The Relationship Between Facebook Use and Well-Being Depends on Communication Type and Tie Strength

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An extensive literature shows that social relationships influence psychological well-being, but the underlying mechanisms remain unclear. We test predictions about online interactions and well-being made by theories of belongingness, relationship maintenance, relational investment, social support, and social comparison. An opt-in panel study of 1,910 Facebook users linked self-reported measures of well-being to counts of respondents' Facebook activities from server logs. Specific uses of the site were associated with improvements in well-being: Receiving targeted, composed communication from strong ties was associated with improvements in well-being while viewing friends' wide-audience broadcasts and receiving one-click feedback were not. These results suggest that people derive benefits from online communication, as long it comes from people they care about and has been tailored for them.

New communication technologies are often met with questions about their impact on psychological well-being. Today the spotlight is on social networking sites (SNSs), with scholars testing the relationship between online communication and such outcomes as social support, loneliness, and affect (Burke, Kraut, & Marlow, 2011; Deters & Mehl, 2012; Verduyn et al., 2014). Early research on the Internet's impact tended to use overly simplistic measures, treating online activities as interchangeable, and much current research on SNSs falls into the same trap (see Kraut & Burke, 2015 for a review). However, there is now emerging consensus that the impact of online communication on well-being is contingent on a person's goals, the nature of the communication exchanged, and the closeness of communication partners (Huang, 2010; Burke & Kraut, 2013; Burke et al., 2011). Despite consensus that the relationship between SNS use and well-being depends on the ways the technology is used, there is substantially less agreement on what the important factors are.

In the present paper, we explore predictions made from complementary theories on how communication type and partner in an SNS influence psychological well-being. We describe predictions made by theories of belongingness, relationship maintenance, signals of relational investment, social support, and social comparison. SNSs support different kinds of communication that allow us to distinguish between the theories. In particular, we differentiate (1) **targeted, composed communication** consisting of original text written for a specific person, such as a wall post or comment; (2) **stylized or "one-click" communication**, that provides low-effort but targeted feedback such as a "like" or "favorite" on an SNS; and (3) **composed, broadcast communication**, such as a status update, blog post, or tweet aimed at a wide audience. We also distinguish between communication sent by stronger and weaker ties.

Although the theories suggest different routes through which communication influences well-being, together they imply that targeted, composed communication with strong ties will lead to the greatest benefits. This prediction is consistent with results from a three-wave, opt-in panel study of 1,910 Facebook users, linking counts of respondents' activities derived from server logs to changes in self-report measures of well-being. Individuals who received targeted, composed communication from strong ties showed improvements in well-being, but their well-being did not improve after viewing wide-audience broadcasts, receiving one-click feedback, or receiving composed communication from weak ties. These results suggest that people derive benefits from receiving online communication, as long it comes from people they care about and has been tailored for them. Although the results are generally consistent with all five theories, theories of social support best fit the data because of their focus on targeted interactions with strong ties.

We first define what we mean by psychological well-being and briefly derive predictions from five theoretical perspectives, identifying conceptually distinct, but complementary routes through which communication in SNSs could influence well-being. We then describe the methods and empirical results from a longitudinal study of Facebook users.

Psychological Well-Being

There are many definitions of psychological well-being in the literature, with some scholars focusing on positive mental health—such as positive affect, cognitive evaluation of one's life as satisfying, having a meaningful purpose, or good mental health—while others focus on the absence of negative mental health, including anxiety, loneliness, depression, and stress. (Diener, Emmons, Larsen, & Griffin, 2010). In this paper we take a broad view, using a composite measure of multiple related indicators that many researchers consider aspects of well-being, including mood, perceived social support, satisfaction with life, depression, stress, and loneliness. Many previous studies linking Internet use to well-being have included one or more of these indicators as outcomes. For example, in Huang's (2010) meta-analysis of 40 studies, 37 used loneliness as an indicator of well-being, 33 used depression, and 7 used life satisfaction. Others used short-term measures of mood and loneliness (Kross et al., 2013; Verduyn et al., 2015) or perceived social support (Kraut et al., 1998; Ellison et al., 2007). Collectively, these scales measure distinct but related concepts from the psychological literature. Some are hypothesized to be causally related while others are conceptually similar constructs at different time scales or intensities (e.g., depression, negative mood, and positive mood are all measures of affect). Our goal is not to unpack the components of well-being or their causal relationships (see Diener, Suh, Lucas, & Smith, 1999 for a review), but to assess how online communication influences well-being broadly construed.

