Precursors of Adolescents’ Use of Visual and Audio Devices
During Online Communication

Abstract

Theories of computer-mediated communication typically rest upon the assumption that communication via computers lacks visual and auditory cues. However, recent technological advances, such as webcams and microphones, as well as their increased use question this assumption. Moreover, the question arises of what characterizes individuals who use such devices. Drawing on a survey of 1,060 adolescents, we found that 57% of adolescents at least occasionally used webcams during instant messaging, while 32% at least sometimes used microphones. If adolescents perceived the lack of visual cues in online communication to be important, they used webcams less frequently. For early and middle adolescents, greater levels of social anxiety reduced the use of webcams, whereas higher levels of private self-consciousness increased it. Our results suggest that the nature of computer-mediated communication may change considerably in the next years. Theories of computer-mediated communication need to more strongly integrate these changes into theory building.

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Theories of computer-mediated communication typically rest on the assumption that, compared with face-to-face communication, communication via computers lacks visual and auditory cues (for recent reviews, see Thurlow, Lengel, & Tomic, 2004; Walther & Parks, 2002). The lack of visual and auditory cues certainly characterized computer-mediated communication in the 1980's and 1990's, when the reduced cues perspective (e.g., Culnan & Markus, 1987), information richness theory (Daft & Lengel, 1984), social information processing theory (Walther, 1992), social identity/deindividuation (SIDE) theory (Spears & Lea, 1992), and the hyperpersonal communication perspective (Walther, 1996) were developed. However, recent technological advancements especially in online communication, such as webcams and microphones, and their easy applicability challenge the assumption that people generally receive fewer visual and auditory cues in computer-mediated communication than in face-to-face communication.

Anecdotal evidence suggests that, particularly among adolescents, the use of visual and audio devices during online communication has increased dramatically in the recent years (Cross, 2003). We are thus witnessing a transition period in which one group of adolescents communicates online in the traditional text-based fashion and another group enriches online communication with audiovisual tools. This transition period provides us with a unique opportunity to study what characterizes adolescents who use visual and audio devices during online communication, as opposed to those who do not. This is the general goal of this study.

Although there have been several studies on video-mediated or visually enriched communication (e.g., Finn, Sellen, & Wilbur, 1997; Walther, Slovacek, & Tidwell, 2001), two features of these studies render them less appropriate as frameworks for studying the use of visual and audio devices in online communication. First, in much research on video-mediated communication, the visual and auditory cues have been operationalized as objective
characteristics of computer-mediated communication. This operationalization implicitly assumes that particular features of computer-mediated communication affect all people to the same extent. However, people's subjective perceptions of media characteristics have been shown to be more influential than objective features of a medium, in particular with respect to the use of communication media (Carlson & Zmud, 1999; Fulk, Schmitz, & Steinfield, 1990; Ruggiero, 2000). Second, previous research has conceptualized visual and auditory cues as situational influences on how communication via computers develops and which effects it elicits (e.g., Gale, 1991; Whittaker & O’Connaill, 1997; Williams, 1977). Thereby, it has ignored the fact that the personality characteristics of a user may determine first whether visual and audio devices in online communication are used at all. The specific goal of this study is to investigate (a) how adolescents’ subjective perceptions of online communication and (b) how personality characteristics influence their use of visual and audio devices during online communication.

