



A longitudinal study of the relation between adolescent boys and girls' computer use with friends and friendship quality: Support for the social compensation or the rich-get-richer hypothesis?

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ABSTRACT

Using computers with friends either in person or online has become ubiquitous in the life of most adolescents; however, little is known about the complex relation between this activity and friendship quality. This study examined direct support for the social compensation and rich-get-richer hypotheses among adolescent girls and boys by including social anxiety as a moderating factor. A sample of 1050 adolescents completed a survey in grade 9 and then again in grades 11 and 12. For girls, there was a main effect of using computers with friends on friendship quality; providing support for both hypotheses. For adolescent boys, however, social anxiety moderated this relation, supporting the social compensation hypothesis. These findings were identical for online communication and were stable throughout adolescence. Furthermore, participating in organized sports did not compensate for social anxiety for either adolescent girls or boys. Therefore, characteristics associated with using computers with friends may create a comfortable environment for socially anxious adolescents to interact with their peers which may be distinct from other more traditional adolescent activities.

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1. Introduction

Use of the computer for socially-motivated purposes has become ubiquitous in the life of most adolescents. A vast majority of adolescents indicate using the computer with friends either in person or online on a regular basis (Gross, 2004; Lenhart, Rainie, & Lewis, 2001; Yuen & Lavin, 2004); including activities such as playing games, searching for information, and online chatting (e.g., chat rooms, instant messaging, email, and friendship networking sites such as Facebook). For example, Lenhart et al. (2001) found that 83% of the adolescents in their study who accessed the Internet in 2000 reported they did so at times with a group of friends surrounding the computer; 50% of boys in a study by Feierabend and Klingler (2001) indicated playing computer games with friends at least once a week; and Lenhart, Madden, and Hitlin (2005) found that approximately half of adolescents who accessed the Internet in 2004 (or approximately a third of all teens in their study) reported using instant messaging on a daily basis. Given the pervasive social interaction associated with computer use, the use of computers with friends either online or in person may be particularly relevant to the study of friendship quality.

Friendships serve several psychosocial purposes for adolescents. For example, adolescent friendships enhance development of social skills, intimacy, empathy, perspective-taking skills and conflict resolution (Berndt, 1982; Buhrmester, 1990; Furman & Buhrmester, 1992; Hartup, 1993; Ingersoll, 1989; Price, 1996). Moreover, adolescent friendships have been found to be reliable predictors of overall well-being, as well as self-esteem and social adjustment during adolescence and adulthood (Berndt, 1996; Hartup, 1992). Of concern is that individuals who have difficulty formulating and maintaining friendships, such as individuals who report high feelings of social anxiety, may miss out on peer interactions important for positive adjustment (Rubin, Burgess, Kennedy, & Stewart, 2003).

Social anxiety is often associated with social avoidance and distress in social situations (La Greca, Dandes, Wick, Shaw, & Stone, 1988), and extensive research has indicated that feelings of social anxiety typically interfere with positive social interactions (La Greca & Lopez, 1998). In fact, socially anxious youth are often less well liked than less anxious peers (Hymel, Rubin, Rowden, & LeMare, 1990; La Greca et al., 1988; Strauss, Frame, & Forehand, 1987), tend not to be affiliated with a peer crowd (La Greca & Harrison, 2005), and report lower levels of companionship and intimacy (La Greca & Lopez, 1998; Vernberg, Abwender, Ewell, & Beery, 1992); thus having important implications for adolescents' social development. Researchers, however, have suggested that social anxiety may be compensated for through successful and positive interactions with

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close friends (e.g., Vernberg et al., 1992). One method that may provide socially anxious adolescents with this opportunity is by using computers with friends. Research specifically examining whether using computers with friends, either online or in person, compensates for social anxiety among both boys and girls throughout adolescence, however, is limited. The current study specifically addresses this issue.

2. Social compensation vs. rich-get-richer hypotheses

Using the computer with friends, such as engaging in online communication and computer games, has been associated with positive outcomes, including more positive friendship quality (Valkenburg & Peter (2007)), a larger social network (Zhao, 2006), more time with friends (Colwell, Grady, & Rhaiti, 1995), and decreases in loneliness (Shaw & Gant, 2002). For example, among adolescents who communicated online predominately with existing friends, the frequency of using computers with friends, either online or in person, was positively associated with self-reported offline friendship quality for adolescent boys and girls (Valkenburg & Peter, 2007). However, researchers also have suggested that the relation between friendship quality and using computers with friends may differ for adolescents depending on their level of social anxiety, resulting in the formulation of two opposing hypotheses: social compensation and rich-get-richer (Gross, Juvonen, & Gable, 2002; Kraut et al., 2002; McKenna, Green, & Gleason, 2002; Valkenburg & Peter, 2007).

The *social compensation hypothesis* suggests that adolescents with high levels of social anxiety may report more positive friendship quality if they use computers with friends to a greater extent than their peers who also have high social anxiety but do not use computers with friends (Cambell, Cumming, & Hughes, 2006; Gross et al., 2002; Kraut et al., 2002; Peter, Valkenburg, & Schouten, 2005). In fact, some socially anxious individuals report that compensating for their social anxiety is a reason they use computers with friends, particularly online communication (Campbell et al., 2006; Peris et al., 2002; Peter et al., 2005; Peter, Valkenburg & Schouten, 2006). Social interactions that occur over the Internet consist predominately of on-screen text, and thus, unless adolescents use webcams, any visual information typical of traditional face-to-face interactions is concealed during online conversations. Similarly, using computers with friends in person may direct focus and eye gaze away from the socially anxious adolescent and towards the computer screen. Given that socially anxious adolescents often avoid eye contact (Albano, 1995), researchers have suggested that communicating with limited eye contact or audiovisual cues may create a more comfortable social situation for socially anxious adolescents in comparison to traditional face-to-face interactions (McKenna et al., 2002; Tyler 2002), leading to a social compensation hypothesis. In other words, adolescents with high levels of social anxiety may report more positive friendship quality if they use computers with friends to a greater extent than their peers who also have high social anxiety but do not use computers with friends.

In contrast, according to the *rich-get-richer hypothesis*, individuals who already are comfortable in social situations may use the computer, either in person or online, to seek out additional opportunities to socialize (Gross et al., 2002; Kraut et al., 2002; Peter et al., 2005). Indeed, using computers with friends, particularly online chatting, has typically increased social interactions rather than replacing more traditional means of interactions such as talking on the phone (Kraut et al., 2002; Walther, 1992). Due to these individuals' already strong social skills, using the computer with friends may be related to even more positive ratings of friendship quality for these adolescents in relation to their less socially anxious peers

who do not use the computer with friends. In partial support of this hypothesis, Peter and colleagues (2005) indicated that lower ratings of introversion among adolescents were associated with more frequent online self-disclosure, which in turn was related with the development of more online friendships.

