16	0.03	0.000 ***	P	Alter
Ego is male	0.16	0.03	0.000 ***	S	
Days since ego joined Facebook	-0.15	0.01	0.000 ***	S	
Ego's relationship status: unknown	0.14	0.03	0.000 ***	S	
Country: New Zealand	-0.14	0.09	0.100 ·	S	
Ego viewed alter's photo (past 90 days)	0.13	0.03	0.000 ***	P	Ego
Alter's relationship status: unknown	0.12	0.02	0.000 ***	S	
Attended same event	0.12	0.06	0.050 *	C	
Days since alter joined Facebook	-0.12	0.01	0.000 ***	S	
Same gender	0.09	0.02	0.000 ***	S	
Alter viewed ego's profile	0.08	0.01	0.000 ***	P	Alter
Members of the same school network	-0.08	0.02	0.000 ***	S	
Ego is male x Same gender	0.07	0.02	0.000 **	S	
Ego initiated interaction at least once	0.07	0.01	0.000 ***	DC	Ego
Ego tagged alter in photo	0.07	0.02	0.000 ***	DC	Ego
Live in the same city	0.07	0.04	0.080 ·	S	

Ego saved content on alter's wall	0.07	0.02	0.010 **	DC	Ego
Alter commented on ego's content	0.06	0.01	0.000 ***	DC	Alter
Country: Canada	-0.06	0.05	0.250	S	
Alter commented on ego's content (past 90 days)	0.06	0.01	0.000 ***	DC	Alter
Ego viewed alter's profile	0.05	0.01	0.000 ***	P	Ego
Country: South Africa	-0.05	0.06	0.350	S	
Ego's relationship status: in a relationship	-0.05	0.03	0.060 ·	S	
Number of mutual friends	0.05	0.04	0.240	S	
Alter wrote message to ego	0.05	0.01	0.000 ***	DC	Alter
Ego's friend count	-0.05	0.04	0.260	S	
Alter saved content to ego's wall	0.04	0.03	0.110	DC	Alter
Alter tagged ego in photo	0.04	0.02	0.030 *	DC	Alter
Alter poked ego (past 90 days)	0.04	0.03	0.120	DC	Alter
Alter wrote on ego's wall (past 90 days)	0.04	0.01	0.010 **	DC	Alter
Checked in to same location	0.03	0.03	0.360	C	
Alter wrote on ego's wall	0.03	0.01	0.030 *	DC	Alter
Ego liked alter's content	0.03	0.01	0.010 **	DC	Ego
Alter viewed ego's shared content	0.03	0.01	0.030 *	P	Alter
Alter liked ego's content	0.03	0.01	0.020 *	DC	Alter
Alter poked ego	-0.03	0.04	0.540	DC	Alter
Ego poked alter	0.03	0.04	0.560	DC	Ego
Ego viewed alter's shared content (past 90 days)	0.02	0.02	0.180	P	Ego
Alter wrote message to ego (past 90 days)	0.02	0.01	0.060 ·	DC	Alter
Alter viewed ego's profile (past 90 days)	0.02	0.01	0.030 *	P	Alter
Alter's relationship status: in a relationship	0.02	0.02	0.220	S	
Ego wrote on ego's wall	0.02	0.01	0.170	DC	Ego
Alter viewed ego's shared content (past 90 days)	-0.02	0.01	0.210	P	Alter
Ego added alter to group	0.02	0.05	0.750	DC	Ego
Ego wrote message to alter	0.01	0.01	0.310	DC	Ego
Ego viewed alter's other content	0.01	0.02	0.600	P	Ego
Ego viewed alter's photo	-0.01	0.02	0.570	P	Ego
Ego wrote comments on alter's content	0.01	0.01	0.320	DC	Ego
Ego age	0.01	0.00	0.000 ***	S	
Ego viewed alter's shared content	0.01	0.01	0.420	P	Ego
Alter viewed ego's other content	0.01	0.03	0.760	P	Alter
Alter added ego to group	0.01	0.06	0.880	DC	Alter
Members of the same work network	-0.01	0.04	0.890	S	
Ego viewed alter's other content (past 90 days)	0.01	0.03	0.850	P	Ego
Country: Other	-0.01	0.03	0.860	S	
Appeared in same photo	0.00	0.02	0.920	C	
Age difference	-0.00	0.00	0.010 *	S	
Alter viewed ego's photos	0.00	0.02	0.980	P	Alter
Alter liked ego's content (past 90 days)	0.00	0.01	0.950	DC	Alter
Appeared in same thread	0.00	0.01	1.000	C	
Ego age x Age difference	0.00	0.00	0.000 ***	S	

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$

$R^2_{y,\hat{y}}$: 0.53
AIC: 460240, BIC: 461093
Number of Observations: 134480
Number of Groups: Egos: 11701
Number of Groups: Alters in Ego: 82358

Model of tie strength between ego and alter. Features are ordered by weight (absolute value of the coefficient).

† Class: S = Static, C = Coincidental, DC = Directed communication, P = Passive consumption

Chapter 4: Models of well-being outcomes

H1a, RQ1, and RQ2: Directed communication, passive consumption, and broadcasting

	Social support		
	Value	SE	*p*-value
(Intercept)	3.80	0.01	0.00 ***
Social support last month	0.74	0.01	0.00 ***
Age (decades)	0.01	0.01	0.02 *
Male	-0.01	0.02	0.46
Directed communication (both directions)	0.05	0.02	0.01 *
Passive consumption	-0.02	0.01	0.27
Broadcasting	-0.01	0.01	0.32

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.58

Number of observations: 3854, Number of groups: 1927

	Bridging social capital		
	Value	SE	*p*-value
(Intercept)	3.77	0.01	0.00 ***
Bridging social capital last month	0.67	0.01	0.00 ***
Age (decades)	0.00	0.01	0.44
Male	-0.03	0.01	0.05 *
Directed communication (both directions)	0.06	0.02	0.00 **
Passive consumption	-0.03	0.01	0.04 *
Broadcasting	0.01	0.01	0.38

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.48

Number of observations: 3854, Number of groups: 1927

	Happiness		
	Value	SE	*p*-value
(Intercept)	3.47	0.01	0.00 ***
Happiness last month	0.79	0.01	0.00 ***
Age (decades)	0.01	0.01	0.04 *
Male	0.01	0.02	0.50
Directed communication (both directions)	0.05	0.02	0.05 ·
Passive consumption	0.01	0.02	0.66
Broadcasting	-0.03	0.02	0.13

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.63

Number of observations: 3854, Number of groups: 1927

	Loneliness		
	Value	SE	*p*-value
(Intercept)	2.28	0.01	0.00 ***
Loneliness last month	0.79	0.01	0.00 ***
Age (decades)	-0.01	0.01	0.01 **
Male	0.00	0.02	0.81
Directed communication (both directions)	-0.06	0.02	0.01 **
Passive consumption	0.02	0.01	0.12
Broadcasting	0.02	0.02	0.28

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.64

Number of observations: 3854, Number of groups: 1927

	Positive affect		
	Value	SE	*p*-value
(Intercept)	3.64	0.01	0.00 ***
Positive affect last month	0.69	0.01	0.00 ***
Age (decades)	0.03	0.01	0.00 ***
Male	0.03	0.02	0.06 ·
Directed communication (both directions)	0.04	0.02	0.10
Passive consumption	-0.02	0.02	0.13
Broadcasting	0.00	0.02	0.90

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.47

Number of observations: 3854, Number of groups: 1927

	Stress		
	Value	SE	*p*-value
(Intercept)	2.37	0.01	0.00 ***
Stress last month	0.79	0.01	0.00 ***
Age (decades)	-0.02	0.01	0.00 **
Male	-0.01	0.02	0.52
Directed communication (both directions)	-0.02	0.02	0.25
Passive consumption	0.01	0.01	0.74
Broadcasting	0.02	0.02	0.15

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.59

Number of observations: 3854, Number of groups: 1927

	Health this month		
	Value	SE	*p*-value
(Intercept)	3.41	0.02	0.00 ***
Health last month	0.70	0.01	0.00 ***
Age (decades)	-0.02	0.01	0.06 ·
Male	0.02	0.03	0.35
Directed communication (both directions)	0.00	0.03	0.99
Passive consumption	-0.00	0.02	0.94
Broadcasting	-0.01	0.03	0.80

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.50

Number of observations: 3854, Number of groups: 1927

H1b. Inbound and outbound directed communication

	Social support		
	Value	SE	*p*-value
(Intercept)	3.80	0.01	0.00 ***
Social support last month	0.83	0.01	0.00 ***
Age (decades)	0.01	0.00	0.01 **
Male	-0.01	0.01	0.68
Directed communication (in)	0.04	0.02	0.04 *
Directed communication (out)	-0.01	0.02	0.80
Passive consumption	-0.01	0.01	0.42
Broadcasting	-0.01	0.01	0.23

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.58

Number of observations: 3854, Number of groups: 1927

	Bridging social capital		
	Value	SE	*p*-value
(Intercept)	3.77	0.01	0.00 ***
Bridging social capital last month	0.67	0.01	0.00 ***
Age (decades)	0.00	0.01	0.37
Male	-0.03	0.01	0.04 *
Directed communication (in)	0.04	0.02	0.06 ·
Directed communication (out)	0.01	0.03	0.71
Passive consumption	-0.03	0.01	0.06 ·
Broadcasting	0.01	0.01	0.36

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.48

Number of observations: 3854, Number of groups: 1927

	Happiness		
	Value	SE	*p*-value
(Intercept)	3.47	0.01	0.00 ***
Happiness last month	0.79	0.01	0.00 ***
Age (decades)	0.01	0.01	0.02 *
Male	0.01	0.02	0.56
Directed communication (in)	0.07	0.03	0.02 *
Directed communication (out)	-0.03	0.03	0.38
Passive consumption	0.01	0.02	0.47
Broadcasting	-0.03	0.02	0.14

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.63

Number of observations: 3854, Number of groups: 1927

	Depression		
	Value	SE	*p*-value
(Intercept)	2.35	0.01	0.00 ***
Depression last month	0.78	0.01	0.00 ***
Age (decades)	-0.01	0.01	0.08 ·
Male	-0.02	0.02	0.27
Directed communication (in)	-0.04	0.02	0.12
Directed communication (out)	-0.01	0.03	0.76
Passive consumption	0.03	0.01	0.08 ·
Broadcasting	0.02	0.01	0.19