We have selected adolescents as study subjects because they are the defining users of the Internet (Madden & Rainie, 2003). They communicate online more frequently and competently than adults and they more strongly integrate online communication into their social lives (Gross, Juvonen, & Gable, 2002; Wolak, Mitchell, & Finkelhor, 2002). The current changes in the bandwidth of online communication, that is, the multiplicity of communication modes, may therefore be most visible in this age group (Cross, 2003). Partly as a result of our focus on adolescents, in this study we deal with online communication via instant messengers. Instant messaging has become increasingly popular among adolescents and has replaced other forms of computer-mediated communication such as email, message boards, and chat rooms. Most importantly, however, instant messengers enable users to easily increase the bandwidth of online communication by adding visual or audio devices. By visual and audio devices we mean webcams and microphones.
Adolescents may differ in their perceptions of how important they consider the lack of visual and auditory cues during online communication. Whereas some adolescents may attach importance to the absence of visual and auditory cues, others may feel that they cannot express themselves clearly enough in solely text-based communication. Strikingly, this intuitively plausible individual difference has never been investigated in research on online communication. More importantly, in its implicit assumption that there are no individual differences in the perceived importance of lacking visual and auditory cues in online communication, research has supported a somewhat deterministic conceptualization of the influence of this lack on online communication. Allowing the perceived importance of visual and auditory cues to vary individually may enable us to gain new insights into why adolescents use visual and audio devices. We therefore hypothesize that adolescents will use visual devices less frequently if they consider the lack of visual cues in online communication more important (Hypothesis 1a). Likewise, we hypothesize a negative impact of adolescents’ perceived importance of lacking auditory cues on their use of audio devices (Hypothesis 1b).

Social-influence theory and channel-expansion theory have shown that the study of how individuals subjectively perceive the richness of information technologies improves our understanding of information technology use in organizations (Carlson & Zmud, 1999; Fulk, 1993; Fulk et al., 1990). However, research on online communication has not yet devoted much attention to subjective user perceptions of online communication characteristics. For example, it is often theoretically emphasized that online communication increases disinhibited behavior because, due to the lack of visual and auditory cues, individuals may feel less inhibited than in a face-to-face setting (Cooper & Sportolari, 1997; Suler, 2004). Although this presumption has also been confirmed empirically (Joinson, 2001; Leung, 2002; Kiesler,
1986), it is unclear to what extent people equally experience that online communication facilitates disinhibited behavior. Uses-and-gratifications research has demonstrated that perceptions of media characteristics vary widely, which subsequently affects the use of media (for review, see Ruggiero, 2000). Therefore, it may be worthwhile to investigate differences in perceptions of whether online communication facilitates disinhibited behavior. These perceptions may affect the extent to which visual and audio devices are used during online communication. Given that the lack of visual and auditory cues is seen as essential for the development of online disinhibited behavior (Spears & Lea, 1992; Suler, 2004), adolescents’ perception that online communication encourages disinhibited behavior can be expected to reduce their use of visual and audio devices during online communication. Therefore, we hypothesize: As adolescents perceive online communication to facilitate disinhibited behavior, the use of visual devices will decrease (Hypothesis 2a). Likewise, as adolescents perceive online communication to facilitate disinhibited behavior, the use of audio devices will decrease (Hypothesis 2b).

**Social Anxiety**

Generally, socially anxious people feel nervous and distressed in social interactions and are easily embarrassed in face-to-face communication (Cheek & Buss, 1981; Maltby & Day, 2000). Internet research has shown that the socially anxious consider Internet communication more appropriate than face-to-face communication to present their true self (Amichai-Hamburger, Wainapel, & Fox, 2002; McKenna, Green, & Gleason, 2002). Scholars have explained this finding with the particular appeal that the lack of visual and auditory cues in online communication exerts on socially anxious people (McKenna & Bargh, 2000). As a result, people with high social anxiety should use visual and audio devices in online communication less frequently than people with low social anxiety.
For adolescents, however, a more complex pattern may arise. Adolescent theories generally agree that early adolescents are more insecure about their social self than middle or late adolescents (Harter, 1999; Schaffer, 1996). Early adolescents often engage in imaginative audience behavior (Elkind & Bowen, 1979). They are inclined to distorted perceptions of how they appear in the eyes of others and often overestimate the extent to which others watch and evaluate them (Erikson, 1963; Harter, 1999). Webcams and microphones may reinforce these inclinations. If, additionally, individuals are socially anxious, the use of these devices may be especially uncomfortable for them. Consequently, we expect an interaction effect between age and social anxiety on both the use of webcams and microphones: Early adolescents who are socially anxious will use visual and audio devices less frequently than late adolescents who are socially anxious. Thus, we hypothesize that the effect of social anxiety on the use of (a) visual and (b) audio devices will be more negative for early adolescents than for late adolescents (Hypotheses 3a and 3b).

