

## Internet Paradox Revisited

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### Abstract

**Kraut et al. (1998) reported small but reliable negative effects of using the Internet on measures of social involvement and psychological well-being among Pittsburgh families in 1995-1996. We called the effects a “paradox” because participants in the sample used the Internet heavily for communication, which generally has positive effects. In a 3-year follow-up of the original sample, we find that negative effects dissipated over the total period. We also report findings from a longitudinal study in 1998-99 of new computer and television purchasers. This new sample experienced overall positive effects of using the Internet on communication, social involvement, and well-being. Using the Internet generally predicted better outcomes for extraverts or those with more social support but worse outcomes for introverts or those with less support. Although using the Internet had slightly different benefits for teens and adults, controlling for age does not change the main conclusions**

## Internet Paradox Revisited

With the rapidly expanding reach of the Internet into everyday life, it is important to understand its social impact. One reason to expect significant social impact is the Internet's role in communication. From the early days of networked mainframe computers to the present, interpersonal communication has been the technology's most frequent use (Sproull & Kiesler, 1991; PriceWaterhouseCoopers, 1999). Over 90% of people who use the Internet users in a typical day in 2000, sent or received email (Pew Internet Report, 2000), far more than used any other online service. Using email leads people to spend more time online and discourages them from dropping Internet service (Kraut, Mukhopadhyay, Szczypula, Kiesler, & Scherlis, 2000). Other Internet communication services are increasingly popular—instant messaging, chat rooms, multi-user games, auctions, and myriad groups comprising “virtual social capital” on the Internet (Putnam, 2000, pg. 170).

If communication dominates Internet use for a majority of its users, there is good reason to expect that the Internet will have positive social impact. Communication, including contact with neighbors, friends, and family, and participation in social groups, affects people's level of social support, their probability of having fulfilling personal relationships, their sense of meaning in life, their commitment to social norms and to their communities, and their psychological and physical well-being (e.g., Cohen & Wills, 1985; Diener, Sul, Lucas, & Smith, 1999; Gove & Geerken, 1977; Mirowsky & Ross, 1989, p. 140; Thoits, 1983; Williams, Ware, & Donald, 1981).

Through its use for communication, the Internet could have important positive social effects on individuals (e.g., Katz and Aspden, 1997; McKenna & Bargh, 2000), groups, organizations (e.g., Sproull & Kiesler, 1991), communities (e.g., Borgida et al., in press; Hampton & Wellman, 2000), and society at large (e.g., Dertouzos, 1997; Hiltz & Turoff, 1978). Because the Internet permits social contact across time, distance, and personal circumstances, it allows people to connect with distant as well as local family and friends, co-workers, business contacts, and with strangers who share similar interests. Broad social access could increase people's social involvement, as the telephone did (Fischer, 1992; Wellman, 1996). It also could facilitate the formation of new relationships (Katz & Aspden, 1997), social identity and commitment among otherwise isolated persons (Bargh & McKenna, 1998), participation in groups and organizations by distant or marginal members (Sproull & Kiesler, 1991), and political mobilization (Bonchek, 1995).

Whether the Internet will have positive or negative social impact, however, may depend upon the quality of people's online relationships and upon what people give up to spend time online. Stronger social ties generally lead to better social outcomes than do weaker ties (e.g., Neuling & Winefield, 1988; Wellman & Wortley, 1990). Many writers have worried that the ease of Internet communication might encourage people to spend more time alone, talking online with strangers, or forming superficial “drive by” relationships, at the expense of deeper face-to-face discussion and companionship with friends and family (e.g., Putnam, 2000, pg. 179). Further, even if people use the Internet to talk with close ties, these online discussions might displace higher quality face-to-face and telephone conversation (e.g., Cummings, Butler & Kraut, in press).

Research has not yet led to consensus on either the nature of social interaction online or its effects on social involvement and personal well-being. Some survey research indicates that online social relationships are weaker than off-line relationships (Parks & Roberts, 1998), that people who use email regard it as less valuable than other modes of communication for maintaining social relationships (Cummings et al., in press; Kraut & Attewell, 1996), that people who use email heavily have weaker social relationships than those who do not (Riphagen & Kanfer, 1997) and that people who use the Internet heavily report spending less time communicating with their families (Cole, 2000; Nie & Ebring, 2000). In contrast, other survey research shows that people who use the Internet heavily report more social support and more in-person visits with family and friends than those who use it less (Pew Internet Report, 2000). Because this research has been conducted with different samples in different years, it is difficult to identify central tendencies and changes in these tendencies with time. Further, the cross-sectional nature of the research makes it impossible to distinguish self-selection (in which socially engaged and disengaged people use the Internet differently) from causation (in which use of the Internet encourages or discourages social engagement).

In a longitudinal study by Kraut, Patterson, Lundmark, Kiesler, Mukophadhyay and Scherlis (1998), the authors attempted to assess causal direction. The HomeNet field trial followed 93 households in their first 12-18 months online. Although the sample as a whole reported high well-being at the start of the study, those participants who used the Internet more became reliably less socially involved and more lonely and showed an increase in depressive symptoms. These changes occurred even though participants' dominant use of the Internet was communication.