Social Networking Sites and Psychological Well-Being

Much research on the social impact of SNSs rests on the assumption that people benefit from social interaction with others. Decades of research in the offline world have demonstrated that social connections, social support, and social interaction all lead to improvements in happiness, mental health, and physical

health, although the precise mechanisms for these effects are still being debated (see Thoits, 2011 for a review). Here we briefly discuss several mechanisms through which social interaction might influence well-being and differential predictions one can derive from them about the type of social interactions in SNSs that will change participants' well-being. We summarize the mechanisms and predictions in Table 1.

The need to belong

Humans are a social species, with many survival advantages accruing from our connections to others (Baumeister & Leary, 1995). Because humans have a fundamental need to feel that they belong to a group, social interaction should improve well-being by fulfilling these needs. Satisfaction will be greatest if the communication is with strong ties (p. 500). This is because the need to belong is not satisfied by social interaction alone, but also requires stable interpersonal relationships marked by positive concern and caring. If this variant of the theory were correct, then we would expect that an aggregate measure of an individual's Facebook communication with strong ties would predict improvements in well being more than would communication with weaker ties. However, the theory is silent about the nature of the communication, including its content or the effort involved to produce it.

Relationship maintenance

Related theories argue that online communication can influence psychological well-being by helping people maintain their stock of friendships. Thoits reviews the substantial evidence that social ties are causally related to improvements in mental health, physical health, and longevity (2011, p. 145). Social ties have been operationalized in many ways across studies, including the number of close friends and relatives, marital status, and membership in religious and voluntary associations. Social ties need a regular investment of effort to stay alive (Roberts & Dunbar, 2010). Frequent communication increases liking (Festinger, Schachter, & Back, 1950) and provides opportunities for reciprocal self-disclosure and social support, which deepen relationships (Collins & Miller, 1994).

This mechanism requires substantive communication between parties in order to maintain relationships. The theory would predict that having moderately substantive interactions, such as gossiping about a mutual friend or talking about an upcoming family trip, should help maintain friendships, as is generally consistent with previous research on SNSs. For example, Ellison et al.'s *Facebook Relationship Maintenance Behaviors* primarily consist of substantive communication — responding to others' news, offering advice, and responding to their questions (Ellison, Vitak, Gray & Lampe, 2014). Moreover, this mechanism does not exclusively require one-on-one communication; newsy, meaningful broadcasts to many friends at once may also maintain relationships. Burke and Kraut (2014) showed that broadcast wall posts on Facebook as well as targeted comments were associated with increases in tie strength while exchanges of one-click communications such as likes and pokes were not. However, while reading broadcasts was associated with increases in tie strength, it was not linked to improvements in perceived social support in prior work (Burke et al., 2011), casting doubt on this theory's predictions.

Signals of relational investment

In addition to directly maintaining relationships though substantive communication, the symbolic value of communication also can maintain relationships independent of the content exchanged. For example, according to the theory of relational investment (Lin, 2001; Donath, 2008; Ellison et. al, 2014), the frequency and length of messages serve as signals of relationship value. Donath (2008) argues that "cost in time is a signal of the resources one is willing to commit to this relationship" (p. 238) over and above

Table 1 Five theoretical mechanisms through which online communication affects well-being, and predictions from them.

Theory	Mechanism	Hypothesis	Effect of communication type/partner on well-being			
			Targeted, composed	One-click	Broadcast	Strong tie
Belongingness	The need to belong is satisfied most by communication with close ties.	Well-being improves by receiving strong-tie communication, regardless of communication type.				+
Relational maintenance	Frequent, substantive communication grows and maintains social ties.	Well-being improves by receiving composed communication, whether targeted at the recipient, or broadcast to many recipients.	+		+	
Signals of relational investment	Effortful communication indicates that the sender cares for the receiver.	Well-being improves by receiving targeted, composed communication regardless of who sends it.	+			
Social support	Mundane interactions with strong ties cause recipients to believe that they will have support when needed.	Well-being improves by receiving targeted communication from strong ties.	+	+		+
Social comparison	Comparing one's life to others' broadcasts makes one feel worse.	Well-being declines by reading broadcast content, regardless of who posts it.			−	

the value that comes from the content of the communication itself. According to this take on relationships, more effortful communication should have a greater impact on well-being. Concretely, the comments that people use on SNSs to reply to each other should have more symbolic importance than low-effort, stylized communication, such as "likes" that are also used as replies. Similarly, as Latane's (1981) social impact model demonstrates, messages addressed toward a single other person are more powerful than messages broadcast toward larger audiences; with broadcast communication the effort is amortized over more recipients. As a result, signaling theory suggests that receiving targeted, composed communication will have a larger impact on well-being than receiving broadcast or one-click communication.

