Online Communication, Compulsive Internet Use, and Psychosocial Well-Being Among Adolescents: A Longitudinal Study

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The present study investigated the relationships between adolescents’ online communication and compulsive Internet use, depression, and loneliness. The study had a 2-wave longitudinal design with an interval of 6 months. The sample consisted of 663 students, 318 male and 345 female, ages 12 to 15 years. Questionnaires were administered in a classroom setting. The results showed that instant messenger use and chatting in chat rooms were positively related to compulsive Internet use 6 months later. Moreover, in agreement with the well-known HomeNet study (R. Kraut et al., 1998), instant messenger use was positively associated with depression 6 months later. Finally, loneliness was negatively related to instant messenger use 6 months later.

Keywords: online communication, depression, loneliness, compulsive Internet use, adolescents

In the past decade, the Internet has become a widely used communication medium. Almost all Dutch adolescents use the Internet for interpersonal communication, and 84% use the Internet for real time online communication, such as instant messaging and chatting in chat rooms (Valkenburg & Peter, 2007). Instant messaging has become the most popular online communication function both in the Netherlands (Valkenburg & Peter, 2007) and in the United States (Gross, 2004; Subrahmanyan, Greenfield, Kraut, & Gross, 2001). In contrast to e-mail, instant messaging and chatting are forms of online communication whereby users see the message instantly, as soon as the sender hits the return key. Moreover, in contrast to chatting in chat rooms, instant messaging mainly reflects communication between persons who know each other; that is, the use of instant messaging functions (e.g., ICQ, MSN Messenger) requires that both users actively program each other’s instant messaging address (Subrahmanyan, Greenfield, & Tynes, 2004). In the present study, we investigated the relationships between adolescents’ online communication (i.e., email use, instant messaging, and chatting in chat rooms) and their psychosocial well-being.

Among psychologists as well as in the public media, there is an ongoing debate about the impact of online communication on the psychosocial well-being of adolescents. On the one hand, communication with the Internet could have positive consequences, for example, by increasing social support, by enabling easier connections with friends, or by facilitating the formation of new relationships (Kraut et al., 2002; Parks & Roberts, 1998). The Internet may also offer a relatively safe place to have social interaction without requiring the social skills demanded in in-person interactions (Amichai-Hamburger & McKenna, 2006; McKenna, Green, & Gleason, 2002; Ybarra, Alexander, & Mitchell, 2005), which may be particularly beneficial for otherwise isolated teenagers (McKenna & Bargh, 1998). On the other hand, there is a growing concern about excessive Internet use and its potential harmful effects on the psychosocial well-being of youngsters. Several studies have already addressed the potential addictive properties of the Internet (Beard, 2005; Beard & Wolf, 2001; Brenner, 1997; Caplan, 2002; Davis, 2001; Griffiths, 2002; Morahan-Martin & Schumacher, 2000; Young, 1996, 1998), with Internet addiction being defined by core features such as, for instance, loss of control, withdrawal symptoms, preoccupation, intra- and interpersonal conflict, and coping.

It has also been suggested that some adolescents become so involved with certain applications of the Internet that they are no longer capable of controlling their online activity, implying that these youngsters have developed symptoms of compulsive Internet use (Chou & Hsiao, 2000; Johansson & Götestam, 2004; Morahan-Martin & Schumacher, 2000; Wang, 2001), also referred to in the literature as Internet addiction (Young, 1998), problematic Internet use (Caplan, 2002; Morahan-Martin & Schumacher, 2000), pathological Internet use (Davis, 2001), and Internet dependence (Wang, 2001). Compulsive Internet use has been described by core criteria such as (a) one experiences unpleasant emotions when Internet use is impossible, (b) one continues Internet use despite the intention or desire to stop or cut down the use, (c) one uses the Internet to escape from negative feelings, (d) Internet use dominates one’s cognitions and behaviors, and (e) Internet use results in conflict with others or in self-conflict (Meerkerk, van den Eijnden, Vermulst, & Garretsen, 2008).

Online communication is suggested to play a central role in the development of compulsive Internet use (Caplan, 2003; Chou & Hsiao, 2000; Ward, 2001; Young, 1997). The interactive aspects of the Internet are thought to be particularly attractive, creating an
atmosphere for developing a compulsive tendency to seek out companionship and sexual excitement and to alter identities (Young, 1997). In agreement with this notion, a study among Taiwanese college students found that a high score on communication pleasure was related to Internet dependence (Chou & Hsiao, 2000). Furthermore, Caplan (2003) found that students’ preference for online (rather than face-to-face) social interaction was related to compulsive Internet use. In contrast, a study among Norwegian adolescents showed associations between compulsive Internet use and both communication and information applications of the Internet (Johansson & Götestam, 2004). The significance of the latter study is, however, limited because of the cross-sectional nature of the data; that is, a longitudinal study would provide more meaningful associations between Internet functions and compulsive Internet use. Therefore, in the present study, we used a longitudinal research design to test the assumption that online communication, rather than other Internet applications (e.g., information seeking and gaming), is positively related to future compulsive Internet use (Hypothesis 1).

