

Provided for non-commercial research and education use.
Not for reproduction, distribution or commercial use.



This article appeared in a journal published by Elsevier. The attached copy is furnished to the author for internal non-commercial research and education use, including for instruction at the authors institution and sharing with colleagues.

Other uses, including reproduction and distribution, or selling or licensing copies, or posting to personal, institutional or third party websites are prohibited.

In most cases authors are permitted to post their version of the article (e.g. in Word or Tex form) to their personal website or institutional repository. Authors requiring further information regarding Elsevier's archiving and manuscript policies are encouraged to visit:

<http://www.elsevier.com/copyright>

Contents lists available at [SciVerse ScienceDirect](#)

Computers in Human Behavior

journal homepage: www.elsevier.com/locate/comphumbeh

Online chronemics convey social information

Yoram M. Kalman^{a,*}, Lauren E. Scissors^b, Alastair J. Gill^c, Darren Gergle^b^a The Open University of Israel, 1 University Road, Ra'anana 43537, Israel^b Northwestern University, 2240 Campus Drive, Evanston, IL 60208, USA^c King's College London, 26-29 Drury Lane, London, WC2B 5RL, UK

ARTICLE INFO

Article history:

Available online 8 February 2013

Keywords:

Computer-mediated communication
Chronemics
Social information processing

ABSTRACT

Chronemic research explores the involvement of time-related messages in communication, and has shown that time is an important component of the message in both traditional and online communication. Social information processing (SIP) theory posits that online communicators exchange social information through chronemic cues. This study points to a gap in SIP theory research, and proceeds to close the gap by demonstrating that changes in socially important attributes are reflected in measurable chronemic changes. A two-person social dilemma online game is used to demonstrate that changes in a simple chronemic variable, interpost pause, reflect differences in the players' personality (level of extraversion), as well as differences in trust within the dyad. These findings support SIP theory by showing how online chronemics provide cues to important personal and situational information.

© 2013 Elsevier Ltd. All rights reserved.

1. Introduction

Text-based computer-mediated communication (CMC) has become pervasive in modern life. Email, text-messaging, instant messaging (IM), and other forms of text-based CMC are now used to conduct many aspects of personal and professional communication. Text-based CMC lacks elements of face-to-face (FtF) communication such as tone of voice, pitch, facial expressions, and body language. An active area of CMC research in the last three decades is exploring the consequences of this deficiency (Walther, 2011). The emerging consensus is that in the absence of the nonverbal cues of spoken communication, online communicators use other cues afforded by CMC. This study focuses on the ability of one set of such online cues, chronemics, to convey important information about the sender. Chronemics are time-related cues such as pauses, conversational rhythm, or time of day.

Research conducted over the last two decades reveals the important role of chronemics in CMC, and how chronemics influence online interaction (Walther, 2002). For instance, imagine you are having a conversation over IM with a colleague about the next stage of a project. If the conversation feels like it has a "flow" to it, you might feel that you are making progress, or that you and your colleague work well together. You might pose a question to your colleague who responds quickly, which may give you

the sense that your colleague is attentive, prepared or decisive. Then imagine that your colleague's responses take longer to arrive, and are punctuated by long pauses. Is your colleague suddenly distracted and neglecting your conversation? Or did you say something wrong, making your colleague unsure of how to respond? Perhaps you are wrong in attributing meaning to the longer pauses, which might be the result of a technical delay, or simply of your colleague taking the time to carefully reflect before responding. This scenario is just one example of how chronemics may influence the nature of CMC.

One of the most productive theoretical frameworks for researching chronemics in CMC is social information processing (SIP) theory (Walther, 1992). Studies carried out under this framework provided evidence for a causal relationship between chronemic patterns and the impression formed by the recipient (e.g., Kalman & Rafaeli, 2011), as well as impressions formed by an outside observant of the interaction (e.g., Walther & Tidwell, 1995). Such SIP oriented studies strengthen SIP theory's claim that chronemics are an important component in the exchange of social messages during CMC. However, a careful examination of these studies reveals that they were all experimental studies in which chronemics were the independent variable and the dependent variable was the impression formed of the communicator. The studies showed that changes in the chronemic cues influence impression formation, thus establishing that chronemics are used as cues about the sender. The goal of the current study is to explore chronemics as they vary naturally during an online interaction, and ask whether attributes of the sender are reflected in the chronemic patterns. Until this is established, proponents of deficit theories of CMC (e.g., media richness theory: Daft & Lengel, 1986) can argue

* Corresponding author. Address: The Open University of Israel, 1 University Road, Ra'anana 43107, Israel. Tel.: +972 9 778 0941; fax: +972 9 778 2668.