Researchers, however, have yet to explore the moderating role of social anxiety in the association between using computers with friends and friendship quality for adolescents, and thus have not directly assessed the social compensation and rich-get-richer hypotheses as discussed above. One study instead focused on whether online communication acts as a mediator in the typically negative relation between social anxiety and friendship quality, and thus addressed whether the negative relation between social anxiety and friendship quality could be offset by using computers with friends to a greater extent (Valkenburg & Peter, 2007). That is, Valkenburg and Peter tested a model which included social anxiety as a direct and indirect predictor (by way of online communication perceptions) of the frequency of online communication, and frequency of online communication as a direct predictor of closeness to friends. Social anxiety was negatively related to online communication, while online communication was positively related to closeness to friends, suggesting that less socially anxious adolescents are more likely to turn to online communication than their more anxious peers. However, when online communication perceptions also were included in the model, social anxiety was positively related to perceptions of the Internet as a more effective means than face-to-face interactions for sharing intimate conversations, which was positively related to online communication and, in turn, closeness to friends, supporting a social compensation hypothesis. Given the prevalence of online communication today among adolescents, however, it is no surprise that there were conflicting findings. Most adolescents use online communication, whether they are socially anxious or not (Amichai-Hamburger & Ben-Artzi, 2003; Campbell et al., 2006; Gross, 2004). What is less clear, however, is whether the positive association between online communication and friendship quality is stronger for adolescents with low levels of social anxiety (social compensation) or high levels of social anxiety (rich-get-richer). In order to directly test the social compensation and rich-get-richer hypotheses in terms of this question, we need to examine whether social anxiety acts as a moderator in the relation between computer use with friends and friendship quality.

2.1. Is support for the social compensation and rich-get-richer hypotheses the same for adolescent girls and boys?

The moderating role of social anxiety in the association between using computers with friends and friendship quality for adolescents, however, may differ between adolescent boys and girls. For example, adolescent girls typically report higher levels of social anxiety than boys (La Greca & Harrison, 2005; La Greca & Lopez, 1998; Vernberg et al., 1992). In addition, although adolescent girls often report a smaller number of friendships than boys, their peer relationships are rated as closer and more intimate (Berndt, 1982; Eder & Hallinan, 1978). More importantly, however, the preferred route to intimate peer relations may not be the same for adolescent boys and girls. Adolescent boys typically develop and sustain friendships through shared activities and interests, whereas adolescent girls report engaging in discussion (e.g., talking about topics and events, gossiping, and sharing compliments) and personal disclosure behaviors (e.g., talking about one's own experiences, expressing opinions, and making affective disclosures) as a means for developing intimacy with their friends (Berndt, 1982; Caldwell & Peplau, 1982; Camarena, Sariginani, & Peterson 1990; Jones & Dembo, 1989; Maccoby, 1990; McNelles & Connolly, 1999; Papini, Farmer, Clark, Micka, & Barnett, 1990; Wright, 1982). In fact,

adolescent girls themselves have regarded conversation-based activities as very important for facilitating friendship quality whereas boys acknowledge shared activities as important (Mathur & Berndt, 2006).

2.1.1. Adolescent girls

Activities that foster personal disclosure and discussion, therefore, are likely valuable for adolescent girls' friendship quality. Searching the Internet with friends, for example, may provide adolescents with topics for conversation. Similarly, online communication may provide the opportunity for adolescent girls to discuss personal information. In fact, researchers have consistently found that online conversations involve intimate discussions, including boy/girlfriend-related issues, the day's events, plans for upcoming events, school work and gossip (Boneva, Quinn, Kraut, Kiesler, & Shklovski, 2006; Grinter & Palen, 2002; Gross et al., 2002; Schiano et al., 2001). Because online communication involves personal disclosure and has been found to supplement traditional social interactions (Kraut et al., 2002; Walther, 1992), using computers with friends may be associated with more positive friendship quality for less socially anxious adolescent girls, providing support for the rich-get-richer hypothesis.

At the same time, however, high socially anxious adolescent girls may be less anxious during computer-based interactions rather than traditional face-to-face interactions given the ability to conceal visual information when communicating online and the ability to avoid eye contact when using the computer with friends in person. In support of this social compensation hypothesis, Brunet and Schmidt (2007) found that socially anxious undergraduate females had lower instances of sharing personal information with unfamiliar partners during an online conversation than less anxious females when a webcam was included, while a comparable level of personal disclosure among the participants was observed when the webcam was not present. Overall, therefore, we expected using computers with friends to enhance friendship quality for adolescent girls regardless of level of social anxiety. In other words, we did not expect social anxiety to act as a moderator of the relation between using computers with friends and friendship quality for adolescent girls. Instead, we expected to find support for both the social compensation and rich-get-richer hypotheses.

2.1.2. Adolescent boys

For adolescent boys, using computers with friends in person or online may alleviate social anxiety as the central focus of boys' conversations typically consists of the shared computer-based activities, such as aspects of a computer game, a computer program, or websites (see Orleans & Laney, 2000). For example, Orleans and Laney (2000) found that conversations among adolescent boy dyads, in particular, focused predominantly on computer-oriented activities, such as the configuration of the computer or on the contents of the game they were playing, and included numerous instances of joking around with one another. Again, shared activities are acknowledged as important for increasing intimacy among boys (e.g., Berndt, 1982; Maccoby, 1990; McNelles & Connolly, 1999). Therefore, we expected that highly socially anxious adolescent boys who report using computers with friends to a greater extent would also report more positive friendship quality than their less involved peers, supporting the social compensation hypothesis.

In contrast, using computers with friends may not be associated with friendship quality among less socially anxious adolescent boys. Mathur and Berndt (2006) found that the frequency of participation in activities with friends (e.g., playing board or video games, watching television, and playing sport activities) was not related to perceived friendship quality. Moreover, as adolescent

boys tend to be less concerned with their interpersonal relationships in comparison to girls (Berndt, 1982), they may not engage in conversation that would foster a deeper understanding of ones' peers while using computers with friends, and thus greater engagement in this activity may not be associated with more positive friendship quality. Using computers with friends then may not be related to friendship quality among less socially anxious adolescent boys. Therefore, we expected to find a moderating effect for social anxiety on the relation between computer use with friends and friendship quality for adolescent boys, with support for the social compensation hypothesis only.