These findings were controversial (Caruso, 1998; Harmon, 1998). Some critics argued that because the research design did not include a control group without access to the Internet, external events or statistical regression could have been responsible for participants' declines in social involvement and psychological well-being (e.g., Hamman, 1999; Shapiro, 1999). However, these factors would have affected heavy and light Internet users similarly, so could not account for the differences in outcomes between them.

A more pertinent problem in the original HomeNet study is the unknown generalizability of the results over people and time. The participants in the original study were an opportunity sample of families in Pittsburgh initially with high social involvement and strong social ties, compared with the population as a whole. In 1995 and 1996, when they began the study, few of their family and friends had Internet access. One possibility is that using the Internet disrupted this group's existing social relationships. Had the study begun with a more socially deprived sample or when more of the population was online (Cummings & Kraut, 2000), their use of the Internet for social interaction might have led to more positive effects.

The present article addresses these issues of generalizability in greater depth through a follow up of the original HomeNet sample and a new longitudinal study. The first study examines the longer-term impact of Internet use on those in the original study. Although following the same participants over time does not allow us to distinguish the effects of changes in the sample (e.g., acquisition of more online experience) from effects of changes in the Internet (e.g., more of one's social circle being online), this analysis provides a second look at a group for

whom initial Internet use had poor effects. The second study follows a new sample of people in the Pittsburgh area who had recently purchased a new computer or television set. This study addresses the effects of Internet use in a more recent era. The sample was sufficiently large to permit an analysis of the impact of individual differences in sociability and social support on usage and outcomes and of the possible differences in use of the Internet that could explain different outcomes.

#### Study 1: Follow-up of the original HomeNet sample.

The data are from 208 members of 93 Pittsburgh families, to whom we provided a computer and access to the Internet in 1995 or 1996. The families were recruited through four high school journalism programs and four community development organizations in 8 Pittsburgh neighborhoods. The sample was more demographically diverse than was typical of Internet users at the time. Details of the sampling and research protocol are described in Kraut et al. (1996).

The analyses of social impact reported in Kraut et al. (1998) were drawn from Internet usage records and from surveys given just before participants began the study and again in May 1997. Server software recorded participants' use of the Internet— hours online, email volume, and Web sites visited per week. The surveys assessed demographic characteristics, the personality trait of extraversion (Bendig, 1962), four measures of social involvement (family communication, size of local social network, size of distant social network, and perceived social support [Cohen, Mermelstein, Kamarck, & Hoberman, 1984]), and three well-established measures of psychological well-being: the UCLA Loneliness Scale (Russell, Peplau, & Cutrona, 1980), the Daily Life Hassles Scale, a measure of stress (Kanner, Coyne, Schaefer, & Lazarus, 1981), and the Center for Epidemiological Studies Depression Scale (Radloff, 1977).

In Kraut et al. (1998), we used a regression analysis of the effect of hours of Internet use on social involvement and psychological well-being in 1997 (Time 2), controlling for scores on these measures at the pretest (Time 1). Demographic variables—age, gender, race, and income—and extraversion were controlled since these variables could be associated with Internet use and with outcome variables. Our re-analysis re-examines the impact of the use of the Internet using a third survey administered in February 1998 (Time 3). For about half the participants, the final survey came nearly 3 years after they first used the Internet; for the other half, the final survey came nearly 2 years later.

#### Method

All longitudinal research faces the potential of participant attrition. Our research was especially vulnerable because we had not planned initially to follow the participants for more than 1 year. Many of the high school students in the sample graduated and moved to college. Further, technology changed rapidly during this period, and some participants changed Internet providers, ending our ability to monitor their Internet use. Of the 335 people who qualified for participation in the study, 261 returned a pretest survey at Time 1 (78%), 227 returned a survey at Time 2 (68%), and 154 returned a survey at Time 3 (46%). We limited analysis to participants who completed 2 out of 3 surveys ( $n=208$ ).

To assess changes in social and psychological outcomes, we used a longitudinal panel design to evaluate changes in social involvement and psychological well-being from Time 1 to Time 2, and from Time 2 to Time 3. The analyses were conducted using the xtreg procedure in Stata (StataCorp, 2001) for cross-sectional time series analyses with independent variables as fixed effects and participant as a random effect. When assessing the impact of Internet use on social involvement and psychological well-being at one time, we statistically controlled for the prior level of social involvement and psychological well-being by including a lagged form of the dependent variable as an independent variable in the model. For example, when examining the effect of Internet use on loneliness at Times 2 and 3, we included the lagged variable for loneliness at Times 1 and 2, respectively, in the model to control for the effects of prior loneliness on Internet use and on subsequent loneliness. The analyses of particular interest are the main effects of using the Internet on subsequent measures of social involvement and psychological well-being and the statistical interactions of Internet use and time period on these outcomes. The main effect of Internet use assesses the cumulative impact of Internet use over the study, and the interaction of Internet use with time period assesses whether this impact is the same in the early period (previously reported in Kraut et al., 1998) and in the later period.