E-mail addresses: yoramka@openu.ac.il (Y.M. Kalman), l-scissors@northwestern.edu (L.E. Scissors), alastair.gill@kcl.ac.uk (A.J. Gill), dgergle@northwestern.edu (D. Gergle).

that forming impressions on the basis of CMC cues such as chronemics can be unreliable and misleading. For example, if an experiment shows that users who exhibit shorter pauses between their postings are perceived as more outgoing and assertive, this impression might be unreliable unless we can demonstrate that a user personality trait like extraversion is actually associated with the decreased pauses. In other words, in order to establish that chronemic cues are used to exchange social and emotional messages in CMC, it is necessary to demonstrate not only that the cue influences impression formation, but also that the cue is actually associated with attributes of the communicator who is producing the cues.

To address this gap in the literature, our current work examines chronemics in a text-chat environment and explores the association between two fundamental attributes important to impression formation, and the chronemic cues created in this environment. We show that naturally occurring chronemic patterns reflect attributes of the personality of the users, as well as the level of interpersonal trust during text-chat.

We start by reviewing research on nonverbal cues in CMC, focusing on the role of chronemics in online communication. We present theories that emphasize the inability of users to overcome the lack of traditional nonverbal cues in CMC, as well as theories that demonstrate the ability of users to use whatever cues do exist in CMC in forming impressions of their online counterparts. We then point to the fact that the studies which support these latter theories have demonstrated that the chronemic information is actually being picked up by the users and that it influences the impressions they form. Nevertheless, these studies did not demonstrate that chronemic variations, such as increased or decreased pauses, actually correlate with variables that describe important attributes of the online interaction. In this study we focus on two key attributes: user personality, and interpersonal trust, and ask whether these attributes are reflected in the chronemics of chat sessions that take place during an online social dilemma investment game.

1.1. Computer-mediated communication and nonverbal cues

Theories of CMC have always paid a significant amount of attention to the involvement of nonverbal cues in online communication. A commonly used dichotomy (e.g., Thurlow, Lengel, & Tomic, 2004, p. 48) divides CMC theories into two categories: Deficit theories which perceive FtF communication to be the gold standard and which focus on the limitations of CMC when compared to FtF communication, and theories which place CMC and FtF communication on an equal footing, and investigate how their varied affordances influence usage and outcomes.

One important category of nonverbal cues is chronemics which are time related cues. Chronemics are a core component of human communication, as described by Ballard and Seibold (2004): “Persons’ experience of time affects their communication patterns, and, in turn, their communication patterns help shape their experience of time” (pp. 135 and 136). The study of chronemics examines the role of time and of timing cues, such as time of day, conversational pauses, and conversational rhythm. For example, studies have examined the influence of pauses and silences on conversation (McLaughlin & Cody, 1982). In the next few paragraphs we review the role of nonverbal cues, and of chronemics in particular, in several theoretical frameworks. We conclude with SIP theory, which provides the theoretical framework for this study.

One theoretical construct that attempts to understand the role of chronemics in CMC is the reduced social cues perspective (Kiesler & Sproull, 1992; Sproull & Kiesler, 1986). This perspective is usually cited for its negative conclusions about how reducing social cues leads to more uninhibited behavior, increased self absorption,

and to decisions which take longer to achieve and which are riskier. It is less known for its analysis of the advantages afforded by the chronemics of asynchronous CMC: More equal participation since more than one person can hold the floor at any given time; More time to contemplate before responding without causing an unpleasantly long pause; The ability to “go back in time” and retrieve past messages; And, the ability to bridge people in different time zones (Kiesler & Sproull, 1992; Sproull & Kiesler, 1986). Despite its discussion of these advantages of CMC, the reduced cues perspective does not explore the extent to which chronemic social cues are actually reduced in online communication, or directly studies the effects thereof.