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.61

Number of observations: 3854, Number of groups: 1927

	Loneliness		
	Value	SE	*p*-value
(Intercept)	2.28	0.01	0.00 ***
Loneliness last month	0.79	0.01	0.00 ***
Age (decades)	-0.01	0.01	0.01 **
Male	0.00	0.02	0.81
Directed communication (in)	-0.03	0.03	0.23
Directed communication (out)	-0.02	0.03	0.37
Passive consumption	0.02	0.01	0.13
Broadcasting	0.02	0.02	0.28

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.64

Number of observations: 3854, Number of groups: 1927

	Positive affect		
	Value	SE	*p*-value
(Intercept)	3.64	0.01	0.00 ***
Positive affect last month	0.69	0.01	0.00 ***
Age (decades)	0.03	0.01	0.00 ***
Male	0.03	0.02	0.06 ·
Directed communication (in)	0.02	0.03	0.40
Directed communication (out)	0.01	0.03	0.67
Passive consumption	-0.02	0.02	0.14
Broadcasting	0.00	0.02	0.90

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.47

Number of observations: 3854, Number of groups: 1927

	Negative affect		
	Value	SE	*p*-value
(Intercept)	2.14	0.01	0.00 ***
Negative affect last month	0.71	0.01	0.00 ***
Age (decades)	-0.03	0.01	0.00 ***
Male	-0.03	0.02	0.06 ·
Directed communication (in)	-0.01	0.03	0.83
Directed communication (out)	-0.03	0.03	0.34
Passive consumption	0.03	0.02	0.11
Broadcasting	0.02	0.02	0.25

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.51

Number of observations: 3854, Number of groups: 1927

	Stress		
	Value	SE	*p*-value
(Intercept)	2.37	0.01	0.00 ***
Stress last month	0.79	0.01	0.00 ***
Age (decades)	-0.02	0.01	0.00 **
Male	-0.01	0.02	0.54
Directed communication (in)	-0.03	0.03	0.23
Directed communication (out)	0.01	0.03	0.76
Passive consumption	0.00	0.01	0.85
Broadcasting	0.02	0.02	0.16

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.59

Number of observations: 3854, Number of groups: 1927

	Health this month		
	Value	SE	*p*-value
(Intercept)	3.41	0.02	0.00 ***
Health last month	0.70	0.01	0.00 ***
Age (decades)	-0.02	0.01	0.08 ·
Male	0.02	0.03	0.37
Directed communication (in)	0.02	0.04	0.57
Directed communication (out)	-0.03	0.05	0.57
Passive consumption	0.00	0.02	0.98
Broadcasting	-0.01	0.03	0.82

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.50

Number of observations: 3854, Number of groups: 1927

H2. One-click and composed directed communication

	Social support		
	Value	SE	*p*-value
(Intercept)	3.80	0.01	0.00 ***
Social support last month	0.74	0.01	0.00 ***
Age (decades)	0.01	0.01	0.01 *
Male	-0.01	0.02	0.45
Composed directed communication (in)	0.04	0.02	0.00 **
One-click directed communication (in)	-0.02	0.01	0.18
Passive consumption	-0.01	0.01	0.53
Broadcasting	-0.01	0.01	0.69

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.58

Number of observations: 3854, Number of groups: 1927

	Bridging social capital		
	Value	SE	*p*-value
(Intercept)	3.77	0.01	0.00 ***
Bridging social capital last month	0.67	0.01	0.00 ***
Age (decades)	0.00	0.01	0.36
Male	-0.03	0.01	0.05 *
Composed directed communication (in)	0.05	0.01	0.00 **
One-click directed communication (in)	-0.01	0.01	0.47
Passive consumption	-0.02	0.01	0.10
Broadcasting	0.02	0.01	0.16

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.48

Number of observations: 3854, Number of groups: 1927

	Happiness		
	Value	SE	*p*-value
(Intercept)	3.47	0.01	0.00 ***
Happiness last month	0.79	0.01	0.00 ***
Age (decades)	0.01	0.01	0.02 *
Male	0.01	0.02	0.44
Composed directed communication (in)	0.05	0.02	0.00 **
One-click directed communication (in)	-0.01	0.02	0.51
Passive consumption	0.01	0.02	0.57
Broadcasting	-0.03	0.02	0.11

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.63

Number of observations: 3854, Number of groups: 1927

	Depression		
	Value	SE	*p*-value
(Intercept)	2.35	0.01	0.00 ***
Depression last month	0.78	0.01	0.00 ***
Age (decades)	-0.01	0.01	0.12
Male	-0.02	0.02	0.32
Composed directed communication (in)	-0.02	0.02	0.26
One-click directed communication (in)	-0.01	0.01	0.36
Passive consumption	0.02	0.01	0.14
Broadcasting	0.01	0.01	0.35

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.61

Number of observations: 3854, Number of groups: 1927

	Loneliness		
	Value	SE	*p*-value
(Intercept)	2.28	0.01	0.00 ***
Loneliness last month	0.79	0.01	0.00 ***
Age (decades)	-0.01	0.01	0.01 **
Male	0.00	0.02	0.80
Composed directed communication (in)	-0.05	0.02	0.00 **
One-click directed communication (in)	0.02	0.01	0.23
Passive consumption	0.02	0.01	0.27
Broadcasting	0.01	0.01	0.58

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.64

Number of observations: 3854, Number of groups: 1927

	Positive affect		
	Value	SE	*p*-value
(Intercept)	3.64	0.01	0.00 ***
Positive affect last month	0.69	0.01	0.00 ***
Age (decades)	0.03	0.01	0.00 ***
Male	0.03	0.02	0.06 ·
Composed directed communication (in)	0.04	0.02	0.01 *
One-click directed communication (in)	-0.03	0.02	0.11
Passive consumption	-0.02	0.02	0.20
Broadcasting	0.01	0.02	0.58

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.47

Number of observations: 3854, Number of groups: 1927

	Negative affect		
	Value	SE	*p*-value
(Intercept)	2.14	0.01	0.00 ***
Negative affect last month	0.71	0.01	0.00 ***
Age (decades)	-0.03	0.01	0.00 ***
Male	-0.03	0.02	0.07 ·
Composed directed communication (in)	-0.02	0.02	0.37
One-click directed communication (in)	0.00	0.02	0.88
Passive consumption	0.02	0.02	0.25
Broadcasting	0.01	0.02	0.51

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.51

Number of observations: 3854, Number of groups: 1927

	Stress		
	Value	SE	*p*-value
(Intercept)	2.37	0.01	0.00 ***
Stress last month	0.79	0.01	0.00 ***
Age (decades)	-0.02	0.01	0.00 **
Male	-0.01	0.02	0.50
Composed directed communication (in)	-0.03	0.02	0.10
One-click directed communication (in)	0.01	0.01	0.34
Passive consumption	0.00	0.01	0.91
Broadcasting	0.02	0.01	0.24

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.59

Number of observations: 3854, Number of groups: 1927

	Health this month		
	Value	SE	*p*-value
(Intercept)	3.41	0.02	0.00 ***
Health last month	0.70	0.01	0.00 ***
Age (decades)	-0.02	0.01	0.06 ·
Male	0.02	0.03	0.37
Composed directed communication (in)	0.00	0.03	0.99
One-click directed communication (in)	-0.01	0.02	0.61
Passive consumption	0.00	0.02	0.94
Broadcasting	0.00	0.02	1.00

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.50

Number of observations: 3854, Number of groups: 1927

H3. Public and private directed communication

	Social support		
	Value	SE	*p*-value
(Intercept)	3.80	0.01	0.00 ***
Social support last month	0.74	0.01	0.00 ***
Age (decades)	0.01	0.01	0.02 *
Male	-0.01	0.02	0.44
Semi-public directed communication (in)	0.02	0.02	0.13
Private messages (in)	0.01	0.01	0.40
Passive consumption	-0.01	0.01	0.46
Broadcasting	-0.01	0.01	0.47

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.58

Number of observations: 3854, Number of groups: 1927

	Bridging social capital		
	Value	SE	*p*-value
(Intercept)	3.77	0.01	0.00 ***
Bridging social capital last month	0.67	0.01	0.00 ***
Age (decades)	0.00	0.01	0.35
Male	-0.03	0.01	0.04 *
Semi-public directed communication (in)	0.02	0.01	0.23
Private messages (in)	0.03	0.01	0.01 *
Passive consumption	-0.03	0.01	0.05 ·
Broadcasting	0.02	0.01	0.22

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.48

Number of observations: 3854, Number of groups: 1927

	Happiness		
	Value	SE	*p*-value
(Intercept)	3.47	0.01	0.00 ***
Happiness last month	0.79	0.01	0.00 ***
Age (decades)	0.01	0.01	0.06 ·
Male	0.02	0.02	0.36
Semi-public directed communication (in)	0.08	0.02	0.00 ***
Private messages (in)	-0.02	0.01	0.08 ·
Passive consumption	0.01	0.02	0.46
Broadcasting	-0.05	0.02	0.01 **

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.63

Number of observations: 3854, Number of groups: 1927

	Depression		
	Value	SE	*p*-value
(Intercept)	2.35	0.01	0.00 ***
Depression last month	0.78	0.01	0.00 ***
Age (decades)	-0.01	0.01	0.11
Male	-0.02	0.02	0.29
Semi-public directed communication (in)	-0.02	0.02	0.21
Private messages (in)	-0.01	0.01	0.32
Passive consumption	0.02	0.01	0.12
Broadcasting	0.01	0.02	0.34

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.61

Number of observations: 3854, Number of groups: 1927

	Loneliness		
	Value	SE	*p*-value
(Intercept)	2.28	0.01	0.00 ***
Loneliness last month	0.79	0.01	0.00 ***
Age (decades)	-0.01	0.01	0.01 **
Male	0.00	0.02	0.81
Semi-public directed communication (in)	-0.03	0.02	0.09 ·
Private messages (in)	-0.02	0.01	0.16
Passive consumption	0.02	0.01	0.18
Broadcasting	0.01	0.02	0.35

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.64

Number of observations: 3854, Number of groups: 1927

	Positive affect		
	Value	SE	*p*-value
(Intercept)	3.64	0.01	0.00 ***
Positive affect last month	0.69	0.01	0.00 ***
Age (decades)	0.03	0.01	0.00 ***
Male	0.03	0.02	0.06 ·
Semi-public directed communication (in)	0.01	0.02	0.57
Private messages (in)	0.02	0.01	0.08 ·
Passive consumption	-0.03	0.02	0.10
Broadcasting	0.01	0.02	0.78

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.47

Number of observations: 3854, Number of groups: 1927

	Negative affect		
	Value	SE	*p*-value
(Intercept)	2.14	0.01	0.00 ***
Negative affect last month	0.71	0.01	0.00 ***
Age (decades)	-0.03	0.01	0.00 ***
Male	-0.03	0.02	0.07 ·
Semi-public directed communication (in)	-0.02	0.02	0.38
Private messages (in)	-0.00	0.01	0.95
Passive consumption	0.02	0.02	0.25
Broadcasting	0.01	0.02	0.41