## Results

Table 1 shows results from the analyses. Kraut et al (1998) showed Internet use was associated with declines in family communication, numbers of people in local and distant social circles and increases in loneliness, depressive symptoms, and daily-life stress. Except for the increase in stress with more Internet use, the effects reported in Kraut et al. (1998) were not significant over the longer period. Two significant Internet use X period interactions reflect different trends at different periods. Interaction plots (not shown) indicate that depressive symptoms significantly increased with Internet use during the first period but significantly declined with Internet use during the second period ( $p < .05$ ). Loneliness significantly increased with Internet use during the first period but was not associated with Internet use during the second period ( $p < .01$ ). At the suggestion of the editors and anonymous reviewers, we tested the differential effects of age. There was only one marginally significant interaction: Adults' stress increased more than teens' stress with more Internet use ( $p < .10$ ).

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Insert Table 1 About here

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### Study 2: A longitudinal study of computer and television purchasers

In this study, we attempted to replicate the original HomeNet research design in a sample of households that had recently purchased a new personal computer. We added controls to the design and new measures. First, we attempted to manipulate Internet use to create a true randomized experiment. We randomly offered free Internet service to half of those households purchasing a computer and arranged with the Internet service provider to monitor their usage of the Internet; households in the control condition received an equivalent amount of money (\$225) to participate. Unfortunately, this experimental procedure failed when, by the end of 6 months, 84% of the control households obtained Internet access on their own (versus 94% of the

experimental group). Because this attempt to conduct a true experiment failed, we combined the groups for analyses of the effects of using the Internet.

Another design change was to add a comparison group—recent purchasers of a new television set. The addition of this comparison group (of whom 28% had Internet access after 6 months) helps us to rule out explanations of changes over time based on sample selection. Previous research generally shows that heavy as compared with light television viewers stay at home more, are less socially involved, and experience poorer intellectual, physical, and psychological outcomes (e.g., Andersen et al., 1998; Canary & Spitzberg, 1993; Kubey & Csikzentmihalyi, 1990; Neuman, 1995; Putnam, 2000, pp. 228-246; Sidney et al., 1998). In our analyses of Internet use, we included participants from the television purchaser group, but controlled for sample selection bias by creating a dummy variable indicating whether participants were in the television or computer purchaser group.

Finally, we extended the HomeNet study conceptually by examining the differential effects of individual differences in extraversion and perceived social support on the effects of Internet use. Extraversion is the tendency to like people, to be outgoing, and to enjoy social interaction; it is highly consistent over the life course (Roberts & DelVecchio, 2000), and it is predictive of social support, social integration, well-being, and positive life events (e.g., Von Dras & Siegler, 1997; Magnus, Diener, Fujita, Payot, 1993). The perception of social support refers to feelings that others are available to provide comfort, esteem, assistance, and information or advice; perceived social support buffers the effects of stress (e.g., Abbey & Andrews, 1985; Cohen, 1988; Cohen & Wills, 1985).

We offer two opposing models of the relationship between extraversion and social support and Internet use. A “rich get richer” model predicts that those who are highly sociable and have existing social support will get more social benefit from using the Internet. Highly sociable people would reach out to others on the Internet and use the Internet especially for communication. Highly supported people would use the Internet to reinforce their support networks. If so, these groups would gain more social involvement and well-being from using the Internet than those who are introverted or have poor network relations.

By contrast, a “social compensation” model predicts that those who are introverted or lack social support would profit most from using the Internet. People with fewer social resources could use the new communication opportunities online to form connections with people and obtain supportive communications and useful information otherwise missing locally (McKenna & Bargh, 1998). At the same time, for those who already have satisfactory relationships, using the Internet could interfere with their real-world relationships, if they swap strong ties for weaker ones. Analogous to the finding that cancer patients with emotionally-supportive spouses can be harmed by participation in peer-discussion support groups (Helgeson, Cohen, Schulz, & Yasko, 2000), it is possible that people with strong local relationships might turn away from family and friends if they used the Internet for social interaction.

## Method

Sample. We recruited participants through advertisements placed in local newspapers, soliciting people for a study of household technology who purchased a new computer or new television within the past six months. We obtained agreement from all adults and children in the family above age 10 to complete surveys. Half of the computer purchaser households were randomly offered free Internet access to participate in the study; other participants were offered payments to complete surveys. After the initial telephone contact, we mailed consent forms and pretest surveys with return envelopes. Unlike the procedures used in Study 1, we did not encourage Internet use or provide technology support.

Measures. We administered surveys 3 times during the study, in February 1998, 6 months later, and a year later, February 1999. We used an index of self-reported Internet use from all participants rather than automated measures of usage as in Study 1 ( $\alpha = .86$ ; see Table 2). Automated usage records were available for the computer-experimental group but not for participants in the computer-control group and for TV-purchasers. Within the computer-purchaser group, the correlations between the self report index of Internet use and an automated count of the number of sessions logged into the Internet in the 8 weeks prior to the questionnaire was  $r = .55$  at Time 2 ( $n = 114$ ) and  $r = .42$  at Time 3 ( $n = 106$ ). These analyses reflect moderate validity of the self-report measure, although there is error in both the self-reports and in the server data (e.g., the usage records do not include Internet use at work).