Aside from the risk of developing symptoms of compulsive Internet use, frequent online communication may directly reduce the psychosocial well-being of adolescents. A key study on psychosocial consequences of Internet use, the HomeNet study, confirmed that adolescent Internet use is associated with a decrease in well-being (Kraut et al., 1998). This 2-year prospective study demonstrated that teenagers who spent more time online experienced a greater decline in social and psychological well-being during the first year of access to the Internet. Those who were lonely and depressed beforehand were not more attracted to the Internet; rather, the study suggested that using the Internet in itself was related to a decrease in social well-being. The authors speculated that adolescents’ heavy usage of the Internet for online communication led them to forsake critical relations with local friends and family for weak relations with strangers (the social displacement hypothesis). However, a 3-year follow-up study among the same sample showed that these negative effects on well-being had dissipated over time (Kraut et al., 2002).

Since Kraut et al.’s (1998) study, several researchers have addressed this issue. Most of these studies found no relationship between the frequency of Internet use and psychosocial well-being (Gross, 2004; Gross, Juvonen, & Gable, 2002; Sanders, Field, Diego, & Kaplan, 2000; Wästlund, Norlander, & Archer, 2001). However, a few studies did report a relationship between Internet use and psychosocial well-being. A cross-sectional study by Ybarra et al. (2005) revealed that the intensity of Internet use differentiated adolescents reporting depressive symptoms from their asymptomatic peers; moreover, adolescents who reported using the Internet particularly for e-mailing or chatting more often experienced symptoms of depression. In addition, Weiser (2001) studied reasons and goals for using the Internet and found two empirical robust dimensions: i.e., socioaffective regulation and goods and information acquisition. He showed that Internet use driven by socioaffective regulation (e.g., meeting new people, meeting others, or looking for romance) was negatively related to psychological well-being (i.e., loneliness, depression, and life satisfaction). Internet use driven by goods and information acquisition (e.g., staying well informed), however, was positively related to psychological well-being.

Although these studies imply a negative relationship between online communication and psychosocial well-being, because of their cross-sectional design they give no indication about the direction of the associations. Therefore, the question remains whether, in agreement with the study by Kraut et al. (1998), online communication leads to a decline in psychosocial well-being (e.g., because online communication decreases the amount of real life time spent with important others) or whether low psychosocial well-being leads to an increase in online communication. As stated before, online communication may be a particularly safe way to communicate for those adolescents who have insufficient social skills or who experience social anxiety (Ybarra et al., 2005). Also, both mechanisms may operate simultaneously. To gain insight into the question of bidirectionality, a longitudinal research design is required. However, as far as we know, only two longitudinal studies (Kraut et al., 2002) have been conducted since Kraut et al.’s (1998) study. The results of both studies showed that online communication is related to a decrease in psychological well-being among introverts and those who received low levels of social support, whereas the psychosocial well-being of extraverts and those with more social support tended to benefit from online communication (referred to by Kraut et al., 2002, as the rich-get-richer model). Although Kraut et al. (1998, 2002) and Bessière, Kiesler, Kraut, and Boneva (2004) examined the pathways whereby online communication is related to changes in well-being, they did not test for control for the opposite pathway whereby well-being may be related to changes in online communication. Thus, from their two longitudinal studies, no inferences can be made about the relative importance of the two paths. The present study addresses this shortcoming by examining both pathways simultaneously within a longitudinal research design. We hypothesize that a positive relationship exists between online communication on the one hand and depression and loneliness on the other (Hypothesis 2). Moreover, we tested the two aforementioned pathways, that is, the hypothesis that online communication is positively related to future depression and loneliness (Hypothesis 3), and the hypothesis that depression and loneliness are positively related to future online communication (Hypothesis 4).

As stated before, there is some empirical support for the assumption that those with fewer social resources experience more negative outcomes of online communication than those with more social resources (Kraut et al., 2002). This suggests that adolescents who feel lonely would not profit from online communication and might even be harmed by frequent online communication. In agreement with the rich-get-richer model, this notion is suggesting that the poor get poorer. Indeed, it was found that close online relationships with people encountered online were related to feelings of depression (Wolak, Mitchell, & Finkelhor, 2003) and that online communication with people with whom one has no close affiliation was related to feelings of loneliness and social anxiety (Gross et al., 2002). On the basis of these results, we hypothesize that the association between online communication and future feelings of depression is stronger for adolescents high in loneliness than for adolescents low in loneliness (Hypothesis 5).

Finally, the aforementioned hypotheses were tested separately for boys and girls. Although gender differences in Internet use seem to decrease in time, it has been reported that online communication is particularly popular among girls (Kraut et al., 1998; Subrahmanyam, Kraut, Greenfield, & Gross, 2000). More impor-
tant, some studies have suggested differential associations between online communication and psychosocial well-being (Wolak et al., 2003; Ybarra et al., 2005). For instance, a stronger negative relationship between depressive symptoms and online communication with strangers has been found for boys than for girls (Ybarra et al., 2005).