2.2. Is the pattern of results stable across time?

There are few longitudinal studies examining computer use and friendship quality among adolescents. Most studies in this area have been cross-sectional (e.g., Valkenburg & Peter, 2007). Given the rapidly changing nature of online communication, however, longitudinal studies are critically needed in order to investigate the stability of associations among social anxiety, using computers with friends, and friendship quality over time. In the present study, therefore, we measured social anxiety, friendship quality and using computers with friends at three time points during adolescence.

3. Purpose of the current study

The purpose of the current study was to investigate support for the social compensation and rich-get-richer hypotheses for adolescent girls and boys, and whether the pattern of findings was stable across adolescence. Given the diverse nature of online communication, we included a general measure of socially-motivated computer use that assessed the frequency of using computer with friends either in person or online. This measure, therefore, could include playing computer games with friends online or in person, online chatting and instant messaging, email, friendship networking sites such as *Facebook*, and so on. At the same time, to ensure that our results also would be consistent with a more focused type of online communication, we also measured the prevalence of online chatting (i.e., encompassing both chatting and instant messaging). In fact, Valkenburg and Peter (2007) suggested since a majority of adolescents use both instant message and chat rooms researchers should not exclusively concentrate on either instant messaging or chat alone.

Specifically, we investigated: (1) the relation between friendship quality and using computers with friends either in person or online, as well as between friendship quality and online chatting, for both boys and girls; and (2) whether social anxiety moderated these associations, and if so, if that effect changed over time. First, it was expected that using computers with friends either in person or online would be positively associated with friendship quality for adolescent boys and girls. Second, social anxiety was expected to moderate the relation between using computers with friends and friendship quality for adolescent boys only. We also expected that these effects would be consistent for online chatting.

To test whether using computers with friends either in person or over the Internet offers an environment for interacting with friends that might be distinct from other more traditional adolescent activities, we also assessed frequency of adolescent involvement in organized sports. Unlike using computers with friends, organized sports tend to be a large group activity, and can involve interactions with individuals outside an adolescent's social network (e.g., players on the competing team, audience, and coaches). In addition, sports may put an adolescent at the centre of attention (e.g., when batting in baseball), and do not lend themselves to personal disclosure. Although using computers with friends in person

and organized sports both may both be considered face-to-face activities with limited need for eye contact, socially anxious adolescents may view organized sports as more threatening than using computer with friends. It was expected, therefore, that participation in organized sports would not compensate for social anxiety among adolescent boys and girls.

Finally, we also explored the stability of the social compensation and rich-get-richer hypotheses throughout adolescence by using a longitudinal design. Due to limited research in this area, we did not make any specific predictions regarding changes in the predicted relations over time.

4. Method

4.1. Participants

Students from eight high schools encompassing a school district in Ontario, Canada took part in the study. This study was part of a larger project examining youth lifestyle choices and involved three waves of survey data collection. A total of 1471 grade 9 students completed the survey at Time 1. The overall participation rate at Time 1 was 83%; non-participation was due to student absenteeism (14.2%), parental refusal (2.1%), or student refusal (.7%). The present results are based on 1050 students who completed the survey first when they were in grade 9 and then again in grades 11 and 12. Five hundred and forty-five students completed the survey at all three time periods and 505 students completed the survey at two time periods (all of these latter students completed the survey at Time 1 but 347 completed the survey again only at Time 2 and 158 completed the survey again only at Time 3).

At Time 1, participants (53% male) were in grade 9 and had an average age of 14.27 ($SD = 0.53$). At Time 2 and 3, these participants generally were in grades 11 and 12 and had an average age of 15.99 ($SD = 0.37$) and 17.29 ($SD = 0.50$), respectively. Consistent with the broader Canadian population (Statistics Canada, 2001), 92.7% of the adolescents were born in Canada and the most common ethnic backgrounds reported other than Canadian were Italian (30%), French (18%), British (15%), and German (10%). Data on socioeconomic status indicated mean levels of education for mothers and fathers falling between “some college, university or apprenticeship program” and “completed a college/apprenticeship/technical diploma”. Further, 76% of the longitudinal respondents reported living with both birth parents, 9% with two parents (including one birth parent), 10% with one birth parent (mother or father only), and the remainder with neither parent (e.g., other relatives, foster parents, and guardians).

Participants who completed the survey only in Time 1 did not significantly differ from the longitudinal participants with respect to demographic and study variables with the exception of friendship quality. Longitudinal participants reported more positive friendship quality. The magnitude of the between-group difference, however, was small (a mean difference of .074; η^2 value

was .005). Furthermore, participants who completed three waves of the survey did not significantly differ from students who completed only two waves of the survey on any of the demographic and study measures.

4.2. Procedure

A passive parental consent procedure was used in this study to ensure a representative sample (see Weinberger, Tublin, Ford, & Feldman, 1990 for a discussion on how active parental consent procedures may result in overrepresentation of well-functioning adolescents and families). Active informed assent, however, was obtained from the adolescent participants. Several strategies were applied in order to ensure parental awareness of the study. First, parents were provided with written correspondence mailed directly to each student’s home prior to the survey administration outlining the study; this letter indicated that parents could request that their child not participate in the study (prior to the Time 2 survey, an automated phone message was also left at each student’s home phone number). Second, several parent information sessions were held throughout the school district. Third, there was extensive media coverage outlining the study.

At all time periods, the self-report questionnaire was administered to students in classrooms by trained research staff. To ensure standardization of procedures across classrooms, at least one research staff person was present in each classroom during survey administration. Students were informed that their responses were completely confidential.

4.3. Measures

All measures used in the present study were assessed at all three time points. Study measures are described below; means and standard deviations are provided in Table 1.

4.3.1. Demographic information

Parental education was an average of two items, one per parent (e.g., what is the highest level of education your mother/step-mother/female guardian completed?), using a 6-point-scale ranging from 0 (*did not finish high school*) to 5 (*completed professional/graduate degree*); higher scores indicated greater parental education. The number of computers in the home was assessed with one item (how many computers do you have in your home?), using a 5 point-scale ranging from 0 (*none*) to 4 (*4 or more*).