Social support

Perceived social support is another mechanism through which social interactions may improve well-being. Building a support network through routine interactions, especially with close friends, increases the perception that friends will be available when needed. People with more perceived social support are happier, healthier, and live longer (see Gleason & Iida, 2015 for a recent review). While Thoits (2011) argues that perceived support derives from a history of received support, she believes this received support comprises the "everyday interactions [that] are so minor, so commonplace, and so taken for granted as to be virtually invisible as support provisions" (p. 150). The theory does not specify how minor an interaction can be and still lead to a perception of support, but translated to an online environment, these commonplace markers of support might include very lightweight actions such as "likes" or "pokes" in addition to more substantive text-based interactions.

Moreover, the social support literature distinguishes the roles of strong and weak ties: Strong ties provide more effortful, empathic support, while weak ties are less willing to provide significant services, but instead provide access to new opportunities and ideas (Granovetter, 1973). As Albrecht et al. note, "Nurturing, caring, and tangible assistance are more likely to be expected and provided more readily in closer, multiplex, dense relationships, which also likely carry a presumption of reciprocity of supportive behavior" (2003). Thoits argues that everyday support received from strong ties is what promotes well-being, confirming the recipients' sense of mattering to other people and sustaining a sense of self-worth (Thoits, 2011).

This reasoning suggests that online communication with stronger ties rather than with weaker ones should lead to larger improvements in well-being. This conclusion is consistent with empirical evidence. Teens who use Instant Messenger with strong ties have much higher levels of life satisfaction than those who talk to strangers (Valkenburg & Peter, 2007). Adults talking to strong ties online experience emotional support and declines in depression symptoms, benefits not associated with communication with weaker ties (Bessière et al., 2008). Communicating with strong ties on Facebook is associated with increases in perceived social support and reductions in stress (Burke & Kraut, 2013).

Social comparison

Social comparison theory suggests that some types of online communication can harm well-being. Humans have a bias towards sharing positive news (Bond & Anderson, 1997), and seek to present themselves in a generally self-enhancing way (Goffman, 1959). Therefore, the kinds of stories that people broadcast in social media tend to skew positive and be less intimate (Bazarova et al., 2015). Offline, these positivity biases cause people to underestimate others' difficulties and overestimate their happiness (Jordan et al., 2011). This misperception may persist in social media as well, where viewers see dozens of rosy stories by their social connections. Surveys of college students have

linked reading others' stories in social media with ego-deflation, upward social comparison, envy, and subsequent feelings of depression (Steers, Wickham, & Acitelli, 2014; Chou & Edge, 2012). Participants in lab experiments shown fake profiles of beautiful, successful people felt upward social comparison (Haferkamp & Krämer, 2011; Johnson & Knobloch-Westerwick, 2014). Participants assigned to browse Facebook for 10 minutes without interacting with friends felt envy and lower affect (Verduyn et al., 2015).

Summary

The theoretical perspectives above present complementary predictions about the mechanisms through which communication types and partners could influence psychological well-being in SNSs. Although none of the theories are wholly incompatible with each other, they make somewhat different predictions. Theories of belongingness predict that more communication with stronger ties, independent of its content, should lead to improvements in psychological well-being. This model does not distinguish between targeted and broadcast communication nor does it distinguish composed text from one-click interactions. In contrast, theories of relationship maintenance predict that substantive communication will enhance relationships, regardless of whether it's targeted at an individual or broadcast to many viewers, and that one-click communication will not. Signaling theory predicts that only composed, targeted communication will enhance well-being by making recipients feel that others are investing in their relationships and care about them. However, both relationship maintenance and signaling theories are silent about the role of tie strength. For example, Ellison et al.'s *Facebook Relationship Maintenance Behaviors* (2014) do not differentiate communication exchanged with close versus weak ties. Theories of social support imply that the most valuable communication consists of targeted interactions with strong ties, but the "everyday" and "invisible" support variant suggests that small actions, like one-click "likes" could also generate feelings that supportive friends will be available when needed. Broadcast communication and communication from weak ties should not have similar effects. Finally, social comparison theory predicts that reading broadcast communication will lower well-being. However, targeted, composed communication and one-click communication should not have similar effects. This theory is silent on the role that tie strength would play. Table 1 summarizes the theoretical pathways by which SNS communication could influence psychological well-being.

Method

To analyze the relationship between communication on SNSs and well-being, we conducted an opt-in, three-wave panel survey of Facebook users from June to August 2011. Respondents completed validated scales measuring aspects 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. All data were de-identified and aggregated.

Measuring the relationship between Internet use and well-being poses several methodological challenges that can lead to misleading results, including treating all activities as interchangeable, relying on inaccurate self-reports, and using cross-sectional data, thereby confounding dispositions for using technology with its effects (see Kraut & Burke, 2015 for methodological critiques). The approach used here mitigates some of these problems. We use a panel design to link granular and objective measures of SNS use collected from Facebook's servers with month-to-month changes in participants' self-reports of psychological well-being.