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.51

Number of observations: 3854, Number of groups: 1927

	Stress		
	Value	SE	*p*-value
(Intercept)	2.37	0.01	0.00 ***
Stress last month	0.79	0.01	0.00 ***
Age (decades)	-0.02	0.01	0.00 **
Male	-0.01	0.02	0.49
Semi-public directed communication (in)	-0.02	0.02	0.14
Private messages (in)	0.00	0.01	0.82
Passive consumption	0.00	0.01	0.88
Broadcasting	0.02	0.02	0.11

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.59

Number of observations: 3854, Number of groups: 1927

	Health this month		
	Value	SE	*p*-value
(Intercept)	3.41	0.02	0.00 ***
Health last month	0.70	0.01	0.00 ***
Age (decades)	-0.02	0.01	0.05 *
Male	0.02	0.03	0.37
Semi-public directed communication (in)	0.01	0.03	0.80
Private messages (in)	-0.02	0.02	0.44
Passive consumption	0.00	0.02	0.89
Broadcasting	-0.01	0.03	0.84

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.50

Number of observations: 3854, Number of groups: 1927

H4. and H5. Directed communication with strong and weak ties

	Social support		
	Value	SE	*p*-value
(Intercept)	3.80	0.01	0.00 ***
Social support last month	0.73	0.01	0.00 ***
Age (decades)	0.01	0.01	0.02 *
Male	-0.01	0.02	0.53
Directed communication (in) from strong ties	0.05	0.02	0.00 ***
Directed communication (in) from weak ties	0.00	0.02	0.85
Passive consumption	-0.01	0.01	0.32
Broadcasting	-0.02	0.01	0.29

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.58

Number of observations: 3854, Number of groups: 1927

	Bridging social capital		
	Value	SE	*p*-value
(Intercept)	3.76	0.01	0.00 ***
Bridging social capital last month	0.67	0.01	0.00 ***
Age (decades)	0.01	0.01	0.29
Male	-0.03	0.01	0.03 *
Directed communication (in) from strong ties	-0.01	0.02	0.49
Directed communication (in) from weak ties	0.06	0.02	0.00 ***
Passive consumption	-0.02	0.01	0.06 ·
Broadcasting	0.02	0.01	0.21

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.48

Number of observations: 3854, Number of groups: 1927

	Happiness		
	Value	SE	*p*-value
(Intercept)	3.47	0.01	0.00 ***
Happiness last month	0.79	0.01	0.00 ***
Age (decades)	0.01	0.01	0.05 *
Male	0.02	0.02	0.38
Directed communication (in) from strong ties	0.07	0.02	0.00 ***
Directed communication (in) from weak ties	-0.01	0.02	0.52
Passive consumption	0.01	0.02	0.64
Broadcasting	-0.03	0.02	0.09 ·

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.63

Number of observations: 3854, Number of groups: 1927

	Depression		
	Value	SE	*p*-value
(Intercept)	2.35	0.01	0.00 ***
Depression last month	0.78	0.01	0.00 ***
Age (decades)	-0.01	0.01	0.11
Male	-0.02	0.02	0.24
Directed communication (in) from strong ties	-0.04	0.02	0.01 *
Directed communication (in) from weak ties	-0.01	0.02	0.69
Passive consumption	0.02	0.01	0.10 ·
Broadcasting	0.02	0.01	0.26

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.61

Number of observations: 3854, Number of groups: 1927

	Loneliness		
	Value	SE	*p*-value
(Intercept)	2.28	0.01	0.00 ***
Loneliness last month	0.79	0.01	0.00 ***
Age (decades)	-0.01	0.01	0.01 **
Male	0.00	0.02	0.90
Directed communication (in) from strong ties	-0.06	0.02	0.00 ***
Directed communication (in) from weak ties	-0.00	0.02	0.92
Passive consumption	0.02	0.01	0.15
Broadcasting	0.02	0.02	0.27

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.64

Number of observations: 3854, Number of groups: 1927

	Positive affect		
	Value	SE	*p*-value
(Intercept)	3.64	0.01	0.00 ***
Positive affect last month	0.69	0.01	0.00 ***
Age (decades)	0.03	0.01	0.00 ***
Male	0.04	0.02	0.04 *
Directed communication (in) from strong ties	0.06	0.02	0.00 ***
Directed communication (in) from weak ties	-0.02	0.02	0.44
Passive consumption	-0.02	0.02	0.14
Broadcasting	0.00	0.02	0.87

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.47

Number of observations: 3854, Number of groups: 1927

	Negative affect		
	Value	SE	*p*-value
(Intercept)	2.14	0.01	0.00 ***
Negative affect last month	0.71	0.01	0.00 ***
Age (decades)	-0.03	0.01	0.00 ***
Male	-0.03	0.02	0.04 *
Directed communication (in) from strong ties	-0.05	0.02	0.00 **
Directed communication (in) from weak ties	0.02	0.02	0.39
Passive consumption	0.02	0.02	0.17
Broadcasting	0.02	0.02	0.34

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.51

Number of observations: 3854, Number of groups: 1927

	Stress		
	Value	SE	*p*-value
(Intercept)	2.37	0.01	0.00 ***
Stress last month	0.79	0.01	0.00 ***
Age (decades)	-0.02	0.01	0.00 **
Male	-0.01	0.02	0.46
Directed communication (in) from strong ties	-0.03	0.02	0.06 ·
Directed communication (in) from weak ties	0.00	0.02	0.88
Passive consumption	0.00	0.01	0.79
Broadcasting	0.02	0.01	0.15

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.59

Number of observations: 3854, Number of groups: 1927

	Health this month		
	Value	SE	*p*-value
(Intercept)	3.49	0.02	0.00 ***
Health last month	0.66	0.01	0.00 ***
Had an injury or illness between surveys	-0.56	0.04	0.00 ***
Age (decades)	-0.01	0.01	0.13
Male	0.01	0.03	0.75
Directed communication (in) from strong ties	0.07	0.03	0.00 **
Directed communication (in) from weak ties	-0.04	0.03	0.15
Passive consumption	-0.01	0.02	0.77
Broadcasting	-0.02	0.02	0.44

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.53

Number of observations: 3854, Number of groups: 1927

Social communication skill and well-being

	Social support		
	Value	SE	*p*-value
(Intercept)	3.81	0.01	0.00 ***
Social support last month	0.67	0.01	0.00 ***
Age (decades)	0.00	0.00	0.35
Male	-0.01	0.01	0.63
Social communication skill	0.08	0.00	0.00 ***

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.61

Number of observations: 3854, Number of groups: 1927

	Bridging social capital		
	Value	SE	*p*-value
(Intercept)	3.77	0.01	0.00 ***
Bridging social capital last month	0.63	0.01	0.00 ***
Age (decades)	-0.01	0.00	0.09 ·
Male	-0.03	0.01	0.02 *
Social communication skill	0.06	0.00	0.00 ***

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.50

Number of observations: 3854, Number of groups: 1927

	Happiness		
	Value	SE	*p*-value
(Intercept)	3.48	0.01	0.00 ***
Happiness last month	0.77	0.01	0.00 ***
Age (decades)	0.00	0.01	0.39
Male	0.01	0.02	0.53
Social communication skill	0.04	0.01	0.00 ***

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.64

Number of observations: 3854, Number of groups: 1927

	Depression		
	Value	SE	*p*-value
(Intercept)	2.35	0.01	0.00 ***
Depression last month	0.74	0.01	0.00 ***
Age (decades)	-0.01	0.00	0.08 ·
Male	-0.03	0.01	0.06 ·
Social communication skill	-0.05	0.00	0.00 ***

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.62

Number of observations: 3854, Number of groups: 1927

	Loneliness		
	Value	SE	*p*-value
(Intercept)	2.28	0.01	0.00 ***
Loneliness last month	0.71	0.01	0.00 ***
Age (decades)	-0.01	0.00	0.02 *
Male	0.00	0.02	0.98
Social communication skill	-0.09	0.01	0.00 ***

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.67

Number of observations: 3854, Number of groups: 1927

	Positive affect		
	Value	SE	*p*-value
(Intercept)	3.64	0.01	0.00 ***
Positive affect last month	0.64	0.01	0.00 ***
Age (decades)	0.03	0.01	0.00 ***
Male	0.04	0.02	0.01 *
Social communication skill	0.07	0.01	0.00 ***

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.49

Number of observations: 3854, Number of groups: 1927

	Negative affect		
	Value	SE	*p*-value
(Intercept)	2.14	0.01	0.00 ***
Negative affect last month	0.67	0.01	0.00 ***
Age (decades)	-0.03	0.01	0.00 ***
Male	-0.05	0.02	0.00 **
Social communication skill	-0.06	0.01	0.00 ***

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.53

Number of observations: 3854, Number of groups: 1927

	Stress		
	Value	SE	*p*-value
(Intercept)	2.37	0.01	0.00 ***
Stress last month	0.73	0.01	0.00 ***
Age (decades)	-0.02	0.00	0.00 ***
Male	-0.03	0.02	0.07 ·
Social communication skill	-0.06	0.00	0.00 ***

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.61

Number of observations: 3854, Number of groups: 1927

	Health this month		
	Value	SE	*p*-value
(Intercept)	3.41	0.02	0.00 ***
Health last month	0.69	0.01	0.00 ***
Age (decades)	-0.02	0.01	0.02 *
Male	0.04	0.03	0.17
Social communication skill	0.04	0.01	0.00 ***

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.80

Number of observations: 3854, Number of groups: 1927

Job loss and well-being

	Social support		
	Value	SE	*p*-value
(Intercept)	3.81	0.01	0.00 ***
Social support last month	0.74	0.01	0.00 ***
Age (decades)	0.01	0.00	0.05 *
Male	-0.02	0.01	0.23
Lost job in past month	0.02	0.06	0.77

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.57

Number of observations: 3854, Number of groups: 1927

	Bridging social capital		
	Value	SE	*p*-value
(Intercept)	3.77	0.01	0.00 ***
Bridging social capital last month	0.68	0.01	0.00 ***
Age (decades)	-0.00	0.00	0.57
Male	-0.04	0.01	0.01 **
Lost job in past month	0.05	0.06	0.37

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.48

Number of observations: 3854, Number of groups: 1927

	Happiness		
	Value	SE	*p*-value
(Intercept)	3.48	0.01	0.00 ***
Happiness last month	0.79	0.01	0.00 ***
Age (decades)	0.01	0.01	0.27
Male	0.01	0.02	0.71
Lost job in past month	-0.21	0.07	0.00 **