**Private and Public Self-consciousness**

Both private and public self-consciousness describe a process of self-focused attention. However, whereas private self-consciousness "refers to the dispositional tendency to focus attention on the more private and covert aspects of oneself" (Franzoi & Davis, 1985, p. 769), public consciousness relates to the dispositional tendency to direct attention toward the self as a social object (Fenigstein, Scheier, & Buss, 1975). People high in private self-consciousness typically have more accurate self-knowledge and are thus better equipped to open up to others. As a result, high levels of private self-consciousness increase the amount of personal information people share with others and lead to greater self-disclosure (Franzoi & Davis, 1985; Franzoi, Davis, & Young, 1985). People high in public self-consciousness are likely to see themselves as the object of others’ attention and consider others’ opinions about themselves important. In comparison with individuals low in this trait, they consequently put
more emphasis on outer appearance and are better able to predict their impression on others (Miller & Cox, 1982; Solomon & Schopler, 1982; Tobey & Tunnell, 1981).

These results from personality psychology suggest that both individuals high in private self-consciousness and individuals high in public self-consciousness should be more comfortable with presenting themselves during online communication through visual or audio modes. However, private and public self-consciousness may not operate independently of each other. People high in both private and public self-consciousness are less willing to share personal information than people high in either private or public self-consciousness (Shaffer & Tomarelli, 1989). More specifically, in a study on self-disclosure in computer-mediated communication, Joinson (2001) found that self-disclosure was highest for people high in private and low in public self-consciousness and for those low in private and high in public self-consciousness. We assume that the use of visual and audio devices in online communication is comparable with verbal self-disclosure because both visual and audio devices, as well as verbal self-disclosure involve individuals’ tendency to present information about themselves. In line with Joinson (2001), we expect an interaction effect between private and public self-consciousness on adolescents’ use of visual and audio devices during online communication. Specifically, we hypothesize that adolescents who either are high in private and low in public self-consciousness or are high in public and low in private self-consciousness will use (a) visual and (b) audio devices more frequently than their counterparts (Hypotheses 4a and 4b).

Method

Sample and Procedure

We conducted a survey among 1,174 adolescents between 12 and 17 years of age ($M = 14.5, SD = 1.6, 52\%$ girls). The adolescents were recruited from 6 elementary, middle and high schools in the Netherlands. The schools were chosen in such a way that they represented
adolescents across all levels of socioeconomic status. Because we are interested in the use of visual and audio devices during online communication, for this study we selected only adolescents who had ever used instant messaging \((n = 1,060, 90\%)\).

**Measures – Dependent and Independent Variables**

*Use of visual and audio devices during online communication.* We asked the respondents how often they used (a) a webcam and (b) a microphone during instant messaging. Response categories for each of the two questions ranged from 1 (*never*) to 4 (*always*).

*Perceived importance of lacking visual cues.* Respondents were asked to what extent they considered it important that, during instant messaging, (1) "...others cannot see what your face looks like"; (2) "...others cannot see that you are angry"; (3) "...others cannot see that you are nervous"; (4) "...others cannot see that you are disappointed"; (5) "...others cannot see that you are doing something else at the same time"; (6) "...others cannot see what clothes you are wearing". The response categories for each of the items ranged from 1 (*not important at all*) to 5 (*very important*). The 6 items formed a one-dimensional scale, with a Cronbach’s alpha of .84.