Research site

We conducted this research on Facebook for multiple reasons. First is Facebook's importance as an Internet service; its large size makes it worthy of study in its own right. More than 60% of its 1.4 billion active users use the site on any given day (Facebook, 2015). Second, Facebook is a microcosm of the Internet and its variety of services. Third, Facebook provides new affordances, such as one-click "likes" and "pokes," which allow us to test theoretical mechanisms on a wider range of communication actions than are available offline.

Participants

Participants were recruited through Facebook ads and e-mail targeted at adult English-speakers around the world who had been active on the site in the previous 30 days, stratified by gender and activity level. Respondents were informed that they would complete three surveys a month apart and that their responses would be joined with counts of their behavior on Facebook. Participants were not compensated. The respondents ($N = 10,557$) who completed all three waves ($N = 1,910$) are included in the analyses that follow. There are minor differences between dropouts and returnees in age ($M = 41.2$ versus 46.2 years old, respectively, $p < 0.001$) and gender (59% of returnees were female versus 52% of dropouts, $\chi^2 = 32.5$, $p < 0.001$), but no differences in friend count or site use. Survey takers were approximately 15 years older than a random sample of Facebook users, a difference partially caused by excluding minors from the survey. The people in the sample were 11% more likely to be female ($\chi^2 = 108.1$, $p < 0.001$). They were heavier Facebook users, with about twice the likelihood of logging in during the week prior to the survey and approximately 70 more friends than the average user. The discussion section addresses potential biases related to these selection effects.

Dependent variable: Psychological well-being

Participants completed an online survey including seven validated scales measuring aspects of social and psychological well-being: Perceived Social Support (Cronbach's alpha $= 0.88$; Cohen, Mermelstein, Kamarck, & Hoberman, 1985); Satisfaction With Life (alpha $= 0.86$; Diener et al., 2010); Depression (alpha $= 0.87$; Radloff, 1977); UCLA Loneliness Scale (alpha $= 0.87$; Russell, 1996); Positive and Negative Affect Scale (positive alpha $= 0.82$; negative alpha $= 0.81$; Watson, Clark, & Tellegen, 1988); and the Perceived Stress Scale (alpha $= 0.87$; Cohen, Kamarck, & Mermelstein, 1983). All were measured on 5-point Likert scales and standardized. We excluded Williams' bridging social capital (2006) because it is not necessarily a component of psychological well-being, but rather a measure of connectedness to diverse people and opportunities; does not have convergent validity with structural measures; confounds measures with potential outcomes, and fails to discriminate bridging capital from institutional attachment and belonging (Appel et al., 2014).

The seven scales were correlated (mean absolute $r = 0.55$, range $r = 0.33$ to 0.82). A confirmatory factor analysis (CFA) revealed a common factor underlying these scales and that a one-factor solution was an acceptable fit to the data (CFI $= .991$, SRMR $= .026$, RMSEA $= .071$). Given the substantial correlations among the discrete scales and the CFA results, we treat the seven scales as multiple indicators of a single, latent well-being variable. We constructed a composite well-being measure by reversing the sign of the negatively loading scales (depression, stress, loneliness and negative affect), standardizing the measures, and averaging. In the remainder of the paper we refer to this composite measure as "well-being." This composite measure of well-being had high internal consistency (alpha $= 0.89$).

Independent variables: Facebook communication and tie strength

With informed consent from respondents, we analyzed counts of their activity on Facebook for 3 months, beginning one month prior to the first survey. All variables were aggregated from server logs

Table 2 Descriptive statistics for Facebook activity variables. Variables are monthly averages from three months' data. Composite scales were created by averaging the log-transformed, standardized versions of these variables.

Facebook activities per month	Median	Mean	Std. Dev.	Corr. with scale
Composed communication received (scale alpha = 0.80)				
Comments received	12.0	47.8	104.3	0.83
Messages received	7.0	22.8	69.5	0.65
Wall posts received	1.0	5.4	17.3	0.46
One-click communication received (scale alpha = 0.54)				
Likes received	14.0	53.6	127.1	0.83
Pokes received	0.0	8.1	51.4	0.42
Broadcast communication viewed (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 broadcasts respondent viewed	58.0	112.8	168.2	0.83

and de-identified; no communication content was analyzed. The research was approved by Carnegie Mellon's Institutional Review Board and all analysis took place on Facebook's servers in line with the company's Data Use Policy. All data were observational; no Facebook user's experience was affected by this research.