In summary, the innovative aspects of the present study are as follows: (a) the focus on correlations between important Internet applications (including, e.g., instant messenger use) and increases in compulsive Internet use, (b) the focus on the bidirectionality of the relationship between online communication functions and adolescents’ psychosocial well-being, (c) the longitudinal design with a large sample of early adolescents, and (d) the use of a variety of statistical models using structural equation modeling.

Methods

Sample and Procedure

Data were collected among students in the eighth grade of four schools located in the southern part of the Netherlands. Prior to data collection, all school principals and teachers granted us permission to administer our questionnaire. Parents’ permission was gathered by means of passive informed consent. That is, parents received a letter in which they were informed that their child’s school was participating in a study on Internet use and well-being and that a questionnaire would be administered during school hours. If parents did not agree with the participation of their child, they could either contact the school board or the researchers.

Data collection consisted of written questionnaires filled out in the classroom setting. To administer the questionnaires in class, teachers received careful instruction about the coordination of the survey, including guidelines to guarantee the privacy of participants while filling out the questionnaire. Furthermore, teachers were asked to remind the students about the confidential aspect of participation in this study. A total of 708 students participated. The present study included two measurements times: Time 1 (T1) was November 2003, and Time 2 (T2) was June 2004 (i.e., with an interval of 6 months).

Our analyses included only data from participants who participated in both T1 and T2; 663 students participated in both measurements (94%). We conducted attrition analyses to test possible differences between the selected participants and those who dropped out. A logistic regression analysis showed no significant differences for age, gender, cultural background, education level, compulsive Internet use, or depressive symptoms.

Of the final sample of 663 participants, 318 were male and 345 were female, with an age range of 12 to 15 years (M = 13.37, SD = 0.57). Most of the participants were of Dutch origin; 8% had a different background, having at least one parent born in another country, mainly Turkey and Morocco (2%) or Surinam or the Netherlands Antilles (2%). Of the sample, 8% were involved in lower secondary education (i.e., a vocational training), 32% were involved in intermediate secondary education (i.e., preparatory college), and 60% were in higher secondary education (i.e., university education).

Measures

Online communication and other Internet functions. Participants were asked to indicate how often they engaged in the following Internet behaviors: (a) seeking information, (b) surfing, (c) gaming, (d) searching for pornography, (e) downloading music, films, software, and so forth, (f) e-mailing, (g) chatting in a chat room, and (h) instant messaging. Answers were given on a 5-point scale ranging from 1 = less than once a week to 5 = (almost) daily. The investigated online communication applications were e-mail, instant messaging, and chatting. For these three functions, an additional question was asked about the importance of these forms of communication for keeping in contact with friends and peers; the response scale ranged from 1 = absolutely unimportant to 5 = very important.

Compulsive Internet use. To measure compulsive Internet use, the shortened version of a recently developed and validated scale was used: the Compulsive Internet Use Scale (Meerkerk et al., 2008). This shortened version consists of 10 items identifying the core features of compulsive Internet use. These core features are (a) preoccupation or salience (e.g., “How often do you look forward to your next Internet session?”), (b) loss of control (e.g., “How often do you find it difficult to stop using the Internet when you are online?”), and (c) continued use of Internet despite the intention to stop (e.g., “How often have you unsuccessfully tried to spend less time on the Internet?”). Answers were given on a 5-point scale ranging from 1 = never to 5 = very often. The internal consistency of the scale was good (Cronbach’s α = .82 at T1 and .85 at T2).

Depressive symptoms. To assess depressive symptoms, the Depressive Mood List was used (Kandel & Davies, 1982, 1986). On a 6-item scale, respondents were asked to report negative feelings over the past 12 months. For example, items asked how often participants felt unhappy, sad, or depressed and how often they felt nervous or tense. This scale has been extensively used, and sufficient psychometric properties have been shown in terms of internal consistency, reliability, and stability over time (Kendall, Cantwell, & Kazdin, 1989). We used the Dutch version of the Depression Mood List (Engels, Finkenauer, Meeus, & Dekovic, 2001); Cronbach’s α was .75 at T1 and .78 at T2.

Loneliness. Feelings of loneliness were assessed with the 10-item Loneliness Scale developed by Russell, Peplau, and Cutrona (1980); this scale contained 5 positive and 5 negative items. Examples of items are “I am feeling alone,” “I do not have real friends,” and “there are people who really understand me.” Negative items were recoded before summing the 10 items into a scale. The internal consistency of the scale was high; Cronbach’s α was .85 at T1 and .90 at T2.

Strategy of Analysis

Before analysis, we inspected the data file for missing values. Of the 663 respondents, 3 showed missing values in a systematic way, meaning that values were missing on 21 of the 38 variables used for our analyses; these respondents were removed from the data file. For the remaining data from 660 respondents, the mean percentage of missing values per variable was 1.1% (range = 0.2% to 4.2%). The missing values were replaced by values estimated by the expectation maximization algorithm in SPSS, which is a method to obtain maximum likelihood estimates when some data are missing (Allison, 2002).