4.3.2. Using computers with friends either in person or over the Internet

Using computers with friends either in person or over the Internet was assessed with one question (How often do you use the computer with friends either in person or over the Internet?), using a 4-point-scale ranging from 0 (*never*) to 3 (*always*). Higher scores

Table 1
Means and standard deviations of study measures for boys and girls.

Variable	Girls			Boys		
	Grade 9 M (SD)	Grade 11 M (SD)	Grade 12 M (SD)	Grade 9 M (SD)	Grade 11 M (SD)	Grade 12 M (SD)
Parental education	1.74 (1.28)	N/A	N/A	1.82 (1.29)	N/A	N/A
Number of home computers	1.66 (.77)	N/A	N/A	1.72 (.87)	N/A	N/A
Using computers with friends	1.93 (.77)	1.83 (.81)	1.84 (.81)	1.73 (.77)	1.87 (.77)	1.84 (.81)
Online chatting	.84 (.37)	.84 (.36)	.79 (.41)	.69 (.46)	.74 (.44)	.68 (.47)
Organized sports	2.20 (1.19)	1.89 (1.08)	1.86 (1.22)	2.74 (1.24)	2.48 (1.24)	2.38 (1.26)
Social anxiety	.74 (.57)	.71 (.54)	.70 (.55)	.76 (.63)	.73 (.64)	.76 (.59)
Friendship quality	2.39 (.45)	2.37 (.48)	2.25 (.51)	2.05 (.43)	2.07 (.46)	2.00 (.50)

indicated higher levels of using computers with friends either online or in person.

4.3.3. Online chat

Online chatting was assessed with one question: Do you go to chat rooms/ICQ or MSN messenger when on the Internet? A score of 0 indicated “no” and a score of 1 indicated “yes”.

4.3.4. Organized sport activities

Involvement in organized sports was assessed with two questions (How often do you play school sports and How often do you play organized sports outside of school), using a 5-point-scale ranging from 0 (*never*) to 4 (*every day*). Higher scores indicated higher levels of playing organized sports.

4.3.5. Friendship quality

Friendship quality was assessed by an 18-item scale measuring attachment to one’s friends (e.g., my friends understand me), adapted from Armsden and Greenberg (1987), using a 4-point-scale ranging from 0 (*almost never/never*) to 3 (*almost always/always*). Higher scores indicated more positive ratings of one’s friendships ($\alpha = .89, .91, \text{ and } .90$ for grades 9, 11, and 12, respectively).

4.3.6. Social anxiety

Social anxiety-related symptoms were assessed with 14 questions from the social anxiety scale created by Ginsburg, La Greca, and Silverman (1998) using a 4-point-scale ranging from 0 (*almost never/never*) to 3 (*almost always/always*). Higher values indicated higher levels of social anxiety ($\alpha = .92, .92, \text{ and } .93$ for grades 9, 11, and 12, respectively).

4.4. Missing data

Missing data within each wave were imputed using the EM (expectation-maximization) algorithm in SPSS. EM is an iterative maximum-likelihood (ML) procedure in which a cycle of calculating means and covariances followed by data imputation is repeated until a stable set of estimated missing values is reached. Methodological research has demonstrated that ML estimation is preferable to other methods such as pair-wise deletion, list-wise deletion, or means substitution (Schafer & Graham, 2002). Missing data across waves was not imputed (Raudenbush, Bryk, & Congdon, 2005; Singer & Willet, 2003).

5. Results

Descriptive statistics for the study measures are reported in Table 1. To address the main research questions of (a) whether using the computer with friends either in person or over the Internet, online chatting, and organized sport involvement were associated with friendship quality across grade for both girls and boys, and (b) whether these associations differed depending on level of social anxiety, separate analyses were conducted for online chatting, using the computer with friends, and involvement in organized sports. Each analysis also was conducted separately for girls and boys. Parental education and number of computers in the home were entered in each analysis as control variables given the past research suggesting that these factors may be important influences in technology use (e.g., Rocheleau, 1995; Subrahmanyam, Kraut, Greenfield, & Gross, 2000).

Analyses were conducted with multi-level modeling using the Hierarchical Linear Modeling (HLM) program (Raudenbush et al., 2005). In multi-level modeling, two levels of equations are specified for each outcome variable. The level-1 equation describes

within-individual change in the outcome variable as a function of time and level-1 predictors. Level-1 predictors are measured at all times, and are therefore described as *time-varying predictors*. Level-2 of the multi-level model predicts the initial level and the rate of change in the outcome variable as a function of predictors that vary between individuals. Level-2 predictors are measured at only one time point, and are therefore described as *fixed predictors*. Model fitting for these analyses followed guidelines suggested by Singer and Willet (2003), where several nested models are fitted and models are respecified in order to determine the best-fitting model. For all analyses, our index variable was centered on grade 9 (the grade in which all participants in this sample entered the study), and predictor variables were standardized. Therefore, coefficients also can be interpreted as measures of effect size, such that a one standard deviation change in the predictor variable corresponds to a one unit change in the outcome variable.

For each analysis, six nested models were tested. First, an unconditional means model was specified in order to establish whether systematic variation existed in friendship quality. Second, an unconditional growth model was specified to establish whether significant change occurred across grade in friendship quality. In the third model, demographic covariates (number of computers in the home and parental education) were added to the level-2 equations. In the fourth model, our main study variables (e.g., social anxiety, using the computer with friends, online chatting, and organized sports) were added to the level-1 equation. In the fifth model, the 2-way interactions were added to the level-1 equation. In the sixth model, the 3-way interaction was added.

Eq. (1) presents our level-1 equation for online chatting with friendship quality as the outcome variable.

$$\begin{aligned} \text{FRIENDSHIP}_{ij} = & \pi_{0i} + \pi_{1i}(\text{GRADE}) + \pi_{2i}(\text{ANXIETY}) + \pi_{3i}(\text{CHAT}) \\ & + \pi_{4i}(\text{ANXIETY_X_GRADE}) + \pi_{5i}(\text{CHAT_X_GRADE}) \\ & + \pi_{6i}(\text{CHAT_X_ANXIETY}) \\ & + \pi_{7i}(\text{GRADE_X_CHAT_X_ANXIETY}) + e_{ij} \end{aligned} \quad (1)$$

The coefficients are interpreted similarly to a regular regression equation. The interaction coefficients are interpreted in the same way as a moderating effect in a regression equation. For example, if π_{6i} is significant, this indicates that the relation between friendship quality and social anxiety varies as a function of online chatting.