Media richness theory (Daft & Lengel, 1986) is another highly cited contemporary of the reduced social cues perspective. It is based on the concept of media richness (previously called information richness) which is defined as “the ability of information to change understanding within a time interval” (p. 560). The richness of a medium is based on four criteria (Daft, Lengel, & Trevino, 1987): The immediacy of feedback it affords; The number of social cues it can transmit; The range of meaning that can be conveyed by the language used by that medium; And, the ability to infuse personal feelings and emotions into the message and tailor it to the receiver of the message. FtF communication is considered by the proponents of this theory to be the richest medium, since it maximizes all four criteria. These four criteria include implicit and explicit assumptions about chronemic variables and cues. The response time the medium allows, as well as the extent to which chronemic cues can be used to convey social cues, to communicate meaning, to personalize the message, and to tailor the message to the recipient are all factors that might influence the “richness” of a given medium. Media richness studies classify text-based CMC media such as email and text-chat as relatively poor or lean media, pointing to the paucity of nonverbal cues they are able to convey when compared to rich communication settings such as FtF communication or video conferencing. Media richness theory does not explore the influence of the chronemic variables that are transmitted in lean media.

Social identity/deindividuation theory (SIDE) (Lea & Spears, 1992) acknowledges the claim of deficit theories regarding the paucity of cues CMC is able to transmit. It then suggests that when individuals meet anonymously online, they interpret whatever few cues CMC is able to transmit, and assign the anonymous participants to social groups based on these cues. SIDE theory makes some reference to chronemic aspects of CMC, for example by noting that different groups that met to collaborate online converged onto different meeting times during the day, and differed in their time perspective (Postmes, Spears, & Lea, 2000). Yet, SIDE theory studies do not go beyond investigating the relationship between chronemic cues and social identity.

The theoretical framework that best recognizes the role of CMC chronemics is social information processing (SIP) theory (Walther, 1992). This theory developed out of a critique of earlier deficit theories such as reduced social cues and media richness theory. It points out an abundance of evidence suggesting that users find ways to use CMC to effectively convey personal and relational information despite the difference in affordances between FtF and CMC. It claims that some of the nonverbal cues can be replaced by verbal cues, and that other cues, especially chronemic cues, can be transmitted via CMC, and can convey relational information (Walther & Tidwell, 1995) such as intimacy or dominance.

An important contribution made by SIP theory is using time to explain away some of the purported deficiencies of CMC. For instance Walther (2002) suggests that studies in which CMC communication was found to be inferior to FtF communication often did not provide the participants with sufficient time to exchange messages, and that when this restriction was lifted, the quality of the

outcomes improved significantly. This focus on the importance of time in general, and of chronemic cues in particular, led to further studies that explored the influence of chronemic variables such as the time of day or the length of the pause that preceded a response, on impression formation (Döring & Pöschl, 2008; Kalman & Rafaeli, 2011; Sheldon, Thomas-Hunt, & Proell, 2006). These studies show the significant influence of chronemics on impressions formed during online interactions. Moreover, they underline the context dependency of this influence. For example, in two studies of perceptions of delays in online replies, one study found that a delayed response by a high status respondent was interpreted more positively than the same delay by a lower status respondent (Sheldon et al., 2006). In contrast, another study showed that a delayed response by a high reward valence respondent led to a negative impression of that respondent, while the same delay by a low reward valence respondent did not have the same effect (Kalman & Rafaeli, 2011). These studies strengthen SIP's central claim, that "...when denied the nonverbal cues available in face to face interaction, communicators substitute the expression of impression-bearing and relational messages into the cues available through the CMC. Thus, SIP theory posits that *communicators exchange social information through the content, style, and timing of verbal messages on-line*" (Italics added: Walther & Parks, 2002, p. 535). Nevertheless, the support these studies provide to this central claim of SIP theory is only partial. In order to ascertain that chronemics are used to exchange social information between communicators it is necessary, but not sufficient, to demonstrate that variance in the chronemic variables influences impression formation. It is also necessary to demonstrate that online chronemic variables actually reflect important social information about the communicators. Filling this gap in research is the goal of this study. An analogy can be made to the link between deception and specific behavior such as increased hand fidgeting: the fact people who fidget with their hands are perceived as more deceptive is not sufficient to claim that information about trustworthiness is exchanged through hand movement. Rather, it is also necessary to explore whether fidgeting actually does (or does not) increase when people engage in deceptive behavior.