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Insert Table 2 About here

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We used self-report measures to assess demographic characteristics of the participants, and measures from the original HomeNet study, including perceived social support (Cohen et al., 1984), size of local and distant social circles, and time talking with other family members. We used the same measure of extraversion (Bendig, 1962). We added new measures of anomie (Srole, 1956), trust in people (Rosenberg, 1957, revised from Survey Research Center, 1969), community involvement (adapted from Mowday and Speers' 1979 measure of organizational commitment; Price & Mueller, 1986), and intentions to stay in the Pittsburgh area. We also assessed respondents' peer relationships with 10 specific family and friends by asking them to identify family members or friends (5 living in the Pittsburgh area and 5 living outside of the area) who were closest to them in age. Participants described their feelings of closeness to each nominee at each time period on a 5-point Likert scale.

To assess well-being, we again used the CES-D to measure depressive symptoms (Radloff, 1977), the daily life stresses scale (Kanner, Coyne, Schaefer, & Lazarus, 1981), and the UCLA Loneliness Scale (Russell, Peplau, & Cutrona, 1980) from the original HomeNet study. We added measures of self-esteem (Heatherton & Polivy, 1991), positive and negative affect (Watson, Clark, & Tellegen, 1988), perceived time pressure (adapted from Kraut & Attewell, 1997) and physical health (scales from the SF-36; Ware, Snow, Kosinski, & Gandek, 1993).

Finally, because the Internet is a source of information as well as communication, we added measures of knowledge. We included a self-report measure of skill using computers, expanded from the original HomeNet study. We also added a test of knowledge, including multiple choice items on national current events, Pittsburgh current events, and general knowledge from a high school equivalency test (GED). The latter measures contained different items at different time periods. Table 2 describes the unpublished scales in the study.

Analyses. Data come from 216 households, and respondents who completed at least two surveys. Of the 446 household members who were eligible to be in sample, 96% completed survey 1, 83% completed survey 2 and 83.2% completed survey 3. The analyses were similar to the analyses for Study 1. We used Stata statistical software (StataCorp, 2001) to conduct longitudinal panel design analyses with participant as a random effect. In the Study 2 models, social involvement, well-being, and knowledge outcomes at the second and third time period were regressed on self-reported Internet use during that period, controlling for demographic characteristics and the lagged dependent variables. The models control for whether the respondent came from the TV purchaser or computer purchaser subsample and whether the dependent variables were collected at the second or third time period. To test whether levels of extraversion and social support moderated the effects of using the Internet, we included the main effects for the Bendig (1962) measure of extraversion and Cohen et al.'s (1984) measure of social support and the interaction of these variables with Internet use.

## Results

Table 3 shows descriptive statistics for computer and television purchasers in February 1998, August 1998, and February 1999, and the average correlations among all variables. (The correlations did not differ across time periods.)

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Insert Table 3 About here

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Effects on social involvement. Models testing the effects of using the Internet on interpersonal communication and community involvement are shown in Tables 4 and 5, respectively. The main effects of Internet use on these measures of social involvement generally were negligible or positive. Participants who used the Internet more had larger increases in the sizes of their local ( $p < .01$ ) and distant social circles ( $p < .01$ ) and their face-to-face interaction with friends and family ( $p < .05$ ), increased. They also became more involved in community activities ( $p < .10$ ) and felt greater trust in people ( $p < .05$ ), although those who used the Internet more were less likely to want to stay in the Pittsburgh area ( $p < .05$ ).

The interaction with extraversion shows that the association of Internet use with increases in community involvement was greater for extraverts ( $p < .05$ ). Interactions of Internet use with social support show that the association of Internet use with increases in family communication was larger for those who initially had more social support ( $p < .01$ ). Each of these interaction effects supports the “rich get richer” hypothesis.



Finally, interactions of age with Internet use suggest different positive effects for adults and teens. Teens, as compared with adults, increased their social support ( $p < .10$ ) and family communication ( $p < .10$ ) with more Internet use, whereas adults increased their face-to-face interaction with family and friends ( $p < .05$ ) and their closeness to distant relatives and friends ( $p < .05$ ) with more Internet use.

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Insert Table 4 and 5 about here

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Effects on psychological and physical well-being. Table 6 shows the effects of Internet use on psychological well-being. These analyses show that, overall, both stress ( $p < .05$ ) and positive affect ( $p < .001$ ) increased with more Internet use. The several interactions of Internet use with extraversion indicate that Internet use was associated with better outcomes for extraverts than for introverts. In particular, extraverts who used the Internet more reported decreased levels of loneliness ( $p < .05$ ), negative affect ( $p < .01$ ), time pressure ( $p < .01$ ), and increased self-esteem ( $p < .01$ ) whereas these effects were in the reverse (negative) direction for introverts. We illustrate these effects in Figure 1A, showing the effects of extraversion and Internet use on loneliness. There were no interactions with social support or with age, and no effects on measures of physical health (not shown in the table).

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Insert Figure 1 and Tables 6 and 7 About Here

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*Insert Table 6 & 7 about here*

Effects on skill and knowledge. Table 7 shows the effects of Internet use on self-reported computer skill and multiple choices tests of worldly knowledge. Computer skill increased with more Internet use ( $p < .001$ ); this increase was larger among those with more social support ( $p < .05$ ). Knowledge of national current events and general knowledge (not shown in table) did not change with Internet use, but those who used the Internet more became less knowledgeable about the local Pittsburgh area ( $p < .05$ ).