The level-2 equations for friendship quality are presented in equations two and three.

$$\begin{aligned} \pi_{0i} = & \gamma_{00} + \gamma_{01}(\# \text{ OF COMPUTERS IN HOME}) \\ & + \gamma_{02}(\text{PARENT_EDUCATION}) + r_{0j} \end{aligned} \quad (2)$$

$$\begin{aligned} \pi_{1i} = & \gamma_{10} + \gamma_{11}(\# \text{ OF COMPUTERS IN HOME}) \\ & + \gamma_{12}(\text{PARENT_EDUCATION}) + r_{1j} \end{aligned} \quad (3)$$

These equations specify that the initial level of friendship quality (π_{0i}) and the rate of change in friendship quality (π_{1i}) is a function of *between-individual differences* in number of computers in the home and parental education. Although number of computers in the home and parental education could change over time, in the present study it was measured only at the first wave of data collection (when participants were in grade 9) and is therefore treated as a fixed predictor.

5.1. Online chatting

5.1.1. Girls

The unconditional means model demonstrated that significant variability existed in both within and between person sources of variation. The unconditional growth model showed that there

Table 2
Growth curve results for final model with online chatting.

	Parameter	Girls Coefficient (SE)	Boys Coefficient (SE)
<i>Fixed effects</i>			
Intercept	γ_{00}	2.34*** (.02)	2.04*** (.01)
Number of Computers in the Home	γ_{01}	.04* (.02)	.01 (.01)
Parental Education	γ_{02}	.01 (.02)	.01 (.01)
Grade (rate of change)	γ_{10}	-.05*** (.01)	-.01 (.01)
Number of computers in the home	γ_{11}	-.02† (.01)	-.02† (.01)
Parental education	γ_{12}	.01 (.01)	-.01 (.01)
Social anxiety	γ_{20}	-.16*** (.01)	-.15*** (.01)
Chat	γ_{30}	.03* (.01)	.03** (.01)
Social anxiety X grade	γ_{40}	-.03** (.01)	-.04*** (.01)
Chat X grade	γ_{50}	-.00 (.01)	-.01 (.01)
Chat X social anxiety	γ_{60}	.00 (.01)	.03* (.01)
		SD (variance)	SD (variance)
<i>Variance components</i>			
Level-1: within-person	σ_e^2	.33 (.11)	.33 (.11)
Level-2: between-person			
In intercept	σ_0^2	.26*** (.08)	.23*** (.06)
In rate of change	σ_1^2	.11*** (.01)	.12*** (.02)

Note: SE = standard error, SD = standard deviation. As all the predictors were standardized, coefficients can be interpreted as measures of effect size, such that a one standard deviation change in the predictor variable corresponds to a one unit change in the outcome variable.

† $p < .07$.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

was a significant decrease in friendship quality across the course of high school ($\gamma_{10} = -.04$, $SE = .01$, $p < .001$). Results from this model also showed that significant variation existed in both initial level of friendship quality, $\chi^2(489, N = 490) = 1563.11$, $p < .001$, and the rate of growth in friendship quality, $\chi^2(489, N = 490) = 654.85$, $p < .001$. The third model, where the covariates were added, showed that adolescents reporting a greater number of computers in the home also reported higher initial levels of friendship quality ($\gamma_{01} = .05$, $SE = .02$, $p < .01$) and a trend for a steeper rate of decline in friendship quality across grade ($\gamma_{11} = -.02$, $SE = .01$, $p = .07$). Parental education was not significantly associated with friendship quality.

The fourth model, adding the main effects of social anxiety and online chatting, revealed that both social anxiety ($\gamma_{20} = -.15$, $SE = .01$, $p < .001$) and online chatting ($\gamma_{30} = .03$, $SE = .01$, $p < .05$) were significant, such that lower levels of social anxiety and higher levels of chatting online were associated with higher levels of friendship quality. The fifth model added the two-way interactions (see Table 2 for full results). The main effects of social anxiety ($\gamma_{20} = -.16$, $SE = .01$, $p < .001$) and chat ($\gamma_{30} = .03$, $SE = .01$, $p < .05$) still were significant, as well as the interaction between social anxiety and grade ($\gamma_{40} = -.03$, $SE = .01$, $p < .01$), indicating that higher levels of social anxiety were associated with steeper declines in friendship quality across grade. The sixth model with the three-way interaction was not significant. Goodness-of-fit statistics ($-2LL$) also indicated that the addition of the two-way interaction terms in the fifth model resulted in a significantly better fit than the fourth model, $\Delta\chi^2 = 9.13$, $\Delta df = 3$, $p < .05$, and therefore, the fifth model was taken as the final model.¹

¹ Given that online chatting could be subsumed under the more general category of “using computers with friends, either online or in person,” all analyses for using computers with friends also were rerun controlling for online chatting (and vice versa). All results were identical to those reported above.

5.1.2. Boys

The unconditional means model demonstrated that significant variability existed in both within and between person sources of variation. The unconditional growth model showed that there was not a significant decrease in friendship quality across the course of high school for boys ($\gamma_{10} = -.01$, $SE = .01$, $p > .05$). Results from this model also showed that significant variation existed in both initial level of friendship quality, $\chi^2(553, N = 554) = 1299.02$, $p < .001$, and the rate of growth in friendship quality, $\chi^2(553, N = 554) = 705.47$, $p < .001$. The third model, where the covariates were added, showed that a higher number of computers in the home was significantly associated with a steeper rate of decline in friendship quality ($\gamma_{11} = -.02$, $SE = .01$, $p < .05$).

The fourth model, adding the main effects of social anxiety and online chat, indicated that both social anxiety ($\gamma_{20} = -.16$, $SE = .01$, $p < .001$) and online chat ($\gamma_{30} = .03$, $SE = .01$, $p < .01$) were significant, such that lower levels of social anxiety and higher levels of chatting online were associated with higher levels of friendship quality. The fifth model added the two-way interaction terms (see Table 2 for full results). The main effects of social anxiety ($\gamma_{20} = -.15$, $SE = .01$, $p < .001$) and online chat ($\gamma_{30} = .03$, $SE = .01$, $p < .01$) still were significant, as well as the interaction between social anxiety and grade ($\gamma_{40} = -.04$, $SE = .01$, $p < .001$), indicating that higher levels of social anxiety were associated with steeper declines in friendship quality across grade. Importantly, the interaction between social anxiety and online chat also was significant ($\gamma_{60} = .03$, $SE = .01$, $p < .01$), demonstrating that adolescents with the highest levels of social anxiety reported more positive friendship quality if they engaged in online chatting than if they did not engage in online chatting. See Fig. 1. The sixth model was not significant. Goodness-of-fit statistics ($-2LL$) also indicated that the addition of the two-way interaction terms in the fifth model resulted in a significantly better fit than the fourth model, $\Delta\chi^2 = 23.21$, $\Delta df = 3$, $p < .001$, and therefore, the fifth model was taken as the final model.¹