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.64

Number of observations: 3854, Number of groups: 1927

	Depression		
	Value	SE	*p*-value
(Intercept)	2.35	0.01	0.00 ***
Depression last month	0.78	0.01	0.00 ***
Age (decades)	-0.01	0.00	0.07 ·
Male	-0.01	0.02	0.36
Lost job in past month	0.12	0.06	0.03 *

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.61

Number of observations: 3854, Number of groups: 1927

	Loneliness		
	Value	SE	*p*-value
(Intercept)	2.28	0.01	0.00 ***
Loneliness last month	0.80	0.01	0.00 ***
Age (decades)	-0.01	0.00	0.02 *
Male	0.01	0.02	0.48
Lost job in past month	-0.04	0.06	0.49

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.64

Number of observations: 3854, Number of groups: 1927

	Positive affect		
	Value	SE	*p*-value
(Intercept)	3.64	0.01	0.00 ***
Positive affect last month	0.69	0.01	0.00 ***
Age (decades)	0.03	0.01	0.00 ***
Male	0.03	0.02	0.11
Lost job in past month	-0.10	0.07	0.14

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.47

Number of observations: 3854, Number of groups: 1927

	Negative affect		
	Value	SE	*p*-value
(Intercept)	2.14	0.01	0.00 ***
Negative affect last month	0.71	0.01	0.00 ***
Age (decades)	-0.03	0.01	0.00 ***
Male	-0.03	0.02	0.05 ·
Lost job in past month	0.24	0.07	0.00 ***

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.51

Number of observations: 3854, Number of groups: 1927

	Stress		
	Value	SE	*p*-value
(Intercept)	2.36	0.01	0.00 ***
Stress last month	0.78	0.01	0.00 ***
Age (decades)	-0.02	0.00	0.00 ***
Male	-0.01	0.02	0.49
Lost job in past month	0.21	0.06	0.00 ***

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.59

Number of observations: 3854, Number of groups: 1927

	Health this month		
	Value	SE	*p*-value
(Intercept)	3.49	0.02	0.00 ***
Health last month	0.66	0.01	0.00 ***
Had an illness or injury between surveys	-0.55	0.04	0.00 ***
Age (decades)	-0.01	0.01	0.13
Male	0.00	0.03	0.88
Lost job in past month	-0.13	0.10	0.16

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.81

Number of observations: 3854, Number of groups: 1927

RQ3. Interactions between job loss and strong/weak tie communication on well-being

	Social support		
	Value	SE	*p*-value
(Intercept)	3.81	0.01	0.00 ***
Social support last month	0.74	0.01	0.00 ***
Age (decades)	0.01	0.01	0.03 *
Male	-0.01	0.02	0.42
Lost job in past month	-0.01	0.06	0.93
Directed communication (in) from strong ties	0.04	0.02	0.02 *
Directed communication (in) from weak ties	0.00	0.02	0.95
Passive consumption	-0.01	0.01	0.37
Broadcasting	-0.01	0.01	0.42
Lost job in past month x Directed communication (in) from strong ties	-0.06	0.13	0.65
Lost job in past month x Directed communication (in) from weak ties	0.10	0.12	0.40

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.57

Number of observations: 3854, Number of groups: 1927

	Bridging social capital		
	Value	SE	*p*-value
(Intercept)	3.76	0.01	0.00 ***
Bridging social capital last month	0.67	0.01	0.00 ***
Age (decades)	0.01	0.01	0.21
Male	-0.03	0.01	0.03 *
Lost job in past month	0.01	0.06	0.86
Directed communication (in) from strong ties	-0.00	0.02	0.82
Directed communication (in) from weak ties	0.06	0.02	0.00 ***
Passive consumption	-0.02	0.01	0.09 ·
Broadcasting	0.01	0.01	0.32
Lost job in past month x Directed communication (in) from strong ties	-0.19	0.13	0.13
Lost job in past month x Directed communication (in) from weak ties	0.19	0.11	0.09 ·

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.48

Number of observations: 3854, Number of groups: 1927

	Happiness		
	Value	SE	*p*-value
(Intercept)	3.48	0.01	0.00 ***
Happiness last month	0.79	0.01	0.00 ***
Age (decades)	0.01	0.01	0.06 ·
Male	0.01	0.02	0.43
Lost job in past month	-0.20	0.07	0.01 **
Directed communication (in) from strong ties	0.06	0.02	0.00 **
Directed communication (in) from weak ties	-0.00	0.02	0.89
Passive consumption	0.01	0.02	0.75
Broadcasting	-0.03	0.02	0.07 ·
Lost job in past month x Directed communication (in) from strong ties	-0.20	0.15	0.20
Lost job in past month x Directed communication (in) from weak ties	0.05	0.14	0.70

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.64

Number of observations: 3854, Number of groups: 1927

	Depression		
	Value	SE	*p*-value
(Intercept)	2.35	0.01	0.00 ***
Depression last month	0.78	0.01	0.00 ***
Age (decades)	-0.01	0.01	0.15
Male	-0.02	0.02	0.26
Lost job in past month	0.14	0.06	0.03 *
Directed communication (in) from strong ties	-0.04	0.02	0.02 *
Directed communication (in) from weak ties	-0.00	0.02	0.94
Passive consumption	0.02	0.01	0.09 ·
Broadcasting	0.02	0.01	0.31
Lost job in past month x Directed communication (in) from strong ties	0.31	0.13	0.02 *
Lost job in past month x Directed communication (in) from weak ties	-0.17	0.12	0.14

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.61

Number of observations: 3854, Number of groups: 1927

	Loneliness		
	Value	SE	*p*-value
(Intercept)	2.28	0.01	0.00 ***
Loneliness last month	0.79	0.01	0.00 ***
Age (decades)	-0.01	0.01	0.02 *
Male	0.01	0.02	0.77
Lost job in past month	-0.02	0.06	0.81
Directed communication (in) from strong ties	-0.05	0.02	0.01 **
Directed communication (in) from weak ties	0.00	0.02	0.99
Passive consumption	0.02	0.01	0.16
Broadcasting	0.01	0.02	0.33
Lost job in past month x Directed communication (in) from strong ties	0.13	0.14	0.34
Lost job in past month x Directed communication (in) from weak ties	-0.14	0.12	0.25

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.64

Number of observations: 3854, Number of groups: 1927

	Positive affect		
	Value	SE	*p*-value
(Intercept)	3.64	0.01	0.00 ***
Positive affect last month	0.69	0.01	0.00 ***
Age (decades)	0.03	0.01	0.00 ***
Male	0.03	0.02	0.07 ·
Lost job in past month	-0.12	0.07	0.08 ·
Directed communication (in) from strong ties	0.02	0.02	0.37
Directed communication (in) from weak ties	0.01	0.02	0.48
Passive consumption	-0.02	0.02	0.17
Broadcasting	0.01	0.02	0.70
Lost job in past month x Directed communication (in) from strong ties	-0.30	0.15	0.05 *
Lost job in past month x Directed communication (in) from weak ties	0.20	0.13	0.13

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.47

Number of observations: 3854, Number of groups: 1927

	Negative affect		
	Value	SE	*p*-value
(Intercept)	2.13	0.01	0.00 ***
Negative affect last month	0.71	0.01	0.00 ***
Age (decades)	-0.02	0.01	0.00 ***
Male	-0.03	0.02	0.05 ·
Lost job in past month	0.25	0.07	0.00 ***
Directed communication (in) from strong ties	-0.03	0.02	0.23
Directed communication (in) from weak ties	0.00	0.02	1.00
Passive consumption	0.02	0.02	0.17
Broadcasting	0.01	0.02	0.43
Lost job in past month x Directed communication (in) from strong ties	0.15	0.15	0.31
Lost job in past month x Directed communication (in) from weak ties	-0.11	0.13	0.43

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.51

Number of observations: 3854, Number of groups: 1927

	Stress		
	Value	SE	*p*-value
(Intercept)	2.36	0.01	0.00 ***
Stress last month	0.78	0.01	0.00 ***
Age (decades)	-0.02	0.01	0.00 **
Male	-0.01	0.02	0.46
Lost job in past month	0.21	0.06	0.00 ***
Directed communication (in) from strong ties	-0.02	0.02	0.19
Directed communication (in) from weak ties	-0.00	0.02	0.87
Passive consumption	0.00	0.01	0.75
Broadcasting	0.02	0.01	0.17
Lost job in past month x Directed communication (in) from strong ties	0.27	0.13	0.04 *
Lost job in past month x Directed communication (in) from weak ties	-0.10	0.12	0.38

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.59

Number of observations: 3854, Number of groups: 1927

	Health this month		
	Value	SE	*p*-value
(Intercept)	3.50	0.02	0.00 ***
Health last month	0.66	0.01	0.00 ***
Had an illness or injury between surveys	-0.55	0.04	0.00 ***
Age (decades)	-0.01	0.01	0.11
Male	0.01	0.03	0.84
Lost job in past month	-0.13	0.10	0.20
Directed communication (in) from strong ties	0.06	0.03	0.07 ·
Directed communication (in) from weak ties	-0.03	0.03	0.24
Passive consumption	-0.01	0.02	0.74
Broadcasting	-0.02	0.02	0.48
Lost job in past month x Directed communication (in) from strong ties	-0.34	0.22	0.12
Lost job in past month x Directed communication (in) from weak ties	0.16	0.19	0.42