Facebook communication

The five theories discussed above indicate that different forms of communication should have different well-being effects. In particular, theories of relationship maintenance, relationship investment, and social support all suggest that receiving written communication aimed at oneself should improve well-being, while they make varying predictions about the importance of less effortful activities like "likes" and broadcast communication like status updates. Therefore, we categorized the communication participants received into three categories: composed, one-click, and broadcast. **Targeted, composed communication** consists of one-on-one exchanges between a user and another particular Facebook friend that included text. The measure was constructed by averaging the variables listed in the top section of Table 2, including the number of messages, wall posts, and comments received. Targeted, composed communication may be visible to other mutual friends of the sender and recipient (as in the case of a comment), but unlike broadcast communication, it targets a specific person. **One-click communication** consists of targeted, single-click actions directed at a particular friend: "like" and "poke." Poking and liking occurred regularly; 81% of participants received at least one "like" and 30% at least one poke. **Broadcast communication** consists of views of broadcast content, such as reading News Feed stories, viewing others' photos, and visiting profiles. To determine whether the data support separating composed, one-click, and broadcast communication, we compared two CFAs, one assuming a single latent factor representing all communication and the second distinguishing composed, one-click, and broadcast communication. According to a log likelihood ratio test, the three-factor model fit the data better ($\chi 2 = 694.9$, df = 1, $p < .0001$): For the one-factor model, CFI = .773, RMSEA = .241, and for the three-factor model CFI = .950, RMSEA = .120.

Tie strength

We automatically categorized each respondent's friends as strong or weak ties using the following method. On the survey, participants selected up to six Facebook friends to whom they felt close. Respondents were instructed to select ties " … you discuss important matters with, really enjoy socializing with, or anyone else you feel especially close to" (Marin & Hampton, 2007). On average, participants selected 4.4 close friends. After participants selected close ties, the survey software randomly selected additional Facebook friends to bring the total to eight. For each of the eight friends, participants then reported "How close do you feel to [tie name]?" on a 7-point scale ranging from "Not at all close" to "Extremely close."

These self-reported tie strength ratings were used to train a multilevel linear regression model of tie strength at the dyad level across all of their Facebook friends, with independent variables coming from Facebook's server logs and users' profiles for the 90 days prior to the first survey. For each dyad, tie strength is a linear combination of features from users' Facebook histories that indicate homophily, family and romantic relationships, and communication frequency. There were 77 features included in the model (see Burke, 2011, p. 153 for complete list). In a held-out sample, tie strength predicted by this algorithm was highly correlated with self-reported tie strength ($r = 0.66$). This model was then applied to the social networks from participants in the present study, generating a tie strength estimate for each of their friendships.

For ease of presentation and computational feasibility in the subsequent models, tie strength was converted to a binary variable for each friend, with ties of strength 5 or higher classified as "strong" and all others "weak." This threshold of 5 was chosen because it was both the mean and median self-reported closeness value for ties participants selected as their "closest" friends on the original survey. With this threshold, the median participant had 14 close friends out of 116 (Mean = 21 out of 207). Participants received approximately half of their composed and one-click communication from strong ties ($M = 52.2\%$). Though dichotomization of continuous variables reduces power and may yield misleading results in some cases (MacCallum, Zhang, Preacher, & Rucker, 2002), robustness checks show that the results described below were substantively the same with higher thresholds for a "strong" tie—6 or 7 on the 7-point scale—or comparing each person's top quartile of friends to their bottom quartile.

Control variables

Several variables were included as controls in the following models (see Table 3). Participants reported major life events (Holmes & Rahe, 1967) that occurred during the data collection period including marriage, divorce, losing a job, or the death of a loved one. We included these items to control for effects of exogenous events that might influence well-being. Only divorce, illness, and job loss were associated with changes in the well-being measures in this sample so we only include them as controls. Respondents described their overall health using a single item from the MOS Short-Form Health Survey (Ware & Sherbourne, 1992): "In general, would you say your health is Poor/Fair/Good/Very Good/Excellent?" A binary variable indicates whether the respondent had used Facebook the day before completing the survey as a proxy for engagement, and Facebook friend count is a proxy for the respondent's opportunities for communication. Country was not a significant predictor and was excluded from the models.

Method of analysis

To determine how different types of inbound communication predict changes in well-being, we conducted a multilevel regression analysis that included a lagged dependent variable and participant as a

Table 3 Descriptive statistics for control variables.