5.2. Using computers with friends either in person or over the Internet

5.2.1. Girls

The first three models (unconditional means, unconditional growth, and covariate) were identical to those outlined above with the online chat analysis. The fourth model, adding the main effects of social anxiety and using computers with friends, revealed that

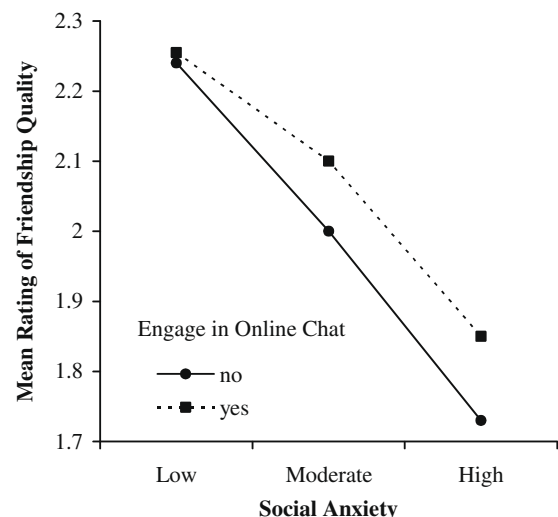


Fig. 1. Mean friendship quality for boys as a function of the interaction between social anxiety and online chatting.

Table 3
Growth curve results for final model with using computer with friends either online or in person.

	Parameter	Girls Coefficient (SE)	Boys Coefficient (SE)
<i>Fixed effects</i>			
Intercept	γ_{00}	2.34*** (.01)	2.04*** (.01)
Number of Computers in the Home	γ_{01}	.04* (.02)	.01 (.01)
Parental education	γ_{02}	.01 (.02)	.01 (.01)
Grade (rate of change)	γ_{10}	-.05*** (.01)	-.02 (.01)
Number of computers in the home	γ_{11}	-.02† (.01)	-.02† (.01)
Parental education	γ_{12}	.01 (.01)	-.01 (.01)
Social anxiety	γ_{20}	-.16*** (.01)	-.16*** (.01)
Playing computer with friends	γ_{30}	.07*** (.01)	.03** (.01)
Social anxiety X grade	γ_{40}	-.04*.01	-.04*** (.01)
Playing computer with friends X grade	γ_{50}	-.01 (.01)	-.03** (.01)
Playing computer with friends X social anxiety	γ_{60}	.00 (.01)	.03* (.01)
		SD (variance)	SD (variance)
<i>Variance components</i>			
Level-1: within-person			
	σ_e^2	.33 (.11)	.33 (.11)
Level-2: between-person			
In intercept	σ_0^2	.26*** (.07)	.23*** (.05)
In rate of change	σ_1^2	.11*** (.01)	.13*** (.02)

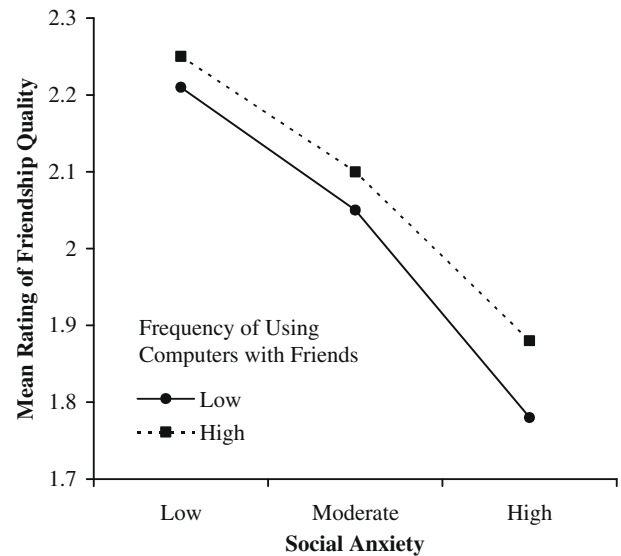
Note: SE = standard error, SD = standard deviation. As all the predictors were standardized, coefficients can be interpreted as measures of effect size, such that a one standard deviation change in the predictor variable corresponds to a one unit change in the outcome variable.

† $p < .08$.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

both social anxiety ($\gamma_{20} = -.15$, $SE = .01$, $p < .001$) and using computers with friends ($\gamma_{30} = .07$, $SE = .01$, $p < .001$) were significant, such that lower levels of social anxiety and higher levels of using computers with friends were associated with higher levels of friendship quality. The fifth model added the two-way interactions (see Table 3 for full results). The main effects of social anxiety ($\gamma_{20} = -.16$, $SE = .01$, $p < .001$) and using computers with friends ($\gamma_{30} = .07$, $SE = .01$, $p < .001$) still were significant, as well as the interaction between social anxiety and grade ($\gamma_{40} = -.04$, $SE = .01$, $p < .01$), indicating that higher levels of social anxiety were associated with steeper decreases in friendship quality across grade. The sixth model with the three-way interaction was not significant. Goodness-of-fit statistics ($-2LL$) also indicated that the addition of the two-way interaction terms in the fifth model resulted in a significantly better fit than the fourth model, $\Delta\chi^2 = 10.71$, $\Delta df = 3$, $p < .05$, and therefore, the fifth model was taken as the final model.¹

5.2.2. Boys

The first three models (unconditional means, unconditional growth, and covariate) were identical to those outlined above with the online chat analysis. The fourth model, adding the main effects of social anxiety and using computers with friends, revealed that both social anxiety ($\gamma_{20} = -.16$, $SE = .02$, $p < .001$) and using computers with friends ($\gamma_{30} = .04$, $SE = .01$, $p < .01$) were significant, such that lower levels of social anxiety and higher levels of using computers with friends were associated with higher levels of friendship quality. In the fifth model, the main effects of social anxiety ($\gamma_{20} = -.16$, $SE = .01$, $p < .001$) and using computers with friends ($\gamma_{30} = .03$, $SE = .01$, $p < .01$) still were significant, as well as the two-way interactions between social anxiety and grade and between using computers with friends and grade ($\gamma_{40} = -.04$, $SE = .01$,



Note: Low for computer playing with friends are collapsed scores for “never” and “sometimes” categories, and high are collapsed scores for “often” and “always” categories.