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$ $R^2_{y,\hat{y}}$: 0.81

Number of observations: 3854, Number of groups: 1927

Appendix C. Correlations and factor analysis

Chapter 2: Correlation between dyad-level activity variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Ego-reported tie strength	1.00	0.05	-0.04	-0.01	-0.18	-0.02	0.14	-0.02	-0.04	0.30	0.03	0.08	0.05	0.15	0.01	0.05	0.11	0.06
2. Ego age	0.05	1.00	-0.55	-0.46	-0.19	-0.45	-0.02	-0.18	0.01	-0.14	-0.03	-0.07	-0.03	-0.09	-0.01	-0.03	-0.07	-0.03
3. Age difference	-0.04	-0.55	1.00	0.26	-0.11	0.25	0.03	0.13	-0.05	0.02	0.01	0.02	0.02	0.04	0.01	0.00	0.01	0.02
4. Ego's number of friends‡	-0.01	-0.46	0.26	1.00	0.32	0.99	0.26	0.46	0.14	0.15	0.04	0.08	0.04	0.10	0.02	0.04	0.06	0.03
5. Alter's number of friends‡	-0.18	-0.19	-0.11	0.32	1.00	0.31	0.15	0.14	0.39	0.11	0.02	0.03	0.01	0.05	0.01	0.03	0.04	0.05
6. Number of mutual friends‡	-0.02	-0.45	0.25	0.99	0.31	1.00	0.27	0.47	0.14	0.15	0.04	0.08	0.05	0.09	0.02	0.04	0.05	0.03
7. Days since ego joined Facebook‡	0.14	-0.02	0.03	0.26	0.15	0.27	1.00	0.48	0.47	0.06	0.02	0.04	0.03	0.04	0.00	0.02	-0.02	0.01
8. Days since alter joined Facebook‡	-0.02	-0.18	0.13	0.46	0.14	0.47	0.48	1.00	0.27	0.08	0.03	0.04	0.04	0.03	0.00	0.02	0.02	0.01
9. Days since they became Facebook friends‡	-0.04	0.01	-0.05	0.14	0.39	0.14	0.47	0.27	1.00	0.06	0.01	0.03	0.03	0.02	0.00	0.01	0.01	0.01
10. Days ego initiated interaction	0.30	-0.14	0.02	0.15	0.11	0.15	0.06	0.08	0.06	1.00	0.07	0.19	0.13	0.54	0.07	0.16	0.52	0.31
11. Attended same event	0.03	-0.03	0.01	0.04	0.02	0.04	0.02	0.03	0.01	0.07	1.00	0.05	0.02	0.04	0.00	0.02	0.03	0.04
12. Co-appeared in photo	0.08	-0.07	0.02	0.08	0.03	0.08	0.04	0.04	0.03	0.19	0.05	1.00	0.10	0.18	0.01	0.10	0.18	0.04
13. Checked-in to same location	0.05	-0.03	0.02	0.04	0.01	0.05	0.03	0.04	0.03	0.13	0.02	0.10	1.00	0.07	0.00	0.02	0.07	0.01
14. Appeared in same thread	0.15	-0.09	0.04	0.10	0.05	0.09	0.04	0.03	0.02	0.54	0.04	0.18	0.07	1.00	0.05	0.10	0.28	0.31
15. Ego views of alter's other content	0.01	-0.01	0.01	0.02	0.01	0.02	0.00	0.00	0.00	0.07	0.00	0.01	0.00	0.05	1.00	0.01	0.03	0.03
16. Ego views of alter's photos	0.05	-0.03	0.00	0.04	0.03	0.04	0.02	0.02	0.01	0.16	0.02	0.10	0.02	0.10	0.01	1.00	0.13	0.04
17. Ego views of alter's profile	0.11	-0.07	0.01	0.06	0.04	0.05	-0.02	0.02	0.01	0.52	0.03	0.18	0.07	0.28	0.03	0.13	1.00	0.30
18. Ego views of alter's shared content	0.06	-0.03	0.02	0.03	0.05	0.03	0.01	0.01	0.01	0.31	0.04	0.04	0.01	0.31	0.03	0.04	0.30	1.00
19. Ego comments on alter's content	0.13	-0.06	0.00	0.07	0.06	0.07	0.02	0.02	0.02	0.49	0.03	0.13	0.05	0.80	0.04	0.11	0.29	0.37
20. Groups ego added alter to	0.04	-0.04	0.01	0.02	0.00	0.02	-0.02	-0.01	-0.02	0.06	0.00	0.03	0.01	0.06	0.02	0.00	0.03	0.03
21. Ego likes of alter's content	0.08	-0.04	0.02	0.06	0.04	0.06	0.01	0.01	0.01	0.39	0.03	0.14	0.04	0.54	0.04	0.07	0.30	0.33
22. Messages written by ego to alter	0.04	-0.03	0.01	0.02	0.00	0.02	-0.01	0.00	-0.01	0.17	0.01	0.17	0.04	0.17	0.01	0.02	0.31	0.05
23. Pokes by ego to alter	0.04	-0.03	0.01	0.02	0.01	0.02	0.00	0.01	0.00	0.22	0.00	0.14	0.00	0.14	0.01	0.01	0.19	0.04
24. Content saved by ego on alter's wall	0.05	-0.05	0.02	0.04	0.02	0.04	0.01	0.02	0.02	0.18	0.01	0.05	0.04	0.21	0.01	0.03	0.20	0.23
25. Wall posts written by ego on alter's wall	0.10	-0.06	0.01	0.06	0.03	0.06	0.01	0.02	0.01	0.30	0.01	0.16	0.04	0.37	0.01	0.06	0.25	0.14
26. Photo tags by ego of alter	0.07	-0.07	0.03	0.07	0.02	0.07	0.03	0.04	0.01	0.18	0.03	0.57	0.10	0.18	0.01	0.06	0.19	0.04
27. Days ego initiated interaction (90d)	0.31	-0.13	0.02	0.17	0.12	0.17	0.12	0.10	0.10	0.92	0.07	0.17	0.12	0.52	0.06	0.15	0.48	0.30
28. Ego likes of alter's content (90d)	0.09	-0.04	0.02	0.07	0.05	0.07	0.03	0.02	0.02	0.40	0.03	0.12	0.04	0.50	0.04	0.07	0.29	0.35
29. Messages written by ego to alter (90d)	0.04	-0.04	0.01	0.02	0.01	0.02	-0.01	0.00	0.00	0.18	0.01	0.13	0.02	0.15	0.01	0.02	0.26	0.06
30. Pokes by ego to alter (90d)	0.05	-0.03	0.01	0.03	0.01	0.03	0.01	0.02	0.01	0.22	0.01	0.06	0.01	0.11	0.01	0.02	0.12	0.03
31. Attended same event (90d)	0.05	-0.04	0.02	0.05	0.02	0.05	0.03	0.04	0.03	0.10	0.59	0.07	0.05	0.05	0.01	0.02	0.03	0.04
32. Co-appeared in photo (90d)	0.12	-0.10	0.03	0.12	0.05	0.11	0.06	0.07	0.04	0.24	0.06	0.72	0.10	0.20	0.02	0.09	0.17	0.06
33. Checked-in to same location (90d)	0.06	-0.03	0.02	0.05	0.02	0.05	0.04	0.05	0.03	0.13	0.03	0.08	0.77	0.07	0.00	0.04	0.07	0.01
34. Appeared in same thread (90d)	0.16	-0.10	0.04	0.11	0.05	0.11	0.06	0.05	0.04	0.53	0.03	0.15	0.07	0.88	0.06	0.10	0.26	0.30
35. Views of alter's other content (90d)	0.02	-0.01	0.00	0.02	0.02	0.02	0.00	0.01	0.00	0.09	0.00	0.01	0.00	0.07	0.89	0.01	0.03	0.05

‡Continuous variable that was logged (base 2, after adding 1), divided by SD, and centered at mean.