To test the concurrent and construct validity of our measure of perceived importance of lacking visual cues, we correlated it with a theoretically appropriate criterion (i.e., social anxiety) and a theoretically inappropriate criterion (i.e., number of MSN nickname changes per year). McKenna and Bargh (2000) have argued that computer-mediated communication appeals more strongly to socially anxious individuals because it lacks visual and auditory cues. As a result, the concurrent validity of our construct would manifest itself in a positive correlation between the perceived importance of lacking visual cues and social anxiety. This was the cases, \(r = .28, p < .001\).
In contrast, there is no really theoretically plausible reason to assume that the perceived importance of lacking visual cues is associated with the number of MSN-nickname changes per year. Consequently, construct validity would manifest itself in a non-significant correlation between the perceived importance of lacking visual cues and the number of MSN-nickname changes per year. The correlation between the two constructs was indeed non-significant, \( r = .03, p > .05 \). In conclusion, the concept of perceived importance of lacking visual cues showed satisfactory concurrent and construct validity.

**Perceived importance of lacking auditory cues.** To operationalize adolescents’ perceived importance of auditory cues, we used 4 items. Three of the items were comparable to items (2), (3), and (4) of the perceived importance of lacking visual cues scale, only adjusted for audio cues ("...others cannot hear that..."). In addition, we used the item "...others cannot hear how your voice sounds". The 4 items formed a one-dimensional scale, with a Cronbach’s alpha of .86.

To test the concurrent and construct validity of perceived importance of lacking auditory cues, we followed the same procedure as just described for the perceived importance of lacking visual cues. As expected, the correlation with social anxiety was significantly positive, \( r = .28, p < .001 \), which demonstrated the concurrent validity of the concept. Also in line with the expectation, the correlation with the number of MSN-nickname changes per year was non-significant, \( r = .05, p > .05 \), which demonstrated the construct validity of the concept.

**Perceived facilitation of disinhibition online.** We measured this construct with three items: (1) "During instant messaging, I feel less constrained to use certain words than in a face-to-face meeting"; (2) "During instant messaging, I feel less restricted to talk about certain things than in a face-to-face meeting" and (3) "During instant messaging I feel more free to talk about things than in a face-to-face meeting". The anchors of the response categories were
1 (completely disagree) and 5 (completely agree). The 3 items formed a one-dimensional scale, with a Cronbach’s alpha of .77.

Applying the same procedure to test the concurrent and construct validity of the concept as above, we found a positive correlation with social anxiety, $r = .19$, $p < .001$, and a non-significant correlation with the number of MSN-nickname changes per year, $r = .03$, $p > .05$. In conclusion, the concept of perceived facilitation of disinhibition online also demonstrated satisfactory concurrent and construct validity.

**Social anxiety.** The construct was measured with items from the Social avoidance and distress – new people subscale of the Social Anxiety Scale for Adolescents (La Greca & Lopez, 1998). From the original scale, we selected the four items with the highest factor loadings. The response categories for each of the items ranged from 1 (completely disagree) to 5 (completely agree). The 4 items formed a one-dimensional scale, with a Cronbach’s alpha of .78.

**Private and public self-consciousness.** We used items from the private and public self-consciousness subscale that belong to the Fenigstein Self-Consciousness Scale (Fenigstein et al., 1975). The response categories for each of the items ranged from 1 (completely disagree) to 5 (completely agree). The sub-scales have successfully been employed to measure private and public self-consciousness among adolescents (Rankin, Lane, Gibbons, & Gerrard, 2004). However, based on research regarding the factor structure of the scales (Cramer, 2000; Dillard & Hunter, 1989), we removed 4 items from the original private self-consciousness scale and 2 items from the public self-consciousness scale, because those items have been shown to only unreliably define the constructs. Private self-consciousness was eventually operationalized with 6 items, and public self-consciousness with 5 items. A factor analysis with varimax rotation yielded two independent factors with an explained variance of 55%. Cronbach’s alpha
was .80 for the private self-consciousness scale and .82 for the public self-consciousness scale.