Fig. 2. Mean friendship quality for boys as a function of the interaction between social anxiety and using computers with friends.

$p < .001$, $\gamma_{50} = -.03$, $SE = .01$, $p < .01$, respectively). See Table 3 for full results. Higher levels of social anxiety were associated with steeper declines in friendship quality across grade, and higher levels of using computers with friends were associated with steeper declines in friendship quality across grade. Importantly, the interaction between social anxiety and using computers with friends was significant ($\gamma_{60} = .03$, $SE = .01$, $p < .05$), demonstrating that adolescents with the highest levels of social anxiety reported more positive friendship quality if they used computers with friends than if they did not use computers with friends (see Fig. 2). The sixth model with the three-way interaction was not significant. Goodness-of-fit statistics ($-2LL$) also indicated that the addition of the two-way interaction terms in the fifth model resulted in a significantly better fit than the fourth model, $\Delta\chi^2 = 29.22$, $\Delta df = 3$, $p < .001$, and therefore, the fifth model was taken as the final model.¹

5.3. Playing organized sports

5.3.1. Girls

The first three models (unconditional means, unconditional growth, and covariate) were identical to those outlined above. The fourth model, adding the main effects of social anxiety and frequency of involvement in organized sports, indicated that only social anxiety ($\gamma_{20} = -.15$, $SE = .01$, $p < .001$) was significant, while the fifth model, adding the two-way interactions (see Table 4 for full results), revealed a significant interaction between social anxiety and grade only ($\gamma_{40} = -.03$, $SE = .01$, $p < .01$). The sixth model with the three-way interaction was not significant. Goodness-of-fit statistics ($-2LL$) also indicated that the addition of the two-way interaction terms in the fifth model resulted in a significantly better fit than the fourth model, $\Delta\chi^2 = 10.31$, $\Delta df = 3$, $p < .05$, and therefore, the fifth model was taken as the final model. Most importantly, there were no significant effects for frequency of involvement in organized sports on friendship quality.

5.3.2. Boys

The first three models (unconditional means, unconditional growth, and covariate) were identical to those outlined above.

Table 4
Growth curve results for final model with involvement in sports.

	Parameter	Girls Coefficient (SE)	Boys Coefficient (SE)
<i>Fixed effects</i>			
Intercept	γ_{00}	2.34*** (.02)	2.04*** (.01)
Number of computers in the home	γ_{01}	.04** (.02)	.01 (.01)
Parental education	γ_{02}	.01 (.02)	.01 (.01)
Grade (rate of change)	γ_{10}	-.05*** (.01)	-.01 (.01)
Number of computers in the home	γ_{11}	-.02 (.01)	-.02† (.01)
Parental education	γ_{12}	.01 (.01)	-.01 (.01)
Social anxiety	γ_{20}	-.16*** (.01)	-.15*** (.01)
Sports	γ_{30}	.00 (.01)	.01 (.01)
Social anxiety X grade	γ_{40}	-.03* (.01)	-.04*** (.01)
Sports X grade	γ_{50}	-.00 (.01)	-.02† (.01)
Sports X social anxiety	γ_{60}	.02 (.01)	.01 (.01)
		SD (variance)	SD (variance)
<i>Variance components</i>			
Level-1: Within-person			
	σ_e^2	.32 (.11)	.33 (.11)
Level-2: between-person			
In intercept	σ_0^2	.26*** (.07)	.24*** (.06)
In rate of change	σ_1^2	.12*** (.01)	.13*** (.02)

Note: SE = Standard Error, SD = Standard Deviation. As all the predictors were standardized, coefficients can be interpreted as measures of effect size, such that a one standard deviation change in the predictor variable corresponds to a one unit change in the outcome variable.

† $p < .06$.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

The fourth model, adding the main effects of social anxiety and frequency of involvement in organized sports, indicated that only social anxiety ($\gamma_{20} = -.16$, $SE = .01$, $p < .001$) was significant, while the fifth model, adding the two-way interactions (see Table 4 for full results), revealed a significant interaction between social anxiety and grade only ($\gamma_{40} = -.04$, $SE = .01$, $p < .01$). The sixth model with the three-way interaction was not significant. Goodness-of-fit statistics ($-2LL$) also indicated that the addition of the two-way interaction terms in the fifth model resulted in a significantly better fit than the fourth model, $\Delta\chi^2 = 21.24$, $\Delta df = 3$, $p < .001$, and therefore, the fifth model was taken as the final model. Again, there were no significant effects for frequency of involvement in organized sports on friendship quality.

6. Discussion

Consistent with previous research, we found that friendship quality declined throughout high school and that social anxiety was negatively associated with friendship quality for both boys and girls (e.g., La Greca & Lopez, 1998; Vernberg et al., 1992). Specifically, adolescents who reported lower feelings of social anxiety indicated more positive friendship quality than their socially anxious peers. Moreover, we found that higher levels of social anxiety were associated with steeper declines in friendship quality over time. This finding is not surprising as social anxiety tends to be associated with avoidance of social interactions, which likely hinders the development of close friendships and leads to even greater anxiety over time (Hymel et al., 1990; La Greca et al., 1988).

The current study, more critically, sought to examine the complex relation among using computers with friends, social anxiety and friendship quality. We investigated whether the positive association between using computers with friends in general or online communication and friendship quality was stronger for adolescent girls and boys with low levels of social anxiety (rich-get-richer) or

high levels of social anxiety (social compensation). As predicted, we found support for both hypotheses among adolescent girls and evidence for the social compensation hypothesis only among adolescent boys.

First, among adolescent girls, social anxiety did not moderate the relation between frequency of using computers with friends, either in person or online, and friendship quality. Independent of social anxiety, adolescent girls who used the computer with friends to a greater extent reported more positive friendship quality than their peers who rarely used the computer with friends. This finding was stable across adolescence and identical for online chatting. Using computers with friends then may provide adolescent girls, regardless of feelings of social anxiety, with opportunities to engage in social exchanges that foster self-disclosure, and in turn perceived friendship quality. This finding is especially important for socially anxious adolescent girls. Researchers have suggested that the non-face-to-face interactions associated with online chatting, for example, may create a more comfortable social situation for socially anxious adolescents in comparison to traditional face-to-face interactions (McKenna et al., 2002). In fact, Brunet and Schmidt (2007) found that socially anxious females shared personal information to a greater extent when they were concealed from their peers than when they were not concealed. Moreover, adolescents, including those who report high levels of social anxiety, indicate they are able to be their "real self" when online (see Amichai-Hamburger, Wainapel, & Fox, 2002; McKenna & Bargh, 2002). Similarly, using computers with friends in person may have also been associated with positive outcomes for socially anxious girls given that gaze aversion would be acceptable among peers in this context. This may have created a more comfortable situation for socially anxious girls to engage in discussions with their friends.