Different uses of the Internet. Because how people choose to use the Internet could strongly influence its effects, we had asked participants to report how often they used the Internet for various purposes. We conducted a factor analysis of these items to create four scales reflecting different uses of the Internet: (a) for acquiring information and other instrumental purposes such as shopping; (b) for communication with friends and family; (c) for meeting new people or socializing in chat rooms, and (d) for entertainment such as playing games and downloading music, and escape. Table 8 shows the Pearson correlations of overall Internet use, the measures of extraversion and social support, and different purposes of using the Internet. Using the Internet for information ( $r = .62$ ) and for communication with family and friends ( $r = .69$ ) had the highest association with overall Internet use. Extraverts were somewhat more likely than introverts to use the Internet to keep up with friends and family ( $r = .10$ ,  $p < .05$ ) and to meet new people or frequent chat rooms ( $r = .12$ ,  $p < .05$ ). Those with stronger initial social support were less likely than those with weaker support to use the Internet to meet new people or

use chat rooms online ( $r = .11$ ,  $p < .05$ ) or for entertainment ( $r = -.14$ ,  $p < .05$ ). Teens were especially more likely to use the Internet for meeting new people (adults vs. teens,  $r = -.41$ ,  $p < .001$ ) and for entertainment (adults vs. teens,  $r = -.29$ ,  $p < .001$ ). However, adding the measures of specific Internet use to the models in Tables 3-6 did not significantly affect the overall interactions between Internet use and extraversion or social support. \

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Insert Table 8 About Here

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## Discussion

The original HomeNet sample began using the Internet in 1995 or 1996. Our follow-up of participants remaining in the sample in 1998 showed that, overall, the previously-reported negative outcomes associated with more use of the Internet had all but disappeared, /except for the association with increased stress. The statistical interactions of loneliness and depressive symptoms with time period, however, suggest that use of the Internet led to negative outcomes early in participants' history online and more positive outcomes later.

In study 2, conducted from 1998 to 1999, more use of the Internet was associated with mainly positive outcomes over a range of dependent variables measuring social involvement and psychological well-being—local and distant social circle, face-to-face communication, community involvement, trust in people, positive affect, and unsurprisingly, computer skill. On the other hand, heavier Internet use also was associated with greater stress, less local knowledge, and lower desire to stay in the local area. In general, having more social resources amplified the benefits that people got from using the Internet. Among extraverts as compared with introverts, using the Internet was associated with larger increases in community involvement and self-esteem, and larger declines in loneliness, negative affect, and time pressure. Similarly, among people with more rather than less social support, using the Internet was associated with more family communication and greater increases in computer skill. Adults and teens gained slightly different benefits from more Internet use, with adults more likely to increase their face-to-face interactions locally, and their closeness to distant relatives and friends.

There were many differences between the original HomeNet sample and the Study 2 sample. For example, the original sample included a larger proportion of teens, minority households, and computer novices. The sample differences preclude direct comparisons of the two studies. However, the similarity of findings in the later period of Study 1 with the findings in Study 2 suggest that changes in the Internet environment might be more important to understanding the observed effects than differences between the two samples. From 1995 to 1998, the number of Americans with access to the Internet at home more than quadrupled. As a result, many more of the participants' close family and friends were likely to have obtained Internet access. Similarly, the services offered online changed over this period. More news, useful health, financial, hobby, work, community, and consumer information, new synchronous communication services such as instant messaging, and online shopping became widely available. These changes could have promoted better integration of participants' online behavior and Internet use into their lives. Our finding from Study 2, that extraverts and those with more

support benefited more from their Internet use, is consistent with this idea. That is, the Internet may be more beneficial to individuals to the extent they can leverage its opportunities to enhance their everyday lives. Those who are already effective in using social and informational resources in the world are likely to be well positioned to take advantage of a powerful new technology like the Internet.

The mechanisms by which different uses of the Internet may account for its social impact remain unclear. One might expect that interpersonal communication with friends and family would have more beneficial effects than using the Internet for playing computer games or communicating with strangers. If we are to test these ideas and understand how Internet activities ranging from shopping online to meeting a romantic partner affect people, we need better studies of these activities, preferably with comparisons to their real-world counterparts. Unfortunately, it is probably late in the evolution of the Internet to carry out true experiments, at least in North America. We tried to conduct an experiment on Internet use for Study 2, but in fewer than 6 months, 84% of the participants in the control group had acquired Internet access on their own. Nonetheless, researchers should continue to attempt to discern how using the Internet is affecting people's lives with the best designs possible. As the technology, users, and applications change, the impact the Internet will have on personal lives is likely to change as well. We believe longitudinal research will advance understanding of what people do online and offline over time because these methods allow researchers to relate these detailed descriptions to changes in important domains of life.

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Table 1. Analysis of the original HomeNet study after 3 years ( $n = 208$ ).