Control variables	Median	Mean	Std. Dev.
Age	47.3	46.3	17.4
Gender		40.5% female	
Overall Facebook use			
Was active on FB yesterday (binary)	1.0	0.9	0.3
Friend count	116.0	207.2	301.5
Major life events and health (from survey)			
Overall health (range 1–5)	4.0	3.5	1.0
		Pct. experienced event	
Moved to a new city		3.9%	
Divorce or relationship breakup		3.8%	
Fired or lost job		2.4%	
New job		6.9%	
Pregnancy or new family member		4.1%	
Death of close friend or family		11.5%	
Personal injury or illness		14.2%	

random effect. Coefficients represent the impact on changes in well-being from a unit increase of an independent variable (e.g., a standard deviation more composed communication in the month between surveys). While it is impossible to truly determine a causal relationship without randomized assignment of participants—e.g., randomly reducing or encouraging the flow of inbound communication to Facebook users for a month—the regression analysis is appropriate for observational studies. By including the lagged well-being measure, the analysis controls for an individual's previous level of well-being and the unmeasured factors that contributed to it. Lagged independent variables (i.e., online communication the previous month) were not included because they were highly collinear with communication in the current month and would produce biased estimates. All continuous independent variables were standardized. Multicollinearity was not a problem, with all variance inflation factors less than 4. A robustness check in which we controlled for outbound Facebook communication (communication that participants initiated) produced substantively similar results. The dataset includes three questionnaires for each respondent, and thus two observations of the lagged dependent variable (the participant's well-being in the previous month).

Results

We present the results through a series of regressions in Table 4, with each analysis breaking apart aggregate communication variables in the preceding analysis. We start by examining the overall effect of receiving Facebook communication (Model A); then break it down into communication with strong vs. weak ties (Model B); then differentiate the effects of receiving composed, one-click, or broadcast communication (Model C); and finally examine whether the effects of the three types of communication depend upon tie strength with the sender (Model D). This analysis cascade reveals that respondents' well-being increased most when they received composed, targeted communication from strong ties. Receiving broadcasts, weak-tie communication, or one-click feedback from strong ties did not have similar beneficial effects.

Table 4 Estimated changes in psychological well-being from Facebook communication.

	Model A Overall Communication			Model B Strong vs. Weak Ties			Model C Composed vs. One-Click vs. Broadcast			Model D Communication Type x Tie Strength		
	Coef	SE	p-value	Coef	SE	p-value	Coef	SE	p-value	Coef	SE	p-value
Intercept	0.03	0.04	0.41	0.03	0.04	0.37	0.03	0.04	0.42	0.03	0.04	0.42
Lagged well-being	0.85	0.01	0.00***	0.85	0.01	0.00***	0.85	0.01	0.00***	0.85	0.01	0.00***
Controls												
Wave	−0.01	0.01	0.41	−0.01	0.01	0.41	−0.01	0.01	0.35	−0.01	0.01	0.39
Male	0.01	0.01	0.28	0.01	0.01	0.28	0.02	0.01	0.21	0.01	0.01	0.15
Age (years)	0.02	0.00	0.00***	0.02	0.00	0.00***	0.02	0.00	0.00***	0.02	0.00	0.00***
Active on FB prev. day	0.00	0.02	0.93	0.00	0.02	0.93	0.01	0.02	0.71	0.01	0.02	0.79
Facebook friend count	0.01	0.01	0.22	0.01	0.01	0.22	0.01	0.01	0.21	0.01	0.01	0.13
Overall health	0.08	0.01	0.00***	0.08	0.01	0.00***	0.08	0.01	0.00***	0.08	0.01	0.00***
Divorce	−0.07	0.03	0.03*	−0.07	0.03	0.03*	−0.07	0.03	0.03*	−0.07	0.03	0.04*
Illness	−0.04	0.02	0.04*	−0.04	0.02	0.04*	−0.04	0.02	0.04*	−0.04	0.02	0.02*
Lost job	−0.10	0.04	0.01*	−0.10	0.04	0.01*	−0.10	0.04	0.01*	−0.10	0.04	0.01*
Facebook communication received or viewed												
Overall FB comm.	0.01	0.01	0.49									
From strong ties				0.04	0.01	0.00**						
From weak ties				−0.01	0.01	0.17						
Composed communication							0.02	0.01	0.06			
From strong ties										0.02	0.01	0.04*
From weak ties										0.01	0.01	0.70
One-click communication							−0.00	0.01	0.86			
From strong ties										0.01	0.01	0.67
From weak ties										−0.01	0.01	0.33
Broadcast communication							−0.02	0.01	0.10			
From strong ties										0.01	0.01	0.67
From weak ties										−0.02	0.01	0.10
AIC/BIC	3234.51 / 3321.3			3228.02/3321.06			3234.07/3333.3			3233.87 / 3351.7		
Log Likelihood	−1603.25			−1599.01			−1601.0			−1597.9		
Residual Std. Dev.	0.38			0.38			0.38			0.37		

Overall Facebook communication

Model A in Table 4 shows how aggregate communication received on Facebook relates to changes in well-being month-to-month, after taking the controls into account. The intercept of 0.03 is the average well-being score for a typical person in the sample. The coefficient for lagged well-being ($\beta = .850$) shows that well-being was very stable month-to-month. Aggregating over all the communication activities from Table 2, Model A shows that receiving more Facebook communication in general was not associated with changes in well-being ($\beta = .010$, $p = .493$).