On the other hand, for adolescent boys, our results indicated that social anxiety did moderate the relation between using computers with friends and friendship quality. Specifically, adolescent boys who reported high feelings of social anxiety and use of the computer with friends also reported more positive friendship quality in comparison to their socially anxious peers who rarely used the computer with friends; supporting the social compensation hypothesis. In contrast, friendship quality among boys who used the computer with friends frequently was not significantly different than boys who rarely used the computer with friends, suggesting that the rich do not get richer at least when considering computer use involving friends. This finding was also stable across adolescence and identical for online chatting. This finding for boys is consistent with previous research which has identified that some socially anxious adolescents have indicated that they use online communication to compensate for their social anxiety (Peris et al., 2002; Peter & Valkenburg, 2006). Online games, for example, typically provide players with the option to chat with their teammates or enemies. The lack of eye contact associated with this activity may create a comfortable social context for socially anxious boys, enabling them to bond through shared interests. To specifically test this hypothesis, we also examined involvement in organized sports. We hypothesized that if the opportunities for discussion and the lack of focus on the socially anxious adolescent are important factors in explaining why using computers with friends operates as a moderator in the relation between social anxiety and friendship quality, we should find no significant interaction between social anxiety and friendship quality in an activity that limits discussion and may put focus on the socially anxious adolescent, such as involvement in organized sports.

For both adolescent girls and boys, participating in organized sports did not compensate for social anxiety; in fact, playing organized sports was not significantly related to friendship quality at all. Playing sports may not be conducive to sharing personal information, an important component of friendship among adolescent

girls (see Berndt, 1982; Maccoby, 1990). While adolescent boys typically bond through participation in activities with friends, a higher frequency in activities with friends is not associated with more positive friendship quality (Mathur & Berndt, 2006). Indeed, less socially anxious boys reported similar levels of friendship quality regardless of frequency of participation in organized sports. Moreover, the lack of social compensation for adolescent boys who played organized sports suggests that simply engaging in shared activities with peers may not translate to positive social experiences. During sports, for example, socially anxious players may be uncomfortable with being the centre of attention at some point in the game (e.g., batting during baseball).

On the other hand, given the finding that frequency of involvement in organized sports was not significantly associated with friendship quality (i.e., there was no significant main effect for boys or girls), we can not rule out the possibility that adolescents may be more likely to engage in sports activities with peers who they do not consider to be their friends than they are to communicate online with peers who are not friends. Indeed, Peter and colleagues (2006) did find that a vast majority of adolescents predominately chat with existing friends online rather than strangers. Our measure of online communication and organized sports involvement did not specifically assess how often adolescents used online communication and played organized sports with “friends” as opposed to peers in general. Further research is needed to assess whether there are qualitative differences in the referents for these activities. It seems likely, however, that adolescents would consider many of their teammates to be “friends”; in fact, sports participants have consistently indicated that sports provides opportunities to interact with existing friends or to make new friendships (Csikszentmihalyi, 1975; Scanlan, Stein, & Ravizza, 1989; Stuart, 2003).

It is important to note also that the interpretation of our findings is limited by the phrasing of the questions within the questionnaire. That is, participants were asked whether or not they engaged in online chat, and thus this variable was dichotomous (yes/no). However, identical results were found with our other measure, using computer with friends either online or in person, which was a 4-point Likert scale for frequency of use, suggesting that the dichotomous nature of our online chatting measure was not the reason for our findings. It would be interesting for future research to address, nonetheless, whether a higher frequency of online chatting is associated with more positive friendship quality for socially anxious adolescents in comparison to a lower frequency, or whether it is only important whether one does engage in online chat, regardless of frequency. Furthermore, although we included frequency of involvement in organized sports as a measure of a face-to-face activity where adolescents may become the centre of attention and have limited opportunities for discussions specifically to test the distinctiveness of using computers with friends for fostering friendship quality, further research is needed on how computer-oriented activities operate differently from other more traditional adolescent activities, or even across different organized sport activities. Finally, although the findings were identical for the general measure of using computers with friends either online or in person and the specific activity of online chatting, it is unknown whether the non-face-to-face activities subsumed under using computers with friends were responsible for the similar findings. Therefore, it would be valuable to examine using computers with friends online or in person separately to explore whether using computers with friends in person (a face-to-face activity) may compensate for social anxiety as does online chatting (a non-face-to-face activity).

In addition to exploring the role of online communication and participation in organized sports in facilitating friendship quality, the current study was the first study, to our knowledge, that exam-

ined social anxiety as a *moderator* for the positive relation between online communication and friendship quality. Critically, we also explored this issue through a longitudinal design, demonstrating that the complex relations among social anxiety, online communication, and friendship quality were stable across three time points during adolescence. Consequently, using computers with friends may be a valuable tool for socially anxious adolescents throughout high school. Consistent with researchers' hypotheses (McKenna et al., 2002), the current study offered support for the suggestion that the lack of a visual audience, or even a low frequency of eye contact, may alleviate anxiety surrounding the social interaction, providing socially anxious adolescent girls and boys with unique opportunities to engage in meaningful bonding experiences. In particular, socially anxious girls may feel more comfortable sharing personal information online and boys may have less anxiety when participating in computer-based activities with peers because they are visually hidden from their friends.

7. Conclusion

The current study has implications for educators, parents and adolescents themselves. Instead of being concerned that the computer socially isolates adolescents from their peers, the findings suggest that educators and parents may avoid discouraging (and may even promote) adolescents' use of computers with friends. Adolescent boys who play games on the Internet and make connections with other players or adolescent girls who engage in online chatting may be engaging in activities important for future social development. More importantly, concerns surrounding the idea that socially anxious adolescents' computer-based interactions may be serving as a superficial substitute for face-to-face encounters may be alleviated. Instead, using computers with friends may be valuable as a convenient and accessible tool to support interactions with peers for socially anxious adolescents in addition to other anxiety reducing methods. Although using the computer with friends either in person or online was associated with small improvements in friendship quality by grade 12, these improvements may have significant compounding impact on relationships beyond high school.

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