Measures – Control Variables

There are at least five potentially alternative explanations of why adolescents may use visual and audio devices when communicating online. First, the use of visual and auditory cues may simply be the result of more experience with instant messaging. Second, the use of such devices may be easier when talking with close friends online. Third, adolescents may use visual and audio devices much more frequently, either when they are alone or when they communicate online while friends are present. Fourth, due to developmental transitions, early adolescence is a critical time for seeking new experiences (Brinthaupt & Lipka, 2002; Harter, 1999). Particularly among early adolescents, visual and auditory tools in online communication may stimulate the search for such experiences. Finally, although Leung (2004) has recently found no gender differences in the general frequency of instant messaging among adolescents, related research on personal Internet homepages suggests that males more often opt for more sophisticated web-based technologies (Döring, 2002). This may also apply to the use of visual and audio devices in online communication. Boys may therefore be more likely than girls to use visual and audio devices during online communication.

Based on these five alternative explanations, we controlled for the following variables: (1) experience with instant messaging, operationalized as an additive index of the standardized variables frequency, intensity, and rate of instant messaging, as well as the number of contacts per day (Cronbach's alpha = .66); (2) the number of adolescents’ contact persons in instant messaging that they considered close friends; (3) the frequency of instant messaging while being alone and while being together with friends. (Response categories for these variables ranged from 0 [never] to 4 [always]); (4) age; and (5) gender, with 0 coded as boy and 1 coded as girl.
Data Analysis

In order to test the extent to which the hypothesized influences could be confirmed empirically, we ran hierarchical multiple regressions for each dependent variable (i.e., the use of webcams and the use of microphones). In a first step, we entered the main effects, in a second step we entered the interaction effects to study to what extent the interaction effects would significantly increase the explanatory power of the model (Cohen & Cohen, 1983). To avoid multi-collinearity problems, we centered the variables constituting the interaction terms around the mean (Aiken & West, 1991). Furthermore, we post-hoc probed the interaction effects for significant differences from zero. Aiken and West (1991) recommend selecting, for the moderating variable (e.g., age), values corresponding with the centered mean, with one standard deviation below the mean, and with one standard deviation above the mean. Subsequently, the conditional slopes of the focal independent variable (e.g., social anxiety) along with the pertinent standard errors can be calculated. The resulting $t$-values indicate whether the conditional slopes differ significantly from zero.

Results

Descriptive Analyses

Four percent of the adolescents said they always used a webcam while instant messaging. Fifteen percent reported frequent use of a webcam, and 38% said that they used webcams at least occasionally. The remaining 43% of adolescents never used webcams during instant messaging. As for the use of microphones, 2% percent of the adolescents reported that they always used a microphone during instant messaging. Six percent of the adolescents used a microphone often, and 24% of them used a microphone occasionally. Finally, 68% of the adolescents never used a microphone when instant messaging.

Explanatory Analyses – Use of Visual Devices (webcams)
Hypothesis 1a predicted that adolescents would use visual devices less frequently, if they considered the lacking visual cues in online communication important. Table 1 shows a significant negative impact of the perceived importance of lacking visual cues on the use of visual devices ($b = -.04, p < .05$). The more important the lack of visual cues was to adolescents, the less frequently they used visual devices during online communication. Hypothesis 1a was thus confirmed. However, we did not find support for Hypothesis 2a: Adolescents’ perception of the extent to which online communication facilitates disinhibited behavior did not influence the use of visual devices.

Hypothesis 3a predicted that the effect of social anxiety on the use of visual devices would be more negative for young adolescents than for old adolescents. As the interaction model for visual devices in Table 1 indicates, there was a significant interaction effect between social anxiety and age on the use of visual devices ($b = .04, p < .05$). This interaction effect increased the explanatory power of the model by a significant 0.4%, $F(1,1046) = 4.77$, $p < .05$ (Note that the 1% increase of the explained variance in Table 1 is due to rounding). The younger the adolescents were, the more negative the influence of social anxiety on the use of visual devices. Thus, social anxiety reduced the use of visual devices most strongly among early adolescents. This effect leveled off in the older age groups.