Strong vs. weak ties

Model B distinguishes between overall communication with strong vs. weak ties, and provides results consistent with the theory of belongingness: Receiving communication from strong ties is associated with improvements in well-being ($\beta = .04$, $p = .003$) while receiving communication from weak ties is not ($\beta = -.02$, $p = .174$). The magnitude of the effect of strong-tie communication in a month is roughly the same, but in the opposite direction, as having a personal injury or illness ($\beta = -.04$, $p = .029$).

Composed vs. one-click vs. broadcast communication

Model C separates the effect of the three classes of communication. Receiving composed communication, such as wall posts or comments, was associated with a marginally significant increase in well-being ($\beta = .020$, $p = .063$), while receiving one-click communication ($\beta = -0.002$, $p = .860$) or viewing broadcast communication intended for a wider audience ($\beta = -.018$, $p = .102$) were not. Open-ended survey responses provide insight into the way that receiving comments and Timeline posts could lead to greater well-being: "*[He] frequently comments on my stuff and I feel loved,*" and "*I've been able to reach out and share what I've been going through and have my friends support me. [Facebook has] increased my support network and helps me feel not so alone in what I'm facing.*"

Communication types and tie strength

Model D shows that receiving composed, targeted communication from strong ties was associated with increases in well-being ($\beta = 0.02$, $p = 0.04$), while the same actions from weak ties showed no impact ($\beta = 0.01$, $p = 0.70$). Receiving one-click communication or broadcasts from strong or weak ties was not associated with changes in well-being.

Discussion

Our research derived predictions from five complementary theories about how social interaction on Facebook should affect changes in individuals' psychological well-being. It provides evidence that the effects depend on the nature of the communication and the relationship between communicators. Receiving more personalized communication — targeted, composed text — from strong ties was linked to improvements in well-being. In contrast, receiving text from weak ties, receiving easy-to-produce, one-click interactions, and viewing generic broadcasts of social news even with strong ties were not associated with improvements in well-being over and above the targeted communication they elicited.

The five theories from which we derived predictions supplement each other. Theories of social support, maintenance, and relational investment all predict that well-being improves with composed communication, while both theories of social support and belonging predict that strong-tie communication is crucial. Together the empirical results are most consistent with social support theory. Although the theories fit the data to different degrees, none are perfect matches. Some of the inconsistencies

between theory and empirical results may result from the slipperiness of the theoretical descriptions. The finding that only effortful communication from strong ties was linked to improvements in well-being seems inconsistent with signaling theories of relational investment, but is signaling theory really agnostic about the distinction between strong and weak ties, as we presumed? The finding that lightweight, content-free, everyday actions like "likes" and "pokes" may not be sufficient to generate the perception that a friend will invest more tangible, effortful support when needed is not completely consistent with Thoit's theory of social support. But what does the "invisible support" of Thoit's (2011) theory really consist of? Certainly much of the composed communication on Facebook may still be trivial but generate perceived support. Respondents noted the importance of seemingly trivial interactions, such as sharing jokes or videos: "*I post funny cat videos to her wall and she writes on my wall counting down the days until we're in the same town and get to see each other.*" "His comments are hilarious, we get to trade jabs online." Future work thus requires more precise theory with stronger boundary conditions.

Our research did not identify uses of Facebook significantly associated with declines in overall well-being. Thus, the results do not support the thesis that browsing others' status updates leads to depression or loneliness. Inconsistencies between these results and those of prior survey and lab studies (e.g., Kross, et al. 2013; Verduyn et al., 2015) may result from the short time windows used in prior research; specific episodes of browsing may elicit negative mood or envy that is detectable within a few hours, but the effects may dissipate. Other methodological challenges that may explain the differences are reviewed by Kraut and Burke (2015).