To test the aforementioned hypotheses, we used structural equation modeling (SEM) with the help of the software package Mplus (Mu-
then & Muthén, 2002). The advantage of SEM over, for example, regression analysis is that measurement errors can be separated from the true latent variables, and (as a consequence) estimated structural relationships between latent variables are more valid. Moreover, structural relations are estimated simultaneously, and fit indices are important indicators for the fit of the model.

To test Hypothesis 1 that online communication, more than other Internet applications, is related to increases in compulsive Internet use, we used a multiple indicators multiple causes (MIMIC) model (Bollen, 1989, p. 331; Kaplan, 2000). The Internet functions in this model are the independent variables (multiple causes), and compulsive Internet use (measured by multiple indicators) is the dependent variable (see Figure 1). This SEM model is similar to a regression model. The difference with a regression model is that the dependent variable is a latent variable where measurement errors are implicitly included in the model.

Independent variables were free to correlate. Indicators for a latent variable are usually the individual items (in our case 10 items for compulsive Internet use), but for reasons described later, we replaced items by three parcels (subsets of items). Three models were tested: two cross-sectional models at T1 and T2 and a longitudinal model with Internet functions at T1 related to compulsive Internet use at T2.

To test Hypotheses 2 regarding the relationship between online communication (e.g., e-mail, chatting, and instant messaging) and depression and loneliness, we used SEM with latent variable modeling. E-mail, chatting, and instant messaging were measured by two items each, (i.e., one item on how often one uses these Internet functions and one item on the importance of these forms of communication). Depression and loneliness were latent variables measured by two and three parcels, respectively. Structural relations of depression and loneliness with the three online communication variables were tested.

Additionally, Hypotheses 3 and 4, regarding the bidirectionality of the relationship between online communication and depression and loneliness, were tested with cross-lagged panel analyses (Finkel, 1995). To control for possible confounding effects of compulsive Internet use, this variable was also included in the model.

The aim of cross-lagged analysis with panel data is to determine the causal ordering between variables of interest (Finkel, 1995, p. 23). Cross-relations over time enable us to test causal predominance. For example, is instant messaging the cause of depression, or can depression be seen as the cause of instant messaging (Byrne, 1998, p. 352)? However, the direction of the cross-relations over time is an indication only of causal predominance. The present study is restricted to two waves, but models with three or more waves finding consistent cross-relations over time are more convincing about the causal ordering of variables. To examine the reciprocal relations over time, error terms of corresponding parcels or indicators are allowed to correlate (Byrne, 1998, pp. 359–360).

At both T1 and T2, four latent variables were defined: instant messaging measured by two items, compulsive Internet use measured by three parcels, depression measured by two parcels, and loneliness measured by three parcels. Stability relations over time between corresponding latent variables and cross-relations were tested.

Moderation effects of loneliness (Hypothesis 5) on the cross-lagged associations between online communication applications and depression and loneliness have been tested with multigroup analyses (Bollen, 1989). Loneliness was removed from the aforementioned model, and this model was tested separately for adolescents low and high in loneliness. These two groups were formed with a median split (for a description of this procedure, see Harakeh, Scholte, Vermulst, de Vries, & Engels, 2004). The scores for loneliness were based on the original measure of loneliness at T1, consisting of 10 items. The cross-lagged model for those high on loneliness was compared with the cross-lagged model for those low on loneliness. Differences between the two groups were tested with chi-square difference tests. Next, the cross-lagged model for boys was compared with the cross-lagged model for girls.

![Figure 1](image-url)  
**Figure 1.** Multiple indicators multiple causes model with eight Internet functions as predictors of compulsive Internet use. Three models were tested: Cross-sectional at T1, cross-sectional at T2, and longitudinal with the eight Internet functions at T1 as predictors of compulsive Internet use at T2. The figures are standardized regression weights. For Time 1 (T1), \( \chi^2(16, N = 660) = 40.58, p = .001, RMSEA = .048, CFI = .975 \) (T1), \( R^2 = .46, p = .000 \). For Time 2 (T2), \( \chi^2(16, N = 660) = 41.80, p = .000, RMSEA = .050, CFI = .969 \) (T2), \( R^2 = .34, p = .000 \). For longitudinal, \( \chi^2(16, N = 660) = 32.24, p = .010, RMSEA = .039, CFI = .980, R^2 = .31, p = .000 \). ciu = compulsive Internet use (parcels). * \( p < .05 \), *** \( p < .001 \).
differences in cross-lagged relations were tested with chi-square difference tests.