	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58
1. Ego-reported tie strength	0.13	0.14	0.02	0.04	0.10	0.08	0.11	0.02	0.08	0.04	0.04	0.05	0.10	0.07	0.30	0.08	0.04	0.05	0.06	0.10
2. Ego age	-0.08	-0.06	-0.02	-0.04	-0.07	-0.06	-0.10	-0.02	-0.05	-0.04	-0.03	-0.04	-0.06	-0.07	-0.18	-0.06	-0.04	-0.03	-0.06	-0.08
3. Age difference	0.02	0.01	0.01	0.02	0.03	0.04	0.05	0.01	0.03	0.01	0.01	0.02	0.01	0.02	0.09	0.03	0.02	0.01	0.02	0.03
4. Ego's number of friends‡	0.09	0.08	0.02	0.04	0.07	0.08	0.09	0.02	0.07	0.02	0.02	0.04	0.07	0.07	0.22	0.08	0.02	0.03	0.06	0.08
5. Alter's number of friends‡	0.05	0.06	0.01	0.01	0.01	0.00	0.03	0.01	0.03	0.01	0.01	0.02	0.04	0.04	0.08	0.03	0.01	0.01	0.02	0.02
6. Number of mutual friends‡	0.09	0.08	0.01	0.04	0.07	0.08	0.09	0.02	0.06	0.02	0.02	0.04	0.07	0.07	0.22	0.07	0.02	0.03	0.06	0.08
7. Days since ego joined Facebook‡	0.04	0.05	0.00	0.01	-0.01	0.02	0.02	-0.01	0.02	-0.01	0.00	0.01	0.02	0.03	0.12	0.02	-0.01	0.01	0.03	0.00
8. Days since alter joined Facebook‡	0.03	0.03	0.01	0.02	0.02	0.03	0.03	0.00	0.02	0.00	0.01	0.02	0.03	0.03	0.13	0.02	0.00	0.01	0.03	0.02
9. Days since they became Facebook friends‡	0.03	0.04	0.00	0.00	0.00	0.00	0.01	-0.01	0.00	-0.01	0.00	0.01	0.02	0.02	0.08	0.01	-0.01	0.00	0.02	0.00
10. Days ego initiated interaction	0.36	0.49	0.06	0.11	0.29	0.27	0.39	0.05	0.32	0.17	0.21	0.17	0.28	0.18	0.72	0.33	0.18	0.23	0.15	0.30
11. Attended same event	0.01	0.03	0.00	0.02	0.02	0.03	0.03	0.00	0.03	0.01	0.00	0.02	0.03	0.03	0.08	0.03	0.01	0.01	0.02	0.02
12. Co-appeared in photo	0.18	0.11	0.02	0.21	0.15	0.05	0.18	0.04	0.16	0.18	0.14	0.06	0.18	0.53	0.19	0.15	0.18	0.10	0.19	0.15
13. Checked-in to same location	0.05	0.05	0.01	0.02	0.06	0.02	0.05	0.01	0.04	0.03	0.00	0.01	0.03	0.07	0.13	0.04	0.02	0.01	0.04	0.07
14. Appeared in same thread	0.41	0.73	0.06	0.19	0.38	0.38	0.78	0.05	0.56	0.19	0.14	0.26	0.44	0.18	0.55	0.52	0.19	0.13	0.18	0.36
15. Ego views of alter's other content	0.02	0.05	0.21	0.01	0.02	0.02	0.03	0.05	0.04	0.02	0.01	0.01	0.01	0.01	0.06	0.04	0.01	0.01	0.01	0.01
16. Ego views of alter's photos	0.07	0.10	0.01	0.05	0.05	0.04	0.07	0.01	0.05	0.02	0.01	0.04	0.07	0.18	0.11	0.05	0.02	0.01	0.03	0.05
17. Ego views of alter's profile	0.29	0.28	0.03	0.18	0.32	0.14	0.24	0.04	0.26	0.30	0.19	0.11	0.20	0.09	0.30	0.25	0.28	0.16	0.14	0.32
18. Ego views of alter's shared content	0.15	0.39	0.03	0.05	0.14	0.34	0.24	0.03	0.26	0.06	0.04	0.26	0.13	0.05	0.24	0.26	0.07	0.04	0.05	0.15
19. Comments by ego on alter's content	0.42	0.85	0.04	0.12	0.29	0.28	0.54	0.04	0.44	0.14	0.10	0.18	0.37	0.18	0.44	0.40	0.14	0.09	0.12	0.28
20. Groups ego added alter to	0.04	0.04	0.04	0.01	0.05	0.03	0.06	0.03	0.06	0.02	0.02	0.01	0.07	0.01	0.06	0.07	0.02	0.02	0.01	0.04
21. Ego likes of alter's content	0.25	0.45	0.03	0.17	0.32	0.27	0.46	0.04	0.64	0.19	0.17	0.14	0.30	0.14	0.34	0.61	0.19	0.14	0.13	0.30
22. Messages written by ego to alter	0.11	0.12	0.02	0.25	0.26	0.05	0.19	0.05	0.21	0.95	0.28	0.03	0.13	0.04	0.16	0.18	0.92	0.23	0.19	0.22
23. Pokes by ego to alter	0.06	0.08	0.01	0.23	0.21	0.03	0.17	0.06	0.22	0.33	1.00	0.01	0.07	0.03	0.22	0.18	0.32	0.93	0.14	0.19
24. Content saved by ego on alter's wall	0.34	0.21	0.01	0.04	0.11	0.30	0.17	0.00	0.14	0.05	0.01	0.24	0.16	0.04	0.17	0.14	0.04	0.02	0.08	0.12
25. Wall posts written by ego on alter's wall	0.82	0.34	0.02	0.08	0.23	0.17	0.35	0.01	0.24	0.10	0.06	0.16	0.45	0.13	0.27	0.24	0.10	0.06	0.11	0.23
26. Photo tags by ego of alter	0.18	0.12	0.03	0.23	0.14	0.05	0.21	0.03	0.18	0.15	0.12	0.03	0.15	0.41	0.17	0.16	0.15	0.09	0.17	0.14
27. Days ego initiated interaction (90d)	0.38	0.53	0.06	0.11	0.28	0.26	0.36	0.04	0.31	0.16	0.20	0.16	0.27	0.17	0.78	0.34	0.18	0.23	0.16	0.31
28. Ego likes of alter's content (90d)	0.26	0.49	0.03	0.12	0.29	0.26	0.40	0.03	0.60	0.13	0.14	0.14	0.27	0.12	0.39	0.63	0.14	0.13	0.11	0.30
29. Messages written by ego to alter (90d)	0.12	0.13	0.02	0.20	0.23	0.05	0.17	0.04	0.19	0.90	0.24	0.03	0.11	0.04	0.19	0.17	0.93	0.20	0.16	0.22
30. Pokes by ego to alter (90d)	0.08	0.09	0.01	0.10	0.14	0.04	0.10	0.02	0.13	0.20	0.85	0.01	0.06	0.03	0.26	0.12	0.20	0.96	0.07	0.15
31. Attended same event (90d)	0.04	0.05	0.01	0.02	0.03	0.05	0.04	0.01	0.04	0.01	0.01	0.03	0.04	0.05	0.12	0.05	0.01	0.01	0.03	0.03
32. Co-appeared in photo (90d)	0.22	0.16	0.02	0.15	0.15	0.08	0.17	0.03	0.14	0.11	0.09	0.10	0.20	0.42	0.28	0.15	0.12	0.08	0.19	0.17
33. Checked-in to same location (90d)	0.06	0.06	0.00	0.02	0.06	0.02	0.06	0.01	0.03	0.02	0.01	0.01	0.03	0.07	0.14	0.04	0.02	0.01	0.04	0.07
34. Appeared in same thread (90d)	0.44	0.81	0.06	0.15	0.33	0.36	0.67	0.04	0.50	0.16	0.11	0.24	0.39	0.17	0.62	0.53	0.17	0.12	0.18	0.35
35. Views of alter's other content (90d)	0.02	0.08	0.21	0.01	0.02	0.04	0.04	0.05	0.05	0.02	0.01	0.02	0.02	0.02	0.08	0.05	0.02	0.01	0.01	0.02

	59	60	61
1. Ego-reported tie strength	0.09	0.11	0.13
2. Ego age	-0.07	-0.07	-0.11
3. Age difference	0.05	0.02	0.06
4. Ego's number of friends‡	0.09	0.08	0.11
5. Alter's number of friends‡	0.01	0.05	0.03
6. Number of mutual friends‡	0.09	0.08	0.10
7. Days since ego joined Facebook‡	0.03	0.03	0.04
8. Days since alter joined Facebook‡	0.04	0.04	0.04
9. Days since they became Facebook friends‡	0.01	0.03	0.01
10. Days ego initiated interaction	0.29	0.31	0.42
11. Attended same event	0.03	0.02	0.03
12. Co-appeared in photo	0.06	0.19	0.16
13. Checked-in to same location	0.03	0.04	0.05
14. Appeared in same thread	0.40	0.46	0.77
15. Ego views of alter's other content	0.03	0.01	0.06
16. Ego views of alter's photos	0.05	0.08	0.07
17. Ego views of alter's profile	0.16	0.21	0.24
18. Ego views of alter's shared content	0.37	0.14	0.25
19. Comments by ego on alter's content	0.31	0.38	0.56
20. Groups ego added alter to	0.04	0.06	0.07
21. Ego likes of alter's content	0.29	0.29	0.45
22. Messages written by ego to alter	0.05	0.12	0.17
23. Pokes by ego to alter	0.03	0.07	0.15
24. Content saved by ego on alter's wall	0.32	0.17	0.17
25. Wall posts written by ego on alter's wall	0.19	0.49	0.35
26. Photo tags by ego of alter	0.07	0.17	0.19
27. Days ego initiated interaction (90d)	0.31	0.32	0.44
28. Ego likes of alter's content (90d)	0.31	0.28	0.45
29. Messages written by ego to alter (90d)	0.07	0.12	0.17
30. Pokes by ego to alter (90d)	0.04	0.08	0.12
31. Attended same event (90d)	0.05	0.04	0.04
32. Co-appeared in photo (90d)	0.09	0.23	0.20
33. Checked-in to same location (90d)	0.03	0.04	0.06
34. Appeared in same thread (90d)	0.43	0.45	0.78
35. Views of alter's other content (90d)	0.04	0.02	0.08

	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
36. Ego views of alter's photos (90d)	0.03	0.02	0.02	0.18	0.01	0.09	0.02	0.12	0.02	0.63	0.14	0.05	0.12	0.01	0.07	0.02	0.01	0.04
37. Ego views of alter's profile (90d)	0.01	0.03	0.02	0.51	0.03	0.14	0.07	0.25	0.03	0.12	0.91	0.34	0.27	0.03	0.27	0.22	0.15	0.19
38. Ego views of alter's shared content (90d)	0.02	0.02	0.02	0.27	0.03	0.03	0.01	0.24	0.03	0.04	0.31	0.90	0.32	0.02	0.28	0.04	0.02	0.22
39. Alter wall posts written by ego (90d)	0.04	0.03	0.03	0.36	0.01	0.18	0.05	0.41	0.02	0.07	0.29	0.15	0.42	0.04	0.25	0.11	0.06	0.34
40. Ego comments on alter's content (90d)	0.05	0.03	0.04	0.49	0.03	0.11	0.05	0.73	0.05	0.10	0.28	0.39	0.85	0.04	0.45	0.12	0.08	0.21
41. Alter views of ego's other content	0.00	0.01	0.00	0.06	0.00	0.02	0.01	0.06	0.21	0.01	0.03	0.03	0.04	0.04	0.03	0.02	0.01	0.01
42. Alter views of ego's photos	0.01	0.02	0.00	0.11	0.02	0.21	0.02	0.19	0.01	0.05	0.18	0.05	0.12	0.01	0.17	0.25	0.23	0.04
43. Alter views of ego's profile	-0.01	0.02	0.00	0.29	0.02	0.15	0.06	0.38	0.02	0.05	0.32	0.14	0.29	0.05	0.32	0.26	0.21	0.11
44. Alter views of ego's shared content	0.02	0.03	0.00	0.27	0.03	0.05	0.02	0.38	0.02	0.04	0.14	0.34	0.28	0.03	0.27	0.05	0.03	0.30
45. Comments by alter on ego's content	0.02	0.03	0.01	0.39	0.03	0.18	0.05	0.78	0.03	0.07	0.24	0.24	0.54	0.06	0.46	0.19	0.17	0.17
46. Groups alter added ego to	-0.01	0.00	-0.01	0.05	0.00	0.04	0.01	0.05	0.05	0.01	0.04	0.03	0.04	0.03	0.04	0.05	0.06	0.00
47. Alter likes of ego content	0.02	0.02	0.00	0.32	0.03	0.16	0.04	0.56	0.04	0.05	0.26	0.26	0.44	0.06	0.64	0.21	0.22	0.14
48. Messages written by alter to ego	-0.01	0.00	-0.01	0.17	0.01	0.18	0.03	0.19	0.02	0.02	0.30	0.06	0.14	0.02	0.19	0.95	0.33	0.05
49. Pokes by alter to ego	0.00	0.01	0.00	0.21	0.00	0.14	0.00	0.14	0.01	0.01	0.19	0.04	0.10	0.02	0.17	0.28	1.00	0.01
50. Content saved by alter on ego's wall	0.01	0.02	0.01	0.17	0.02	0.06	0.01	0.26	0.01	0.04	0.11	0.26	0.18	0.01	0.14	0.03	0.01	0.24
51. Wall posts written by alter on ego's wall	0.02	0.03	0.02	0.28	0.03	0.18	0.03	0.44	0.01	0.07	0.20	0.13	0.37	0.07	0.30	0.13	0.07	0.16
52. Photo tags by alter of ego	0.03	0.03	0.02	0.18	0.03	0.53	0.07	0.18	0.01	0.18	0.09	0.05	0.18	0.01	0.14	0.04	0.03	0.04
53. Days alter initiated interaction (90d)	0.12	0.13	0.08	0.72	0.08	0.19	0.13	0.55	0.06	0.11	0.30	0.24	0.44	0.06	0.34	0.16	0.22	0.17
54. Alter likes of ego content (90d)	0.02	0.02	0.01	0.33	0.03	0.15	0.04	0.52	0.04	0.05	0.25	0.26	0.40	0.07	0.61	0.18	0.18	0.14
55. Messages written by alter to ego (90d)	-0.01	0.00	-0.01	0.18	0.01	0.18	0.02	0.19	0.01	0.02	0.28	0.07	0.14	0.02	0.19	0.92	0.32	0.04
56. Pokes by alter to ego (90d)	0.01	0.01	0.00	0.23	0.01	0.10	0.01	0.13	0.01	0.01	0.16	0.04	0.09	0.02	0.14	0.23	0.93	0.02
57. Alter views of ego's photos (90d)	0.03	0.03	0.02	0.15	0.02	0.19	0.04	0.18	0.01	0.03	0.14	0.05	0.12	0.01	0.13	0.19	0.14	0.08
58. Alter views of ego's profile (90d)	0.00	0.02	0.00	0.30	0.02	0.15	0.07	0.36	0.01	0.05	0.32	0.15	0.28	0.04	0.30	0.22	0.19	0.12
59. Alter views of ego's shared content (90d)	0.03	0.04	0.01	0.29	0.03	0.06	0.03	0.40	0.03	0.05	0.16	0.37	0.31	0.04	0.29	0.05	0.03	0.32
60. Ego wall posts written by alter (90d)	0.03	0.04	0.03	0.31	0.02	0.19	0.04	0.46	0.01	0.08	0.21	0.14	0.38	0.06	0.29	0.12	0.07	0.17
61. Alter comments on ego's content (90d)	0.04	0.04	0.01	0.42	0.03	0.16	0.05	0.77	0.06	0.07	0.24	0.25	0.56	0.07	0.45	0.17	0.15	0.17