Post-hoc probing showed that the conditional slopes at one standard deviation below the age mean, $t(1,045) = -0.151/0.053 = -2.85, p < .05$, and at the age mean, $t(1,045) = -0.07/0.035 = -2.00, p < .05$, were significantly different from zero, whereas the slope at one standard deviation above the age mean was not ($t(1,045) = 0.011/0.048 = 0.23, n.s.$). This more rigorous testing of the interaction effect thus confirms that, as hypothesized, only for early and middle adolescents, social anxiety exerted a negative effect on the use of visual devices. Hypothesis 3a was supported.
Hypothesis 4a specified that adolescents who either are high in private self-consciousness and low in public self-consciousness or are low in public self-consciousness and high in private self-consciousness would use visual devices more often than their counterparts. This hypothesis was not supported. There was no significant interaction effect between private and public self-consciousness ($b = -.02, n.s.$). However, as the main effect model for webcams in Table 1 shows, private consciousness affected the use of visual devices regardless of the levels of public self-consciousness ($b = .09, p < .01$). With increasing private self-consciousness, adolescents were more likely to use visual devices during online communication. Public self-consciousness had no significant main effect.

Three of the control variables significantly affected the use of visual devices. Early adolescents used visual devices during online communication more often than late adolescents. Adolescents who generally communicated online more often also used webcams more frequently. Moreover, if adolescents communicated online in the presence of friends, they were more likely to use visual devices.

**Explanatory Analyses – Use of Audio devices (Microphones)**

Table 1 indicates that there was no support for the hypothesized influences on adolescents’ use of audio devices. Hypotheses 1b, 2b, 3b, and 4b had to be rejected. However, four control variables significantly predicted the use of audio devices during online communication. Early adolescents used audio devices more often than late adolescents, and boys did so more often than girls. The more frequently adolescents were alone during online communication, the more likely they were to use audio devices. Finally, the more experience adolescents had with instant messaging, the more often they used a microphone.

**Discussion**

This study has shown that the use of visual devices, in particular, has become a pervasive phenomenon in adolescent online communication. More than half of the
adolescents used a webcam, at least occasionally, during instant messaging. The results regarding the use of auditory cues are less distinct, but also suggest that computer-mediated communication, with its traditional emphasis on text-only information, has undergone a fundamental change. This study has also demonstrated that the use of visual devices does not occur evenly among adolescents, but attracts certain types of adolescents more than others. Our findings on the prevalence and precursors of visual and, to a lesser extent, audio devices in adolescent online communication may improve our understanding of a new phenomenon. They may also challenge existing theories of computer-mediated communication.

**Understanding the Use of Visual and Audio Devices in Online Communication**

Previous research on computer-mediated communication has implicitly conceptualized the lack of visual and auditory cues as a homogeneous influence on people's interaction via the computer. Essentially, studies have been based on the implicit assumption that the lack of visual and auditory cues in computer-mediated communication is of equal importance to all people and to their decision of whether and how to communicate online. This study is the first to have translated this homogeneity assumption into a researchable variable. We conceptualized the use of visual and auditory cues as being influenced by adolescents' subjective perception of how important the lack of visual and auditory cues in computer-mediated communication are to them. Indeed, adolescents who considered the lack of visual cues in online communication as more important were less likely to use webcams than adolescents to whom the lack of visual cues was less important. This result was obtained even though we controlled for a number of rival explanations.