For the analyses mentioned above, we used the latent variables of compulsive Internet use, depression, and loneliness at T1 and T2. The latent variables were measured by 10, 6, and 10 items, respectively. Testing structural relations between latent variables with this relatively high number of items would lead to an excessive number of parameters to be estimated in relation to the sample size. For this reason, we replaced the original items with parcels to reduce the number of parameters to be estimated. Parcels are the mean or the sum of subsets of items of a latent variable. For these analyses, we computed the means of the subsets of items. The parcels were derived as follows. First, we performed exploratory principal factor analyses with oblique rotation on the items of a scale. Despite the one-dimensional character of the scales, we forced a two- or three-factor solution. The choice of a two- or a three-factor solution was dependent on the quality of the factor pattern. We strived for factor solutions with high loadings on one of the factors on low cross loadings. For compulsive Internet use, we constructed three factors pointing to three aspects of compulsive Internet use: Preoccupation or Salience (5 items), Loss of Control (2 items), and Continuing the Use of Internet Despite the Intention to Stop (3 items). These three factors, or parcels, have a satisfactory reliability at T1 and T2 (range = .74 to .80). For depression, we constructed a two-factor solution. The first factor consisted of 4 items and contained items expressing the feeling of being unhappy, sad, or depressed; the second factor consisted of 2 items expressing the feeling of being nervous or tense. The reliability of the parcels derived in this way ranged from .66 to .74. Loneliness was split into three factors. The first factor (3 items) expressed feelings of being alone, isolated, and withdrawn; the second factor (3 items) expressed the presence of other people who are understanding and supportive; the third factor (4 items) expressed the presence or absence of friends and significant others. The reliability ranged from .73 to .84. In this way, we reduced the 26 items for the three latent variables to 8 parcels. Bandolos and Finney (2001) stated that in applications where the focus is on structural relationships and the latent variables are one dimensional, the use of item parcels is defendable.

All SEM models were tested with the help of the maximum likelihood estimation method. We used two fit measures recommended by several authors: (a) the root mean square error of approximation (RMSEA; Byrne, 1998) and (b) the comparative fit index (CFI; Marsh, Balla, & McDonald, 1988). RMSEA is used to assess approximate fit, preferably with values less than or equal to .05, but values between .05 and .08 are indicative of a fair fit (Kaplan, 2000, pp. 113–114). For CFI, values above .95 are preferred (Kaplan, 2000, p. 107), but values should not be lower than .90 (Kline, 1998, p. 131).

### Results

#### Characteristics of the Sample

Of the participants, 99% reported using the Internet, and 97% reported that they had access to the Internet at home. The mean duration of Internet use was 8 hr per week (SD = 8.85) at the first measurement and was 10 hr per week (SD = 9.90) at the second measurement. Almost all participants (93%) communicated online, particularly with instant messenger (84% at T1 and 89% at T2) and e-mail (85% at T1 and 87% at T2). A minority reported that they participated in chat rooms (35% at T1 and 30% at T2). Instant messaging was also the most frequently used form of online communication: 49% of the respondents at T1 and 55% of the respondents at T2 used the instant messenger on a daily basis, compared with the 19% at T1 and the 13% at T2 who used e-mail and the 5% at T1 and the 3% at T2 who used chat rooms. No gender differences were found for the online communication applications of instant messaging and chatting (Fs < 1), but girls used e-mail more often than boys: M = 2.98 and M = 2.73, respectively; F(1, 685) = 6.14, p < .05.

Table 1 shows means, standard deviations, and correlations for all the Internet functions and the three research variables of interest: depression, loneliness, and compulsive Internet use at T1 and T2.
T2. Of all Internet applications, instant messaging was used most frequently, followed by downloading, e-mailing, surfing, gaming, information seeking, chatting, and searching for pornography. Depression showed consistent (at T1 as well as T2) significant positive correlations with instant messaging at T1 ($r = .16, p < .001$) and at T2 ($r = .17, p < .001$): Increasing depression was associated with more instant messaging. Loneliness showed low significant but inconsistent negative correlations with downloading at T1 ($r = -.11, p < .01$), with e-mail at T2 ($r = -.09, p < .05$), and with instant messaging at T2 ($r = -.11, p < .01$). Compulsive Internet use was positively associated with nearly all Internet functions, especially with surfing, downloading, and the three communication functions of e-mail, chatting, and instant messaging. Depression showed substantial positive correlations with loneliness (T1: $r = .32, p < .001$; T2: $r = .37, p < .001$) and with compulsive Internet use (T1: $r = .33, p < .001$; T2: $r = .35, p < .001$). Loneliness was hardly correlated with compulsive Internet use. The (bold) figures at the diagonal in Table 1 are correlations of the variables at T1 with the corresponding ones at T2. These correlations are all above .40, indicating that Internet behavior and psychosocial well-being are rather stable over time.

**Prediction of Compulsive Internet Use by Online Communication and Other Internet Functions**

To test Hypothesis 1 that online communication, rather than other Internet applications, is positively related to future compulsive Internet use, Figure 1 presents standardized regression weights and fit results of predicting compulsive Internet use from eight Internet functions, resulting from testing MIMIC models with SEM at T1, T2, and longitudinally. The measurement part of the three models (the factor loadings for the three parcels of compulsive Internet use) is reported in Table 2. The loadings are sufficiently high and vary between .61 and .85.

The MIMIC models had a good fit (CFI $\geq .95$ and RMSEA $\leq .05$). The cross-sectional models showed that compulsive Internet use was especially associated with chatting and instant messaging and to a lesser extent with e-mailing. The only noncommunication function related (both at T1 and T2) to compulsive Internet use was downloading. The two important correlates in the cross-sectional models (i.e., chatting and instant messaging) were also the two significant precursors of compulsive Internet use in the longitudinal model. The proportions of explained variance of compulsive Internet use were rather high and ranged from .46 (T1) to .34 (T2) and .31 (longitudinal). We conclude that chatting and instant messaging were important predictors of compulsive Internet use 6 months after our initial assessment.