This brief review of the research on CMC nonverbal cues in general, and of chronemic cues in particular, demonstrates that while some researchers pointed to the paucity and limitation of these cues in CMC, other researchers established that limited as these cues might be, they still exert significant influence on online communication. Nevertheless, even these latter studies do not provide direct evidence that these chronemic cues are actually associated with communicator attributes. In these studies, the chronemics were manipulated by the experimenters. It is still necessary to demonstrate that chronemics reflect such attributes. Until that is demonstrated, it can be claimed that while deficit theories might be incorrect in their claim that users do not utilize available cues when using lean CMC, there is still room for caution in claims regarding the possibility of forming reliable impressions based on chronemic information. This study adopts the assumptions of SIP theory and assumes that CMC users make use of cues that accompany the verbal message in order to deepen their understanding of the subtleties of the ongoing conversation, in a manner that is similar to the use of nonverbal cues in traditional communication. It then attempts to show a possible mechanism by which this is achieved by asking two research questions. The first question is whether differences in a key user attribute (user personality) are associated with differences in the chronemic attributes of the IM conversation created by each user. The second question is whether differences in a key situational attribute (trust) are associated with differences in the chronemic attributes of the conversation. If one or both questions are answered in the affirmative, this suggests a mechanism through which social information could be exchanged

via CMC chronemic cues, effectively utilizing the purportedly poor chronemic cues afforded by lean CMC media.

1.2. Online chronemics

What is known about the role of chronemics in online communication? One of the chronemic aspects of online communication that has received significant attention is the length of the pauses associated with online responsiveness. Responsiveness is an important aspect of communication, and we are attuned to identify even slight delays in responsiveness, delays which often lead to negative consequences such as being perceived as less socially competent (McLaughlin & Cody, 1982). Responsiveness is also an important aspect of customer service, and information systems should support an organization's responsiveness – its ability to respond to customer needs, and to respond promptly (Jiang, Klein, & Carr, 2002).

The chronemics of responsiveness in online communication has been studied in depth. One line of research has focused on the myriad factors that impact responsiveness. Scholars have examined variables related to the message, such as specific rhetorical strategies employed or the number of recipients the message was sent to (Burke, Joyce, Kim, Anand, & Kraut, 2007; Yechiam & Barron, 2003), variables related to the sender, such as having a work relationship with the sender (Dabbish, Kraut, Fussell, & Kiesler, 2005), and variables related to the recipient, such as the recipient's desktop activity at the time the message arrived (Avrahami & Hudson, 2006). Of special interest to the current study are the studies described above that analyzed the consequences of delayed responses and of lack of response (silence) in CMC. As described in Section 1.1, one such study has shown how longer pauses by a high status colleague can positively influence impression formation (Sheldon et al., 2006), while another study has shown how, under different circumstances, delayed responses and silence by a high reward valence job candidate can lead to a negative impression (Kalman & Rafaeli, 2011).

Another line of research focused on identifying the chronemic norms of responsiveness, through a study of the distributions of response latencies in both asynchronous (Kalman, Ravid, Raban, & Rafaeli, 2006; Malmgren, Stouffer, Motter, & Amaral, 2008) and synchronous (Avrahami & Hudson, 2006) communication. These studies show that the distribution of response latencies in online communication is very similar to the distribution in other forms of human communication such as traditional spoken conversation (Jaffe & Feldstein, 1970) and letter writing (Malmgren, Stouffer, Campanharo, & Amaral, 2009): It is highly skewed in favor of short response latencies, and long response latencies are rare. It shows a heavy tailed distribution approximated by a power law distribution (Newman, 2005). This mathematical uniformity highlights the shared characteristics of human responsiveness across diverse media and contexts.

1.3. Chronemics and personality

What is known about the relationship between personality and chronemics? Personality describes the fundamental qualities of a person (Matthews, Deary, & Whiteman, 2003), has been explored with a number of different models, and has important implications for behavior. In general, personality can be thought of as a set of 'traits', or a set of essential orthogonal descriptive factors. These traits traditionally assume a 'causal primacy' and 'inner locus', namely that traits influence behavior, and that they relate to the fundamental, core qualities of the person (Matthews et al., 2003).

One common trait-based model of personality is the five-factor model of personality (Costa & McCrae, 1992), which identifies extraversion, agreeableness, openness (to new experiences), neu-

roticism, and conscientiousness as the five main personality traits. Individuals who score high in extraversion tend to be outgoing, energetic, and seek stimulation from being with other people. Individuals high in agreeableness tend to be friendly, cooperative, and compassionate. Individuals who score high in the openness dimension are thought to be inventive, curious, and appreciative of adventure. Individuals who score high in neuroticism tend to be nervous, sensitive, and are more prone to experiencing negative emotions such as anger. Finally, individuals who score high in conscientiousness tend to be organized, self-disciplined, and efficient.