Independent variables	Social Support			Local social circle (log)			Distant social circle (log)			Family Communication (log)			Stress			Depression			Loneliness		
	beta	se	p	beta	se	p	beta	se	p	beta	se	p	beta	se	p	beta	se	p	beta	se	p
Intercept	0.00	0.04		3.76	3.37		8.85	6.74		-0.03	0.05		0.01	0.01		-0.01	0.03		0.03	0.04	
Adult	-0.13	0.09		-19.37	7.41	**	-49.02	14.70	***	0.34	0.11	**	0.00	0.02		-0.14	0.06	*	0.04	0.09	
Male	-0.16	0.08	*	-2.74	6.89		6.57	13.70		-0.08	0.10		0.00	0.02		0.02	0.05		0.27	0.08	**
Household income	0.00	0.00		-0.20	0.15		0.14	0.29		0.00	0.00		0.00	0.00	*	0.00	0.00		0.00	0.00	
White	0.15	0.09		-8.26	8.23		-6.74	16.38		0.11	0.13		0.04	0.02	+	-0.14	0.07	*	-0.22	0.10	*
Time period	0.10	0.06		0.97	2.52		-4.04	4.66		-0.34	0.10	***	0.06	0.01	***	0.01	0.04		0.12	0.06	+
Stress																0.61	0.17	***			
Extraversion	0.07	0.05		1.04	2.74		-5.28	5.21													
Lagged dependent variable	0.45	0.07	***	0.21	0.06	***	0.33	0.10	***	0.37	0.08	***	0.54	0.06	***	0.18	0.06	***	0.44	0.05	***
Internet hours (log)	0.02	0.05		-1.15	3.29		-5.14	6.27		0.05	0.07		0.03	0.01	*	-0.01	0.03		0.00	0.05	
Internet * period	0.10	0.08		-0.37	3.06		2.88	5.62		0.16	0.12		-0.01	0.02		-0.13	0.05	*	-0.21	0.08	**
Internet * generation	0.06	0.09		5.44	6.08		7.52	11.57		-0.02	0.13		0.04	0.02	+	-0.08	0.06		-0.09	0.10	
$n$	189			189			187			177			195			187			186		
$R^2$	0.29			0.26			0.17			0.15			0.46			0.20			0.36		

+  $p < .10$ , \* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$

Note. Period 1 is 12-18 months, from 1995 or 1996 to 1997. Period 2 is from the first posttest in 1997 to the second posttest in 1998.

Table 2: Non-standardized scales used in Study 2.

	Average Alpha
Internet use	.86
I use the world wide web very frequently.	
I use email very frequently.	
I hardly ever use computers. (R)	
I hardly ever use the WWW. (R)	
I hardly ever use email. (R)	
I hardly ever use MUDs. (R)	
Time per day spent using computers at home.	
Time per day spent using WWW.	
Time per day spent using email.	
Frequency per month of using se a computer at home.	
Frequency per month sending an email message at home.	
Time pressure	.82
I often feel under stress because I don't have enough time.	
I spend enough time with my family and friends. [R]	
I have plenty of time for fun these days. [R]	
I never seem to have enough time to do what's necessary around the house.	
I am frequently interrupted.	
Face-to-face communication	.55
Time spent with friends.	
Time spent with family.	
Communication with friends.	
Frequency visiting friends and relatives.	
Telephone communication	.83
Frequency making phone calls	
Frequency receiving phone calls	
Community involvement	.90
In the past three months, I have spent a lot of time working with others in my local community or school to solve problems of concern to us.	
I feel like I know what's going on in my neighborhood or community.	
In the past three months, I have spent a lot of time working with others outside of my local community to solve problems of concern to us.	
I don't feel I really belong in my local community. [R]	
I feel part of the community in Pittsburgh.	
I spend a lot of time participating in community activities.	
I feel I belong to the community. [R]	
Computer skills	.83

Computers do not scare me. Using computers is fun. I am afraid of using a computer. (R) I am not threatened by computers. I am very skilled at using computers. I know a computer language. I would be at ease at computer class. I am self-confident about computers. I feel comfortable using computers. I don't know much about using computers. (R)	
U.S. knowledge (Examples. Items were changed for each wave)	.41
The Chief Justice of the Supreme Court is (William Rehnquist; Clarence Thomas; Kenneth Starr; Ruth Bader-Ginsberg). Which of the following movies just won the Oscar for best picture ( <i>As Good As It Gets</i> ; <i>L.A. Confidential</i> ; <i>Titanic</i> ; <i>The Full Monty</i> ).	
Local knowledge (Examples. Items were changed for each wave)	.34
What is the University of Pittsburgh best known for (educational school; business school; medical school; computer science department). What is the largest employer in the Pittsburgh area? (US Air; US Steel; Westinghouse; University of Pittsburgh).	
General knowledge (Examples. Items were changed for each wave)	.33
Civilization probably began in (North America; western Europe; New Guinea and Australia; Mesopotamia and the Nile Valley). When a river narrows, the water in the river flows (faster; slower; at varying rates; at the same rate).	

Note. R = reversed scoring



Table 4. Predicting social involvement (interpersonal communication) as a function of use of the Internet over time and individual difference variables. Study 2.