Our findings are in line with several theories from organizational communication (Carlson & Zmud, 1999; Fulk, 1993; Fulk et al., 1990) and uses-and-gratifications research (Ruggiero, 2000) that have shown that individual perceptions of media characteristics guide media use more strongly than objective media features. Our result suggests that we need to be
cautious when generalizing from the objective features of computer-mediated communication to whether and how people actually interact via computers. Rather, we need to more strongly take into account people's subjective perceptions of computer-mediated communication.

The perceived importance of reduced auditory cues did not affect whether adolescents used microphones. The finding, that the perceived importance of lacking cues only affected the use of webcams and not the use of microphones, may be explained with the differential importance of auditory and visual information to human beings. There is sufficient research evidence that, to human beings, visual information is more revealing than auditory information (e.g., Argyle & Cook, 1976). This is reflected in our finding that adolescents attached significantly lower importance to the lack of auditory \( (M = 2.16, SD = .90) \) than to the lack of visual cues in online communication \( (M = 2.29, SD = .83) \), \( t(1095) = 7.67, p < .001 \). Thus, the perceived lack of visual cues in online communication may generally be more relevant to online communication than the perceived lack of auditory cues. Future research may find an interesting task in expanding on this interpretation and in also considering in detail the antecedents of why people differ in the perceived importance of lacking visual cues.

In contrast to our expectations, the perceived facilitation of online disinhibition did not affect the use of visual and auditory cues. What is more, zero-order correlations indicated a positive relationship of this perception and the use of webcams \( (r = .10, p < .01) \), whereas we had predicted a negative one. In the multiple regression analysis, the influence of online disinhibition on the use of webcams only marginally failed to be significant with two-tailed significance testing, \( t(1,047) = 1.8, p = .07 \) (Note that the values of the regression coefficients and their standard errors in Table 1 are rounded). Therefore, we can tentatively conclude that a relationship between this perception and the use of webcams may not be completely illusionary, but different from what we predicted. Adolescents may perceive that online communication facilitates disinhibition, and yet use webcams. In this case, the perception
may reflect a more abstract awareness of what characterizes online communication, but does not influence actual behavior. Clearly, we need more research on this issue, but our finding tentatively suggests a sophisticated, hybrid user who knows the characteristics of online communication well without paying much attention to them in his/her actual online communication.

Much of the previous research is based on the theoretical assumption that the lack of visual and auditory cues appeals particularly to socially anxious people (McKenna & Bargh, 2000). Consequently, we hypothesized that socially anxious adolescents would be less inclined to use visual and audio devices during online communication than non-socially anxious adolescents. A main effect of social anxiety was found neither for the use of webcams nor for the use of microphones. However, we did find an interaction effect between social anxiety and age on the use of webcams. Social anxiety decreased the use of webcams much more strongly among early adolescents than among late adolescents. In the oldest groups of adolescents, social anxiety no longer affected the use of webcams. The strong negative effect of social anxiety on the use of webcams among early adolescents may be the result of non-accomplished developmental tasks in this age group. Early adolescents are most insecure about their social self and, at the same time, preoccupied with how others see and evaluate them. When social anxiety accompanies this tendency, the use of webcams may become uncomfortable. In contrast, late adolescents are more self-assured about their social self and social anxiety does not seem to affect their use of visual devices during online communication. There is a need to replicate our findings with a sample more diverse in terms of age. The oldest respondents in our sample were 17 years old, but our findings suggest that, for post-adolescents or adults, social anxiety may eventually exert a positive impact on the use of visual devices.
In contrast to existing studies (Joinson, 2001), we did not find an interaction effect between private and public self-consciousness on the use of visual and audio devices. This may partly result from our focus on the use of webcams and microphones and not on self-disclosure in computer-mediated communication. However, the strong positive main effect of private self-consciousness on the use of webcams concurs with research from personality psychology on how adolescents high in private self-consciousness behave in face-to-face communication with peers (Franzoi & Davis, 1985; Franzoi et al., 1985). Adolescents high in private self-consciousness are more introspective and in closer touch with their inner life than adolescents low in that trait. Face-to-face meetings with friends are an appropriate outlet for opening up and talking about one's inner life. Because webcam-supported instant messaging (which typically takes place with peers) resembles such face-to-face meetings, adolescents high in private self-consciousness may be more likely to add visual devices to online communication.