Though our research did not analyze text and thus cannot identify whether the substance of composed communications mattered or if just the symbol of receiving a more effortful communication sufficed, we speculate that the communication content plays an important role. Prior research shows that Facebook communication is substantive. While Facebook posts are typically short, they are used to maintain friendships by exchanging good and bad news (Ellison et al., 2014) and requesting resources from friends (Lampe, Gray, Fiore, & Ellison, 2014). By definition, composed communication will have more of this substantive content than will one-click communication. It is also plausible that personalized communication sent to a particular friend will have more intimate and substantive content useful for relationship maintenance than will broadcast communication sent to a wide audience. Targeted communication such as a wall post tends to be more other-focused than broadcast status updates, which tend to be more self-focused (Bazarova, Taft, Choi, & Cosley, 2012). So targeted communication may thus be more personally relevant to the receivers than the other broadcast content in their feeds. And receiving comments on one's own posts may further validate one's self-presentation goals, causing increases in self-esteem and affirmation.

Similarly, without content analysis it is impossible to differentiate the effects of standard, pleasant communication and disagreements or other negative interactions online. Though there is a slight positivity bias among the stories that people share (Burke & Develin, 2016), people also post about distressing world events, political arguments, and personal drama. Broadcast posts describing friends' achievements may elicit upward social comparison or sympathetic joy. Although we do not find any relationship between browsing friends' broadcasts and changes in well-being, it is likely that effects vary widely by the valence of the story and tie strength.

The effect sizes for the SNS variables were modest, both because well-being was stable month-to-month, leaving little variance left to explain, and because well-being is shaped by many factors beyond SNS interaction. To better understand the magnitude of these effects, we examined changes in well-being for participants who reported going through major life events on the survey (e.g., death of a close friend, getting married or having a personal injury). Most of these events were not significantly associated with

either positive or negative changes in well-being in the current data, perhaps because of the short interval between surveys. Of the major life events associated with changes in well-being here, the effects of strong-tie communication were roughly comparable (though in the opposite direction) to the effect of an illness, and half to a third of the size of divorce or losing a job. In summary, although the effects of SNS communication were modest, they were the same order of magnitude as effects associated with some major life events.

These findings underline why accurate, granular measurement of online activity and longitudinal data collection are critical when attempting to answer questions about the impact of social technology. In self-reports of activity, respondents are unlikely to be able to remember the amount of different types of communication they had or their closeness to the partners for particular exchanges. For example, when retrospectively reporting on their SNS usage, they are unlikely to be able to differentiate the number of stories they read online from weak ties or comments received from close friends. And the popular belief that the Internet causes loneliness may jointly bias self-reports of Internet use and well-being when included on the same survey.

Limitations and Future Work

Unlike participants in an experiment randomly assigned to receive different types of communication from different partners, participants in this research decided whether and how to use Facebook. Even the communication they received was partly determined by the communication they sent out. Therefore, this research is open to the critique that time-varying factors changed during the measurement period and influenced both Facebook use and well-being. Only the use of a random-assignment experiment can completely control for self-selection. Yet the methods in this research mitigate some standard concerns about causal inference from correlational data. Because the independent variables, which were objectively measured from the server logs, predicted dependent variables measured through self-report questionnaires, the research design mitigated problems of common method variance which plagues much survey-only research on this topic. Because Facebook use preceded measurement of well-being, the research design reduced problems of reverse causality. By using each respondent as his or her own control and including the lagged dependent variable in the analysis, the research design diminishes the concern that static pre-existing differences among participants, such as their education, extroversion, or mental health influenced both their Facebook use and their well-being. Sensitivity tests controlling for a participant's outbound communication each month produced qualitatively similar results, diminishing these concerns.

One potential concern is endogeneity in the measure of tie strength. In this case, tie strength was inferred from communication patterns for the 3 months prior to the first survey and was not updated based on communication in subsequent waves. This choice minimizes measurement overlap but does not completely eradicate it. The well-being outcome is measured independently, and so is not subject to endogeneity. One interpretation of the results involving tie strength is that receiving recent composed, targeted communication with people with whom one has historically communicated often is linked to improvements in well-being.

Our results may be affected by sampling biases. The participants in the current study were older and had larger networks than typical users. Sensitivity analyses indicated that the results are similar across different age brackets and there were no interactions between age and the variables of interest. The participants came from 91 countries and varied widely in age, increasing generalizability of these findings. Moreover, results for large self-selected samples of Internet users are generally comparable to participants in traditional paper-and-pencil studies (Gosling et al., 2004) and this sample is larger and more representative than surveys of college students upon which much of the literature now rests.

Conclusion

Scholars and the popular press have questioned the impact of social network sites on the well-being of their users. The present data support the idea that online interactions do influence well-being. Yet the effects depend on how people use the sites: simply reading about friends, receiving text communication from weak ties, and receiving one-click communication did not affect well-being, while receiving personalized, effortful communication from close friends was linked to improvements in well-being. People derive benefits from online communication, as long it comes from others they care about and has been tailored for them.

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