Independent variables	Social support			Local social circle (log)			Distant social circle (log)			Family communication (log)			Face-to-face communication			Phone communication			Closeness to local friends			Closeness to distant friends		
	beta	se	p	beta	se	p	beta	se	p	beta	se	P	beta	se	p	beta	se	p	beta	se	p	beta	se	p
Intercept	-0.01	0.02		-0.02	0.03		0.01	0.04		0.29	0.01	***	0.02	0.03		-0.02	0.03		-0.01	0.06		-0.01	0.04	
Adult	0.18	0.05	***	-0.04	0.10		0.31	0.12	*	0.00	0.03		-0.55	0.11	***	0.12	0.10		0.27	0.17		0.15	0.16	
Male	-0.09	0.03	**	0.03	0.06		-0.08	0.07		-0.01	0.02		-0.19	0.07	**	-0.30	0.07	***	-0.29	0.12	*	-0.02	0.09	
White	0.15	0.06	*	0.37	0.12	**	0.28	0.15	+	-0.03	0.04		-0.11	0.13		-0.04	0.13		-0.41	0.25	+	-0.16	0.20	
Household income	0.02	0.01	*	-0.01	0.02		0.01	0.03		-0.01	0.01		-0.01	0.02		0.03	0.02		-0.09	0.04	*	0.01	0.03	
Education	0.01	0.01		0.00	0.03		0.06	0.03	+	0.00	0.01		-0.04	0.03		-0.02	0.03		0.00	0.05		-0.01	0.04	
Computer sample	0.02	0.04		0.12	0.07		0.07	0.09		-0.01	0.02		-0.22	0.08	**	-0.03	0.08		-0.10	0.13		-0.10	0.10	
Time period	0.01	0.02		-0.05	0.04		-0.12	0.05	*	0.00	0.01		0.03	0.05		0.08	0.04	+	0.00	0.00		-0.04	0.06	
Lagged DV	0.53	0.03	***	0.33	0.04	***	0.46	0.03	***	3.86	0.04	***	0.28	0.03	***	0.50	0.03	***	-0.99	0.00	***	0.50	0.04	***
Extraversion	0.15	0.03	***	0.09	0.05	*	0.09	0.06		0.02	0.01		0.14	0.05	**	0.16	0.05	**	0.00	0.00		0.01	0.07	
Social support				0.17	0.05	***	0.13	0.07	+	0.04	0.02	*	0.28	0.07	***	0.11	0.06	+	0.00	0.00		0.30	0.08	***
Internet use	-0.01	0.02		0.12	0.04	**	0.15	0.05	**	0.00	0.01		0.09	0.04	*	0.05	0.04		0.00	0.00		0.07	0.06	
Internet * extraversion	0.01	0.03		0.02	0.06		-0.05	0.07		-0.01	0.02		-0.02	0.07		0.10	0.06		0.00	0.00		0.01	0.08	
Internet * support				0.01	0.07		0.02	0.09		0.05	0.02	**	-0.11	0.08		-0.08	0.07		0.00	0.00		0.15	0.10	
Internet * generation	-0.11	0.06	+	-0.13	0.11		-0.02	0.15		-0.06	0.03	+	0.30	0.13	*	0.04	0.12		0.00	0.00		0.35	0.18	*
<u>n</u>	406			385			365			373			406			391			351			285		
<u>R</u> <sup>2</sup>	.51			.42			.47			.95			.31			.51			.16			.44		

+ p < .10, \*p < .05, \*\*p < .01, \*\*\*p < .001.

Table 5. Predicting social involvement (community) as a function of use of the Internet over time and individual difference variables. Study 2.

Independent variables	Community involvement			Stay in Pittsburgh			Trust			Anomie		
	beta	se	p	beta	se	p	beta	se	p	beta	se	p
Intercept	0.00	0.02		-0.02	0.04		-0.01	0.02		0.00	0.02	
Adult	0.11	0.07		-0.01	0.14		0.30	0.08	***	-0.24	0.06	***
Male	-0.09	0.04	*	0.11	0.08		-0.01	0.05		0.07	0.04	*
White	-0.10	0.09		0.47	0.18	**	0.22	0.10	*	-0.12	0.08	
Household income	-0.05	0.02	**	-0.06	0.03	*	-0.02	0.02		-0.03	0.01	+
Education	0.05	0.02	**	0.01	0.04		0.04	0.02	+	-0.03	0.02	*
Computer sample	0.09	0.05	+	0.11	0.10		0.07	0.06		-0.07	0.05	
Time period	0.01	0.04		-0.07	0.06		-0.01	0.04		0.04	0.03	
Lagged DV	0.51	0.03	***	0.55	0.03	***	0.51	0.03	***	0.43	0.03	***
Extraversion	0.17	0.04	***	0.13	0.07	*	0.07	0.04	+	-0.06	0.03	+
Social support	0.17	0.04	***	0.19	0.08	*	0.21	0.05	***	-0.16	0.04	***
Internet use	0.05	0.03	+	-0.13	0.06	*	0.07	0.03	*	-0.01	0.03	
Internet * extraversion	0.10	0.05	*	0.09	0.09		0.00	0.05		-0.01	0.04	
Internet * support	0.02	0.05		-0.08	0.10		0.02	0.06		0.02	0.05	
Internet * generation	-0.01	.09		0.10	0.17		-0.12	0.10		-0.04	0.08	
<u>n</u>	403			402			405			405		
<u>R</u> <sup>2</sup>	.50			.49			.48			.47		

+  $p < .10$ , \*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$ .