These traits have been explored extensively across a number of mediated and non-mediated environments. For example, individuals high in extraversion were less cooperative in an experimental social dilemma setting (Koole, Jager, van den Berg, Vlek, & Hofstee, 2001), and individuals who scored high on conscientiousness and agreeableness performed better in jobs involving interpersonal interactions (Mount, Barrick, & Stewart, 1998) (cf. Van Hiel, De Cremer, & Stouten, 2008). Personality traits have also been shown to influence the particular language used in everyday communication, whether this is writing an essay, talking with those around us, or in a CMC environment composing an email or a blog (Gill, Nowson, & Oberlander, 2009; Gill, Oberlander, & Austin, 2006; Mehl, Gosling, & Pennebaker, 2006).

Studies that link personality traits to chronemic aspects of conversation often relate to extraversion. In FtF interactions, extraverts show greater desire to communicate and initiate interactions (McCroskey & Richmond, 1990). In terms of conversational behaviors, extraverts use a greater total number of words (Campbell & Rushton, 1978; Carment, Miles, & Cervin, 1965), talk more and initiate more individual and group laughter (Gifford & Hine, 1994). In terms of fluency, which may result in greater conversational contributions, extraverts are generally regarded as having higher speech rate in formal and informal settings (e.g., Dewaele & Furnham, 2000; Tapasak, Roodin, & Vaught, 1978). Additionally, in formal situations, extraverts show less hesitation, however they also make a higher proportion of semantic errors (Dewaele & Furnham, 2000).

In their review of the relationship between spoken speech behavior and personality, Scherer and Scherer (1981) note the paucity of research on fluency aspects of speech such as pauses and tempo, noting the technical challenge of measuring these aspects of spoken speech using automated methods. They review the relationship between extraversion and various aspects of speech, including the evidence for a link between extraversion and shorter and fewer pauses. Later research strengthened the assertion for this link (e.g., Feldstein & Sloan, 1984; Gocsál, 2009), and it is now accepted that in traditional communication response latencies of extraverts are shorter than those of introverts (Mairesse, Walker, Mehl, & Moore, 2007).

1.4. Chronemics and trust online

Trust is an important component in online interactions, yet it is complex and multifaceted (Gefen, 2002). Although early studies of online communication emphasized the difficulty of achieving trust in online interactions, later studies have shown that trust can develop even in media which were considered poor in social and interpersonal cues (Walther & Parks, 2002; Wilson, Straus, & McEvily, 2006). Ridings, Gefen, and Arinze (2002) define trust as “an implicit set of beliefs that the other party will refrain from opportunistic behavior and will not take advantage of the situation”, and explain that in online environments, where rules do not provide sufficient guarantees that others will behave as they are expected to, “trust serves as a subjective substitute to such rules, creating the necessary atmosphere that makes engagement with others more open” (p. 275).

Online trust has been extensively studied in the context of user trust of e-commerce websites and of the people and organizations behind them, as well as in the context of technology acceptance. These studies reveal the complex interactions between trust and myriad factors such as culture, gender, privacy and justice (Benbasat, Gefen, & Pavlou, 2008). Other studies looked specifically at the development of interpersonal trust between users who communicate online, showing the complexity of online interpersonal trust development, and some differences between it and the development of interpersonal trust in FtF situations. Some of the variables that have been shown to influence the development of such interpersonal trust include personal attributes such as empathic accuracy, and message attributes such as its level of supportiveness (Feng, Lazar, & Preece, 2004). Studies of the role of CMC cues on interpersonal trust have shown that both visual and textual cues influence online trust (Scissors, Gill, Geraghty, & Gergle, 2009; Toma, 2010), but there is a dearth of work that explores the relationship between online chronemic cues and trust.