**Challenging Existing Theories of Computer-Mediated Communication**

Theories of computer-mediated communication necessarily reflect the technological state of art at the time they were developed. In the 1980's and 1990's, when the majority of these theories originated, personal communication via computers was to a large extent asynchronous, anonymous, and text-based. These characteristics have influenced our theorizing about computer-mediated communication. However, at least in adolescents' communication via computers, we are currently witnessing a development in which none of these characteristics holds true anymore. Adolescents communicate heavily via instant messengers and communication via instant messengers is often synchronous, non-anonymous, and enriched with visual cues. Assuming that what we are observing among adolescents anticipates future developments in computer-mediated communication, there may be at least four implications for future theorizing in that field.
First, theories that are based on the assumption that computer-mediated communication is asynchronous, anonymous, and exclusively text-based have to more strongly take into account the visual and audio modes newly available in computer-mediated communication. Whether computer-mediated communication is asynchronous, anonymous, and exclusively text-based, has become a matter of individual choice and we need to study what governs these choices. Second, because the bandwidth of computer-mediated communication has become subject to individual decisions, we need to more strongly focus on computer-mediated communication through multiple modes: the combined use of textual, visual, and auditory cues in communication via computers. People no longer have to find functional equivalents for characteristics of face-to-face communication, such as facial expressions, that cannot be expressed in text-only communication. The key question thus becomes when mode extension takes place; that is, when people decide to add visual or audio modes to text-only communication. Third, the individual choice of bandwidth through mode extension requires us to deal with user's information management more thoroughly.

Anonymity may be considered as the extreme end of restrictive information management in computer-mediated communication. But people may gradually disclose more information by increasing the bandwidth of computer-mediated communication, thereby changing their information management. Finally, we know little about which consequences the individual choice of mode extension has on users’ experience with communication via computers. There is evidence that computer-mediated communication that is accompanied by photos reduces social attractiveness and affection (Walther et al., 2001). Still, the influence of webcams and microphones may be different, as research on video-mediated communication on affection suggests (for review, see Whittaker & O'Connaill, 1997). This paper has shown that computer-mediated communication may be in a transition period. Much of the future promise
of theories of computer-mediated communication lies in an adequate reaction to these changes.
References


Table 1

Precursors of Adolescents' Use of Visual and Audio devices

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<th>Control variables</th>
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<th>Audio devices</th>
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| Perceptual variables | | | |
|----------------------| | | |
| Perceived importance of lacking visual cues | -.06*  (.03) | -.06*  (.03) | -.04  (.03) | -.04  (.03) |
| Perceived importance of lacking auditory cues | | | -.01  (.03) | -.01  (.03) |
| Perceived facilitation of online disinhibition | .05  (.03) | .04  (.03) | .03  (.03) | .02  (.03) |

| Personality variables | | | |
|-----------------------| | | |
| Social anxiety        | -.06  (.04) | -.07  (.04) | -.01  (.03) | -.01  (.03) |
| Private self-consciousness | .09** (.03) | .09** (.03) | .03  (.02) | .03  (.02) |
| Public self-consciousness | -.07  (.04) | -.06  (.04) | -.02  (.03) | -.02  (.03) |

| Interaction effects | | | |
|---------------------| | | |
| Social anxiety x Age | .04*  (.02) | <.01  (.02) | | |
| Private x public self-consciousness | -.02  (.03) | <.01  (.03) | | |

| Constant | 1.21 | 1.24 | 1.10 | 1.10 |
| R square  | .18 | .19 | .13 | .13 |

* p < .05, ** p < .01, *** p < .001 (two-tailed)