**Online Communication and Psychological Well-Being**

We hypothesized that a positive relationship exists between online communication on the one hand and depression and loneliness on the other (Hypothesis 2). The structural relations between (a) e-mail, chatting, and instant messaging and (b) depression and loneliness were tested in one model at T1, T2, and longitudinally. The results are given in Figure 2. The fits of the models are all acceptable (CFIs $> .95$, RMSEAs around .05). The measurement parts of the three models, in terms of factor loadings for the parcels and indicators, are given in Table 2 and show substantially high loadings. Figure 2 shows that instant messaging had a significant relationship with depression at T1, T2, and between T1 and T2 but had no significant relationship with loneliness. Participants who often engaged in instant messaging reported higher levels of depression in both cross-sectional and longitudinal analyses. However, the proportion of explained variance in depression was not very high and ranged from .06 to .07. Nevertheless, we conclude that instant messaging was positively associated with feelings of depression 6 months after the initial assessment.

**The Bidirectionality of the Relationship Between Online Communication and Psychosocial Well-Being**

We hypothesized that online communication is positively related to future depression and loneliness (Hypothesis 3) and that
depression and loneliness are positively related to future online communication (Hypothesis 4). Because no associations were found for e-mail and chatting, the following analyses were conducted only for instant messaging.

We used a cross-lagged panel model to simultaneously test the relationships between instant messaging and future depression and loneliness on the one hand and between depression and loneliness and future instant messenger use on the other hand. This model also included compulsive Internet use at T1 and T2. Thus, instant messaging, compulsive Internet use, depression, and loneliness were the latent variables measured at T1 and T2 (see Figure 3). The fit of the model is good (RMSEA < .05 and CFI > .95). To avoid complex models, the measurement part of the model is omitted in Figure 3 and presented in Table 2. The factor loadings are high, varying between .50 and .97.

The stability over time of the latent variables is shown in Figure 3. Instant messaging and compulsive Internet use showed a very high level of stability, with weights of .77 and .75, respectively, and depression and loneliness showed stability to a lesser degree, with weights of .65 and .58, respectively. Three cross-lagged paths were significant (Figure 3). Instant messaging at T1 was positively associated with compulsive Internet use at T2 (β = .09, p < .05) and with depression at T2 (β = .10, p < .05). In addition, loneliness at T1 was negatively related to instant messaging at T2 (β = −.12, p < .001). Thus, it seems more plausible that instant messaging affected compulsive Internet use and depression than that compulsive Internet use and depressive feelings affected instant messaging. Similarly, it seems more likely that loneliness affected instant messaging than the other way around.

**Moderating Effects of Loneliness and Gender on Compulsive Internet Use and Psychosocial Well-Being**

Hypothesis 5, which states that the association between online communication and future feelings of depression is stronger for adolescents high in loneliness compared with adolescents low in loneliness, was tested with multigroup analyses. The same model as depicted in Figure 3 was tested separately for adolescents low and high in loneliness. However, before testing the model, loneliness was removed, and this new model was tested for the complete sample. The relations between instant messaging at T1 and compulsive Internet use and depression at T2 were still significant (p < .05) with values of .08 and .09, respectively. The model showed a good fit: χ²(61, N = 660) = 119.86, RMSEA = .038, CFI = .987. The next step was to compare the low-loneliness group with the high-loneliness group. Results showed that the path from instant messaging at T1 to compulsive Internet use at T2 was marginally significant (β = .12, p = .078) and was not significant for the high-loneliness group (β = .06, ns). The path from instant messaging at T1 to depression at T2 was not significant for the low-loneliness group (β = .07, ns) but was significant for the high-loneliness group (β = .12, p < .05, one sided). Testing differences between the low- and high-loneliness groups with the help of chi-square differences yielded no significant differences, Δχ²(1, N = 660) = 0.52, ns, for the path from instant messaging at T1 to compulsive Internet use at T2 and yielded no significant differences, Δχ²(1, N = 660) = 0.44, ns, for the path from instant messaging at T1 to depression at T2. These results show no significant evidence for the moderating role of loneliness in the relations between instant messaging at T1 and compulsive Internet use and depression at T2 when rigorous model testing was used.

Moderating effects of gender on the relationship between instant messaging and compulsive Internet use, depressive symptoms, and loneliness were examined with multigroup analyses. The same model as depicted in Figure 3 (including loneliness) was tested separately for boys and girls. The path from instant messaging at T1 to compulsive Internet use at T2 was nonsignificant for boys (β = .05, ns) but was significant for girls (β = .14, p < .05). The
The path from instant messaging at T1 to depression at T2 was significant for boys (β = .15, p < .05) but not for girls (β = .06, ns). The path from loneliness at T1 to instant messaging at T2 was significant for boys (β = -.13, p < .05) and for girls (β = -.11, p < .05). The basis of these results, we infer that gender moderates the relationship between instant messaging on the one hand and compulsive Internet use and feelings of depression on the other. Instant messaging has a positive association with later depression, these results were not substantial when rigorous model testing was used.