	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
36. Ego views of alter's photos (90d)	0.08	0.07	0.19	0.09	0.03	0.03	0.02	0.12	0.04	0.13	0.02	1.00	0.15	0.05	0.09	0.14	0.01	0.04
37. Ego views of alter's profile (90d)	0.21	0.15	0.53	0.30	0.22	0.12	0.03	0.16	0.07	0.28	0.03	0.15	1.00	0.38	0.30	0.32	0.03	0.13
38. Ego views of alter's shared content (90d)	0.10	0.03	0.29	0.35	0.05	0.02	0.03	0.05	0.01	0.29	0.05	0.05	0.38	1.00	0.13	0.41	0.03	0.03
39. Alter wall posts written by ego (90d)	0.82	0.18	0.38	0.26	0.12	0.08	0.04	0.22	0.06	0.44	0.02	0.09	0.30	0.13	1.00	0.45	0.03	0.09
40. Ego comments on alter's content (90d)	0.34	0.12	0.53	0.49	0.13	0.09	0.05	0.16	0.06	0.81	0.08	0.14	0.32	0.41	0.45	1.00	0.06	0.10
41. Alter views of ego's other content	0.02	0.03	0.06	0.03	0.02	0.01	0.01	0.02	0.00	0.06	0.21	0.01	0.03	0.03	0.03	0.06	1.00	0.01
42. Alter views of ego's photos	0.08	0.23	0.11	0.12	0.20	0.10	0.02	0.15	0.02	0.15	0.01	0.04	0.13	0.03	0.09	0.10	0.01	1.00
43. Alter views of ego's profile	0.23	0.14	0.28	0.29	0.23	0.14	0.03	0.15	0.06	0.33	0.02	0.06	0.29	0.11	0.25	0.26	0.04	0.25
44. Alter views of ego's shared content	0.17	0.05	0.26	0.26	0.05	0.04	0.05	0.08	0.02	0.36	0.04	0.05	0.15	0.29	0.20	0.27	0.05	0.05
45. Comments by alter on ego's content	0.35	0.21	0.36	0.40	0.17	0.10	0.04	0.17	0.06	0.67	0.04	0.09	0.21	0.19	0.38	0.51	0.04	0.23
46. Groups alter added ego to	0.01	0.03	0.04	0.03	0.04	0.02	0.01	0.03	0.01	0.04	0.05	0.01	0.03	0.03	0.01	0.04	0.03	0.06
47. Alter likes of ego content	0.24	0.18	0.31	0.60	0.19	0.13	0.04	0.14	0.03	0.50	0.05	0.06	0.24	0.21	0.27	0.39	0.05	0.25
48. Messages written by alter to ego	0.10	0.15	0.16	0.13	0.90	0.20	0.01	0.11	0.02	0.16	0.02	0.03	0.22	0.04	0.10	0.12	0.02	0.30
49. Pokes by alter to ego	0.06	0.12	0.20	0.14	0.24	0.85	0.01	0.09	0.01	0.11	0.01	0.01	0.15	0.02	0.06	0.08	0.01	0.23
50. Content saved by alter on ego's wall	0.16	0.03	0.16	0.14	0.03	0.01	0.03	0.10	0.01	0.24	0.02	0.05	0.12	0.19	0.19	0.19	0.01	0.03
51. Wall posts written by alter on ego's wall	0.45	0.15	0.27	0.27	0.11	0.06	0.04	0.20	0.03	0.39	0.02	0.09	0.18	0.10	0.49	0.33	0.02	0.13
52. Photo tags by alter of ego	0.13	0.41	0.17	0.12	0.04	0.03	0.05	0.42	0.07	0.17	0.02	0.14	0.09	0.05	0.17	0.16	0.04	0.09
53. Days alter initiated interaction (90d)	0.27	0.17	0.78	0.39	0.19	0.26	0.12	0.28	0.14	0.62	0.08	0.14	0.33	0.23	0.37	0.51	0.08	0.14
54. Alter likes of ego content (90d)	0.24	0.16	0.34	0.63	0.17	0.12	0.05	0.15	0.04	0.53	0.05	0.07	0.25	0.24	0.28	0.41	0.05	0.21
55. Messages written by alter to ego (90d)	0.10	0.15	0.18	0.14	0.93	0.20	0.01	0.12	0.02	0.17	0.02	0.03	0.22	0.05	0.11	0.13	0.02	0.29
56. Pokes by alter to ego (90d)	0.06	0.09	0.23	0.13	0.20	0.96	0.01	0.08	0.01	0.12	0.01	0.02	0.14	0.03	0.07	0.09	0.01	0.16
57. Alter views of ego's photos (90d)	0.11	0.17	0.16	0.11	0.16	0.07	0.03	0.19	0.04	0.18	0.01	0.04	0.12	0.04	0.15	0.13	0.02	0.60
58. Alter views of ego's profile (90d)	0.23	0.14	0.31	0.30	0.22	0.15	0.03	0.17	0.07	0.35	0.02	0.06	0.31	0.13	0.28	0.28	0.03	0.22
59. Alter views of ego's shared content (90d)	0.19	0.07	0.31	0.31	0.07	0.04	0.05	0.09	0.03	0.43	0.04	0.06	0.18	0.36	0.25	0.34	0.06	0.06
60. Ego wall posts written by alter (90d)	0.49	0.17	0.32	0.28	0.12	0.08	0.04	0.23	0.04	0.45	0.02	0.11	0.21	0.12	0.62	0.38	0.02	0.14
61. Alter comments on ego's content (90d)	0.35	0.19	0.44	0.45	0.17	0.12	0.04	0.20	0.06	0.78	0.08	0.10	0.23	0.23	0.42	0.61	0.07	0.20

	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61
36. Ego views of alter's photos (90d)	0.06	0.05	0.09	0.01	0.06	0.03	0.01	0.05	0.09	0.14	0.14	0.07	0.03	0.02	0.04	0.06	0.06	0.11	0.10
37. Ego views of alter's profile (90d)	0.29	0.15	0.21	0.03	0.24	0.22	0.15	0.12	0.18	0.09	0.33	0.25	0.22	0.14	0.12	0.31	0.18	0.21	0.23
38. Ego views of alter's shared content (90d)	0.11	0.29	0.19	0.03	0.21	0.04	0.02	0.19	0.10	0.05	0.23	0.24	0.05	0.03	0.04	0.13	0.36	0.12	0.23
39. Alter wall posts written by ego (90d)	0.25	0.20	0.38	0.01	0.27	0.10	0.06	0.19	0.49	0.17	0.37	0.28	0.11	0.07	0.15	0.28	0.25	0.62	0.42
40. Ego comments on alter's content (90d)	0.26	0.27	0.51	0.04	0.39	0.12	0.08	0.19	0.33	0.16	0.51	0.41	0.13	0.09	0.13	0.28	0.34	0.38	0.61
41. Alter views of ego's other content	0.04	0.05	0.04	0.03	0.05	0.02	0.01	0.01	0.02	0.04	0.08	0.05	0.02	0.01	0.02	0.03	0.06	0.02	0.07
42. Alter views of ego's photos	0.25	0.05	0.23	0.06	0.25	0.30	0.23	0.03	0.13	0.09	0.14	0.21	0.29	0.16	0.60	0.22	0.06	0.14	0.20
43. Alter views of ego's profile	1.00	0.30	0.42	0.05	0.43	0.30	0.21	0.18	0.38	0.11	0.43	0.40	0.30	0.18	0.19	0.95	0.32	0.36	0.41
44. Alter views of ego's shared content	0.30	1.00	0.37	0.02	0.39	0.06	0.03	0.30	0.17	0.06	0.36	0.38	0.06	0.04	0.08	0.32	0.91	0.18	0.37
45. Comments by alter on ego's content	0.42	0.37	1.00	0.06	0.55	0.23	0.17	0.26	0.52	0.16	0.44	0.51	0.22	0.14	0.20	0.39	0.39	0.52	0.90
46. Groups alter added ego to	0.05	0.02	0.06	1.00	0.06	0.06	0.06	0.04	0.02	0.01	0.05	0.05	0.06	0.04	0.03	0.04	0.02	0.02	0.05
47. Alter likes of ego content	0.43	0.39	0.55	0.06	1.00	0.26	0.22	0.18	0.35	0.12	0.40	0.94	0.26	0.17	0.18	0.41	0.42	0.34	0.54
48. Messages written by alter to ego	0.30	0.06	0.23	0.06	0.26	1.00	0.33	0.04	0.15	0.04	0.18	0.22	0.96	0.26	0.21	0.26	0.07	0.13	0.20
49. Pokes by alter to ego	0.21	0.03	0.17	0.06	0.22	0.33	1.00	0.01	0.07	0.03	0.22	0.18	0.31	0.93	0.14	0.19	0.03	0.07	0.15
50. Content saved by alter on ego's wall	0.18	0.30	0.26	0.04	0.18	0.04	0.01	1.00	0.25	0.07	0.19	0.18	0.04	0.02	0.06	0.18	0.31	0.26	0.27
51. Wall posts written by alter on ego's wall	0.38	0.17	0.52	0.02	0.35	0.15	0.07	0.25	1.00	0.18	0.32	0.33	0.14	0.07	0.15	0.34	0.20	0.87	0.50
52. Photo tags by alter of ego	0.11	0.06	0.16	0.01	0.12	0.04	0.03	0.07	0.18	1.00	0.20	0.11	0.05	0.03	0.11	0.11	0.08	0.20	0.16
53. Days alter initiated interaction (90d)	0.43	0.36	0.44	0.05	0.40	0.18	0.22	0.19	0.32	0.20	1.00	0.44	0.20	0.26	0.20	0.47	0.41	0.38	0.52
54. Alter likes of ego content (90d)	0.40	0.38	0.51	0.05	0.94	0.22	0.18	0.18	0.33	0.11	0.44	1.00	0.23	0.16	0.18	0.41	0.44	0.34	0.56
55. Messages written by alter to ego (90d)	0.30	0.06	0.22	0.06	0.26	0.96	0.31	0.04	0.14	0.05	0.20	0.23	1.00	0.26	0.21	0.27	0.08	0.14	0.21
56. Pokes by alter to ego (90d)	0.18	0.04	0.14	0.04	0.17	0.26	0.93	0.02	0.07	0.03	0.26	0.16	0.26	1.00	0.10	0.17	0.04	0.08	0.14
57. Alter views of ego's photos (90d)	0.19	0.08	0.20	0.03	0.18	0.21	0.14	0.06	0.15	0.11	0.20	0.18	0.21	0.10	1.00	0.19	0.10	0.20	0.21
58. Alter views of ego's profile (90d)	0.95	0.32	0.39	0.04	0.41	0.26	0.19	0.18	0.34	0.11	0.47	0.41	0.27	0.17	0.19	1.00	0.36	0.36	0.41
59. Alter views of ego's shared content (90d)	0.32	0.91	0.39	0.02	0.42	0.07	0.03	0.31	0.20	0.08	0.41	0.44	0.08	0.04	0.10	0.36	1.00	0.22	0.45
60. Ego wall posts written by alter (90d)	0.36	0.18	0.52	0.02	0.34	0.13	0.07	0.26	0.87	0.20	0.38	0.34	0.14	0.08	0.20	0.36	0.22	1.00	0.54
61. Alter comments on ego's content (90d)	0.41	0.37	0.90	0.05	0.54	0.20	0.15	0.27	0.50	0.16	0.52	0.56	0.21	0.14	0.21	0.41	0.45	0.54	1.00