Table 6. Predicting psychological well being as a function of use of the Internet over time and individual difference variables. Study 2.

Independent variables	Stress			Loneliness			Depression			Negative affect			Positive affect			Time
	beta	se	p	beta	se	p	beta	se	p	beta	se	p	beta	se	p	
Intercept	0.00	0.00		0.00	0.02		0.01	0.01		0.01	0.02		0.00	0.02		0.00
Adult	0.04	0.02	**	0.08	0.06		0.01	0.05		-0.12	0.07	+	0.05	0.08		0.23
Male	-0.01	0.01		-0.01	0.03		0.02	0.03		-0.02	0.04		0.07	0.05		-0.18
White	0.00	0.02		-0.10	0.07		0.01	0.06		-0.03	0.09		-0.15	0.09	+	0.12
Household income	0.00	0.00		-0.01	0.01		-0.02	0.01	+	-0.03	0.02	*	0.02	0.02		0.03
Education	0.01	0.00		0.01	0.02		-0.01	0.01		0.03	0.02		0.00	0.02		-0.02
Computer sample	-0.02	0.01	+	-0.06	0.04		-0.03	0.04		-0.08	0.05		-0.02	0.06		-0.03
Time period	0.01	0.01		-0.04	0.03		-0.04	0.02	+	-0.04	0.03		0.07	0.03	*	-0.06
Lagged DV	0.54	0.03	***	0.27	0.03	***	0.48	0.03	***	0.39	0.03	***	0.32	0.03	***	0.41
Extraversion	0.00	0.01		-0.21	0.03	***	0.03	0.02		0.01	0.04		0.09	0.04	*	-0.15
Social support	-0.02	0.01	*	-0.59	0.04	***	-0.21	0.03	***	-0.23	0.04	***	0.41	0.05	***	-0.12
Internet use	0.01	0.01	*	0.03	0.02		0.01	0.02		0.04	0.03		0.14	0.03	***	0.05
Internet * extraversion	-0.01	0.01		-0.08	0.03	*	-0.05	0.03		-0.12	0.04	**	0.04	0.05		-0.14
Internet * support	0.01	0.01		0.01	0.04		0.01	0.04		-0.08	0.05		-0.08	0.06		0.06
Internet * generation	-0.02	0.02		-0.10	0.07		-0.09	0.06		-0.13	0.09		0.10	0.09		-0.06
<u>n</u>	398				406			405			405			405		
<u>R</u> <sup>2</sup>	.51				.66			.48			.40			.43		

+ p < .10, \*p < .05, \*\*p < .01, \*\*\*p < .001.

Table 7. Predicting knowledge as a function of use of the Internet over time and individual difference variables. Study 2.

Independent variables	Computer skill			U. S. knowledge			Local knowledge		
	beta	se	p	beta	se	p	beta	se	p
Intercept	0.02	0.02		0.00	0.01		0.00	0.01	
Adult	-0.11	0.07		0.18	0.04	***	0.13	0.03	***
Male	0.05	0.04		0.04	0.02	+	0.04	0.02	*
White	-0.01	0.08		0.09	0.04	*	0.06	0.04	
Household income	-0.01	0.02		0.00	0.01		0.00	0.01	
Education	0.03	0.02		0.03	0.01	***	0.03	0.01	***
Computer sample	-0.10	0.05	+	0.01	0.03		0.02	0.02	
Time period	0.04	0.03		-0.04	0.02	*	-0.09	0.01	***
Lagged DV	0.65	0.03	***	0.22	0.04	***	0.11	0.04	**
Extraversion	0.02	0.03		-0.02	0.02		0.00	0.01	
Social support	0.03	0.04		0.05	0.02	*	0.01	0.02	
Internet use	0.31	0.03	***	0.00	0.01		-0.03	0.01	*
Internet * extraversion	-0.02	0.04		0.01	0.02		0.03	0.02	
Internet * support	0.10	0.05	*	0.00	0.03		0.00	0.02	
Internet * generation	0.14	0.08		-0.01	0.04		0.01	0.04	
<u>n</u>	400			403			403		
<u>R</u> <sup>2</sup>	.71			.15			.15		

+ p < .10, \*p < .05, \*\*p < .01, \*\*\*p < .001.



Table 8: Purposes of using the Internet. Study 2.

	Purposes of using the Internet			
	Information	Communication with family & friends	Meeting new people, visiting chat rooms	Entertainment
Communication with family & friends	.65***			
Meeting new people; visiting chat rooms	.39***	.48***		
Entertainment (e.g., games, music)	.61***	.52***	.44***	
Overall Internet use	.62***	.69***	.38***	.51***
Extraversion	.06	.10*	.12*	.03
Social support	-.07	.02	-.11*	-.14**
Adult vs. teen	-.13**	-.18**	-.41***	-.29***

Note. Responses were averaged over three survey administrations before computing correlations. N=446.

+  $p < .10$ , \* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$ .

Figure 1. Interaction of Internet Use and Extraversion on Loneliness