Finally, differences were tested between boys and girls under the condition of low loneliness and the condition of high loneliness. Comparing these four groups simultaneously showed that girls under the condition of low loneliness showed a significant relation between instant messaging at T1 and compulsive Internet use at T2 (β = .19, p < .05), and boys under the condition of high loneliness showed a significant relation between instant messaging at T1 and depression at T2 (β = .16, p < .05, one sided). Chi-square difference tests over the four groups, however, showed no significant differences: Δχ²(3, N = 660) = 1.77, ns, for the path from instant messaging at T1 to depression at T2; Δχ²(3, N = 660) = 1.24, ns, for the path from instant messaging at T1 to depression at T2.

In conclusion, although the present data provide some support for the idea that girls who are low in loneliness are particularly vulnerable to developing compulsive Internet use, whereas boys who are high in loneliness are particularly vulnerable to developing feelings of depression, these results were not substantial when rigorous model testing was used.

Discussion

The present study, with a longitudinal design and a large sample of early adolescents, is one of the first to focus on correlations between important Internet applications (including online communication applications, such as instant messenger) and increases in compulsive Internet use among adolescents. In line with Hypothesis 1, the findings showed that frequent online communication was positively related to compulsive Internet use among adolescents. In non-real time, was not associated with compulsive Internet use 6 months after the initial assessment. However, only real time communication functions, that is, instant messaging and chatting, were associated with compulsive Internet use, indicating that adolescents who frequently engaged in instant messaging and chatting had a higher incidence of compulsive Internet use 6 months later. E-mail, which does not occur in real time, was not associated with compulsive Internet use 6 months later.

As far as we know, the present study was also the first to examine the bidirectionality of the relationship between online
communication functions and adolescents’ psychosocial well-being. Partly supporting Hypothesis 2, a positive relationship was found between instant messenger use and feelings of depression. Such a relationship, however, was not found for e-mailing and chatting in chat rooms and was not found for feelings of loneliness. With regard to the association between instant messenger use and depression, the present data confirmed Hypothesis 3, that instant messaging would be positively related to feelings of depression 6 months later. However, these data do not support Hypothesis 4, that feelings of depression would be related to instant messaging 6 months later. Thus, adolescents who spent more time communicating by instant messaging showed a higher incidence of compulsive Internet use after 6 months. These data suggest that excessive use of the instant messenger may be a risk for the psychological well-being of adolescents. Finally, although the pathway from instant messaging to feelings of depression was significant for the high-loneliness group and not for the low-loneliness group, the data do not convincingly support Hypothesis 5 because no significant group differences were found. As a result, no conclusions can be drawn about the moderating role of loneliness. Similarly, no conclusions can be drawn about the moderating role of gender. Although the data suggest that instant messaging was positively related to later compulsive Internet use for girls but not boys and that instant messaging was related to later depressive symptoms among boys but not girls, the results after rigorous testing are not convincing.

An unexpected finding was that feelings of loneliness were negatively related to instant messenger use 6 months later, indicating that those high in loneliness seemed to engage in instant messenger use less often than those low in loneliness. This finding is not in line with the assumption that the Internet would offer a relatively safe place for communication, particularly for otherwise isolated teenagers (McKenna & Bargh, 1998). Similar to the findings of Kraut et al. (1998), this finding contrasts the idea that lonely teenagers would be attracted more to online communication applications than their less lonely counterparts. Instead, lonely teenagers seemed to withdraw from instant online communication. In accordance, it has been suggested that feelings of loneliness may evoke an avoidant coping style in which communication with others is further evaded (Seepersad, 2004). There may even be a downward spiral whereby a person’s use of avoidance to cope with loneliness leads to increased loneliness and further avoidance (Rubenstein & Shaver, 1982). Indeed, Seepersad (2004) found that lonely youths tend to cope with loneliness in an avoidant way and prefer to use the Internet for entertainment functions rather than communication functions. Similarly, social anxiety is reported to be negatively related to online communication (Valkenburg & Peter, 2007).

As far as we know, this is the first study to convincingly show that the use of online instant communication applications, more specifically instant messaging and chatting, is related to later compulsive Internet use among adolescents. More than other Internet functions, instant online communication seems to evoke compulsive tendencies, reflected by symptoms such as loss of control, preoccupation with the Internet, and Internet use resulting in conflict with others or self-conflict. However, although compulsive use of instant online communication applications may occur at the expense of real-life social interactions, no indication was found that it would increase feelings of loneliness. Nevertheless, instant messaging seems to have evoked feelings of depression among some users. Thus, the present study is in agreement with the findings for depression in the HomeNet study (Kraut et al., 1998), in that they indicate that adolescent Internet use is associated with a decrease in well-being. Moreover, although no convincing conclusion can be drawn about the moderating role of loneliness, the present patterns are comparable to poor-get-poorer effects (Kraut et al., 2002).