‡ Continuous variable that was logged (base 2, after adding a start value of 1), divided by its standard deviation, and centered at its mean.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1. Comments written	1.00	0.80	0.68	0.36	0.37	0.69	0.48	0.83	0.88	0.84	0.68	0.38	0.39	0.56	0.55	0.79	0.68	0.68	0.48	0.63	0.54	0.31	0.74
2. Likes	0.80	1.00	0.61	0.37	0.36	0.64	0.46	0.80	0.75	0.83	0.61	0.39	0.40	0.46	0.52	0.72	0.65	0.71	0.46	0.62	0.48	0.33	0.65
3. Messages written	0.68	0.61	1.00	0.38	0.35	0.56	0.42	0.73	0.66	0.65	0.91	0.40	0.37	0.45	0.48	0.70	0.64	0.55	0.43	0.59	0.42	0.23	0.56
4. Pokes	0.36	0.37	0.38	1.00	0.19	0.34	0.23	0.37	0.35	0.37	0.38	0.97	0.21	0.26	0.25	0.35	0.33	0.28	0.22	0.31	0.22	0.24	0.35
5. Content (e.g., links) shared on friends' walls	0.37	0.36	0.35	0.19	1.00	0.34	0.30	0.39	0.38	0.38	0.35	0.20	0.41	0.29	0.32	0.36	0.36	0.43	0.29	0.34	0.30	0.09	0.32
6. Posts written on friends' walls	0.69	0.64	0.56	0.34	0.34	1.00	0.44	0.71	0.65	0.65	0.57	0.35	0.38	0.54	0.49	0.66	0.62	0.53	0.43	0.57	0.39	0.21	0.59
7. Photos tagged	0.48	0.46	0.42	0.23	0.30	0.44	1.00	0.46	0.54	0.50	0.43	0.25	0.33	0.36	0.87	0.48	0.44	0.38	0.44	0.41	0.59	0.15	0.42
8. Distinct people user sent direct communication to	0.83	0.80	0.73	0.37	0.39	0.71	0.46	1.00	0.76	0.80	0.72	0.39	0.43	0.51	0.54	0.91	0.75	0.68	0.48	0.71	0.48	0.33	0.64
9. Comments received	0.88	0.75	0.66	0.35	0.38	0.65	0.54	0.76	1.00	0.88	0.68	0.38	0.44	0.61	0.60	0.83	0.66	0.62	0.49	0.60	0.61	0.28	0.78
10. Likes received	0.84	0.83	0.65	0.37	0.38	0.65	0.50	0.80	0.88	1.00	0.67	0.39	0.44	0.54	0.56	0.84	0.67	0.68	0.47	0.62	0.57	0.39	0.74
11. Messages received	0.68	0.61	0.91	0.38	0.35	0.57	0.43	0.72	0.68	0.67	1.00	0.40	0.41	0.49	0.51	0.75	0.64	0.54	0.44	0.59	0.41	0.23	0.56
12. Pokes received	0.38	0.39	0.40	0.97	0.20	0.35	0.25	0.39	0.38	0.39	0.40	1.00	0.24	0.29	0.27	0.38	0.34	0.29	0.23	0.32	0.24	0.25	0.37
13. Content friends saved on wall	0.39	0.40	0.37	0.21	0.41	0.38	0.33	0.43	0.44	0.44	0.41	0.24	1.00	0.37	0.41	0.48	0.37	0.42	0.33	0.39	0.26	0.08	0.30
14. Wall posts received	0.56	0.46	0.45	0.26	0.29	0.54	0.36	0.51	0.61	0.54	0.49	0.29	0.37	1.00	0.43	0.61	0.44	0.36	0.33	0.39	0.30	0.16	0.46
15. Photos tagged in	0.55	0.52	0.48	0.25	0.32	0.49	0.87	0.54	0.60	0.56	0.51	0.27	0.41	0.43	1.00	0.58	0.50	0.43	0.51	0.48	0.54	0.14	0.44
16. Distinct people user received direct communication from	0.79	0.72	0.70	0.35	0.36	0.66	0.48	0.91	0.83	0.84	0.75	0.38	0.48	0.61	0.58	1.00	0.71	0.62	0.48	0.68	0.51	0.30	0.65
17. Profiles viewed	0.68	0.65	0.64	0.33	0.36	0.62	0.44	0.75	0.66	0.67	0.64	0.34	0.37	0.44	0.50	0.71	1.00	0.72	0.54	0.83	0.46	0.24	0.55
18. News feed stories clicked on	0.68	0.71	0.55	0.28	0.43	0.53	0.38	0.68	0.62	0.68	0.54	0.29	0.42	0.36	0.43	0.62	0.72	1.00	0.43	0.69	0.42	0.19	0.50
19. Photos viewed	0.48	0.46	0.43	0.22	0.29	0.43	0.44	0.48	0.49	0.47	0.44	0.23	0.33	0.33	0.51	0.48	0.54	0.43	1.00	0.54	0.39	0.08	0.38
20. Distinct people whose content user consumed	0.63	0.62	0.59	0.31	0.34	0.57	0.41	0.71	0.60	0.62	0.59	0.32	0.39	0.39	0.48	0.68	0.83	0.69	0.54	1.00	0.40	0.20	0.49
21. Photos posted	0.54	0.48	0.42	0.22	0.30	0.39	0.59	0.48	0.61	0.57	0.41	0.24	0.26	0.30	0.54	0.51	0.46	0.42	0.39	0.40	1.00	0.20	0.51
22. Content posted to own wall	0.55	0.57	0.45	0.27	0.41	0.41	0.33	0.54	0.54	0.59	0.43	0.28	0.35	0.27	0.35	0.50	0.48	0.69	0.31	0.46	0.43	0.25	0.49
23. Status updates	0.74	0.65	0.56	0.35	0.32	0.59	0.42	0.64	0.78	0.74	0.56	0.37	0.30	0.46	0.44	0.65	0.55	0.50	0.38	0.49	0.51	0.28	1.00

Correlations between activity variables on Facebook. All variables have been log-transformed and standardized before correlation calculation.

Chapters 3 and 4: Confirmatory Factor Analysis for classes of communication

Variable	Factor	Value	SE	p-value
Comments received	Directed communication	0.91	0.02	< 0.001 ***
Likes received	Directed communication	0.92	0.02	< 0.001 ***
Messages received	Directed communication	0.74	0.02	< 0.001 ***
Pokes received	Directed communication	0.42	0.02	< 0.001 ***
Content (e.g. links) friends saved on wall	Directed communication	0.50	0.02	< 0.001 ***
Wall posts received	Directed communication	0.62	0.02	< 0.001 ***
Photos tagged in	Directed communication	0.56	0.02	< 0.001 ***
Distinct people received directed communication from	Directed communication	0.92	0.02	< 0.001 ***
Profile views	Passive consumption	0.87	0.02	< 0.001 ***
Shared content views	Passive consumption	0.77	0.02	< 0.001 ***
Photo views	Passive consumption	0.58	0.02	< 0.001 ***
Distinct people whose content was passively consumed	Passive consumption	0.86	0.02	< 0.001 ***
Photos posted	Broadcasting	0.64	0.02	< 0.001 ***
Content (e.g. links) saved on own wall	Broadcasting	0.68	0.02	< 0.001 ***
Status updates	Broadcasting	0.82	0.02	< 0.001 ***
Covariances				
Directed communication <--> Passive consumption		0.79	0.01	< 0.001 ***
Directed communication <--> Broadcasting		0.94	0.01	< 0.001 ***
Passive consumption <--> Broadcasting		0.72	0.02	< 0.001 ***

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$, · $p < 0.10$

Model Chisquare = 2345.5
Goodness-of-fit index = 0.85
RMSEA index = 0.12
Bentler CFI = 0.90

Goodness-of-fit metrics for alternative models

Fit metric	Model with one factor	Model with two factors: production vs. consumption	Model with three factors: directed communication, passive consumption, broadcasting)
Chi-squared	3944.0	2414.2	2345.5
GFI	0.76	0.84	0.85
CFI	0.82	0.89	0.90
RMSEA	0.15	0.12	0.12

The metrics indicate that the three-factor model is the best, though both the two- and three-factor models exhibit comparable performance. Chi-squared and root mean squared error (RMSEA) are minimized, while the comparative fit index (CFI) and goodness-of-fit index (GFI) are maximized. Generally, GFI and CFI values greater than 0.90 indicate good model fit (see {Roberts:Nw5Lawld} for discussion of CFA fit metrics).