How can we explain the fact that depressive symptoms seem to increase among adolescents who make excessive use of instant messenger? As we discussed earlier, it has been suggested that frequent online communication may displace valuable everyday social interaction with family and friends, with negative implications for users’ psychosocial well-being (the social displacement hypothesis). This would imply that online communications would particularly relate to depression when they involve weak-tie relationships (e.g., strangers and acquaintances) as opposed to strong-tie relationships (e.g., close friends and family members; Subrahmanyan et al., 2000). Indeed, studies have shown a negative association between online communication with strangers and psychosocial well-being among adolescents (Valkenburg & Peter, 2007; Ybarra et al., 2005) and adults (Bessière et al., 2004). For instance, in their longitudinal study among adults, Bessière et al. (2004) showed that online communication is related to an increase in depressive affect only when the communication is directed toward meeting new people and not when communication is with family and friends. This may also provide an explanation for findings supporting the poor-get-poorer assumption (i.e., it seems plausible that lonely and socially isolated adolescents, more than their socially integrated peers, communicate online to meet new people). Online communication might evoke feelings of depression, at least among socially isolated youngsters, because these youngsters rely on Internet communication to obtain social support (LaRose, Eastin, & Gregg, 2001), although such support is hard to obtain from the weak-tie relationships with people met online. In addition, the study by Ybarra (2004) showed that youths low in psychosocial well-being are more likely to report being the target of Internet harassment. Because youngsters low in psychosocial well-being seek more interaction with persons exclusively known online (Ybarra, 2004; Ybarra et al., 2005), the risk of harassment is higher for this group.

Although adolescents generally communicate with peers already known to them when using the instant messenger, there are some indications that the number of weak-tie relationships maintained with this medium is rising. Personal communication with young adolescents revealed that they often have more than 50 or 100 addresses in their messenger list and that these addresses are frequently exchanged. This practice may promote an increase in instant messenger communication with strangers and unfamiliar others.

However, contrasting the rich-get-richer model, Bessière et al. (2004) showed that online communication to meet new people was associated with an increase in depressive affect among those initially high in social resources (the rich get poorer) and that online communication to meet new people was related to a decrease in depressive affect among those initially low in social resources (the poor get richer). Bessière et al. argued that these results confirm the social displacement hypothesis (i.e., that online communication with weak-tie relationships may come at the ex-
pense of existing strong-tie relationships in real life) and the social compensation hypothesis (i.e., that online communication with strangers can help to build social resources for those who lack these resources in the offline world; Bessière et al., 2004). The literature, thus, shows contradictory results with regard to the impact that online communication with weak-tie relationships has on the psychosocial well-being of lonely and socially isolated individuals. Future research should address the conditions under which adolescents low in social resources either benefit from or are harmed by online communication with people met online.

Finally, why is it that depressive symptoms do not seem to increase among adolescents who excessively chat in chat rooms, an application that (more than instant messaging) reflects communication with strangers? In this regard, it should be noted that chatting in chat rooms is much less popular among adolescents than instant messaging: Only 3% to 5% of the adolescents visited a chat room on a daily basis, whereas 49% to 55% of the adolescents used the instant messenger on a daily basis. Moreover, adolescents may have lower expectations about persons they meet in chat rooms (e.g., they may hold lower expectations about obtaining social support), because chatting generally reflects communication with total strangers.

Future research should investigate the processes underlying the relationships found between instant messenger use and depression. Such research should address the mediating role of the strength and familiarity of online relationships and the mediating role of online bullying and harassment. Because of physical distance and perceived anonymity, online communication may more easily evoke verbal aggression than face-to-face communication, and this verbal aggression may particularly target socially vulnerable youngsters.

Finally, we discuss some limitations of the present study. First of all, this study exclusively examined short-term associations between online communication and well-being (i.e., the effects after a 6-month interval). As was shown by Kraut et al. (2002), negative short-term effects may dissipate over a longer period of time. Furthermore, this exploratory study focused mainly on young adolescents ages 12 to 15 years. A similar study is needed among older adolescents (e.g., ages 16–19 years) to test whether the associations between online communication and well-being differ between early and late adolescents. Because one of the developmental tasks in teenagers is to establish and maintain social relationships with friends and/or romantic partners, it might be assumed that having contact predominantly with unknown people on the Internet may lead to personal and/or social problems in young adulthood. However, this assumption is highly speculative because no study has investigated the long-term effects of Internet use on the social development of adolescents. A long-term prospective design would also facilitate examining the stability of the use of online communication functions and compulsive Internet use. If, for instance, there is high variation in compulsive Internet use over time (even over relatively short periods of time), the prolonged negative effects of compulsive use might be less widespread.

Although we embedded our questions on Internet use within a broader questionnaire on health and social behaviors, the lack of anonymity while filling out the forms in a classroom setting may have caused some underreporting of Internet use, particularly among the heavy users or those who experienced feelings of depression. It would be worthwhile to replicate our study in a more anonymous setting, as well as among adolescents and their close friends. We assume that multi-informant data on personal matters is more reliable when gathered among peers than among parents.

References
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