Despite the lack of studies focusing on online chronemic cues and trust, it is possible to explore the nature of the relationship between these variables through studies of chronemics and deception in traditional communication, and of online responsiveness and trust. It has been shown that in traditional communication, deceptive communication is characterized by longer response latencies and pauses by the deceptive party (Porter & Brinke, 2010; Rockwell, Buller, & Burgoon, 1997), possibly caused by the increased cognitive load associated with handling deception (Buller, Burgoon, Buslig, & Roiger, 1996; Vrij et al., 2008). Online, research has so far focused only on chronemics as the independent variable. One study found that longer latencies in FtF conversation were interpreted as indicators of deception (Boltz, Dyer, & Miller, 2010). In an online context, the aforementioned Ridings et al. (2002) paper surveyed members of online communities, and found that perceived responsiveness of team members was positively correlated with trust in the team members. Finally, in the study of responsiveness to email messages mentioned in Section 1.1, Kalman and Rafaeli (2011) found that unusually long response latencies as well as online silence can violate expectations, and that these violations can negatively impact the perception of the unresponsive partner who is perceived as less credible and less receptive/trustworthy.

1.5. Hypotheses

Several studies reviewed here demonstrated that experimentally modifying online chronemic variables has significant influence on the formation of impressions during CMC. The goal of this study is to ascertain whether naturally occurring variations in CMC chronemics are sufficiently sensitive and informative to reflect important personal and situational attributes of the online interaction and of its participants.

To answer this question we studied the relationship between an online chronemic variable, and personal and situational attributes, and measured the degree to which these variables covary. The study took place in the context of a dyadic online social dilemma investment game which provides a large number of chronemic data points, as well as the opportunity to unobtrusively measure interpersonal trust. In the game (described below in Section 2), two anonymous players interact only via text-chat (IM). The game is structured so that the financial outcomes of the game reflect the level of trust as it develops in the dyad during the investment game. By collecting this information, by capturing a time-stamped record of the conversation, and by having players fill out personality questionnaires, it is possible to study the relationship between online chronemic variables, user personality, and trust. In this study, we focus on the single most salient chronemic measure in

a text-chat session: interpost pause, or the length of time between each individual posting to the chat conversation. For details about the interpost pause, see Fig. 1 and Section 2.

The first hypothesis is that a user's personality influences the chronemic behavior they exhibit. Based on the extensive literature that links extraversion with shorter response latencies (Mairesse et al., 2007), we hypothesize that:

H1. Users who score higher on extraversion will exhibit shorter interpost pauses.

The second hypothesis links interpersonal trust to the chronemic behavior of the users. Based on the findings that deception is characterized by long response latencies and pauses in FtF settings (Porter & Brinke, 2010; Rockwell et al., 1997), we hypothesize that:

H2. Users who exhibit lower levels of interpersonal trust in their dyad will have longer interpost pauses.

2. Method

2.1. Participants

This study used the data generated by the participants in the Scissors et al. (2009) study. Participants ($N = 124$, 53% female) were students and staff at a mid-sized university in the Midwest region of the United States of America. Participants were randomly assigned to pairs and did not meet prior to or after the study's completion. Participants were all native speakers of English and the average age of participants was 20.4 years. Forty-eight percent of the participants were Caucasian, 30% Asian/Pacific Islander, 6% African-American, 4% Hispanic, and about 12% Mixed-Race/Other. Participants had an average of 7.5 years of experience using IM (1–16 years), with 52% of participants using it daily, 23% using it weekly, 8% using it monthly, and 19% using it less often than monthly.

2.2. Procedure

Prior to playing the game, participants filled out a personality questionnaire. We used the 44-item Big-Five Inventory (BFI-44) (John & Srivastava, 1999) which measures the Big Five factors or dimensions of personality: Extraversion, Agreeableness, Openness to new experiences, Neuroticism and Conscientiousness. The questionnaire instructs participants to answer each personality item on a scale of 1 (strongly disagree) to 7 (strongly agree) (4 = neutral). Items include, for instance, "I see myself as someone who is talkative" (extraversion) and "I see myself as someone who does a thorough job" (conscientiousness).

Sixty-two pairs of participants played the DayTrader social dilemma investment game (originally developed by Bos, Olson, Gergle, Olson, & Wright, 2002). In social dilemma games, the interests of the individual are typically at odds with the interests of the group. In the DayTrader game, individuals can earn the most money by convincing their partners to trust them and to contribute more money to the group than the individuals themselves do. However, doing this runs the risk of alienating one's partner which in subsequent turns may lead to partners losing trust and not working together, and ultimately earning fewer profits on the whole. Players were each given 60 tokens to invest into the "market" during 28 investment rounds. During each round, the tokens one does not invest are doubled and the player keeps these profits. However, the tokens invested in the market by each player are grouped together, tripled, and then split among each player. In other words, keeping 60 tokens to oneself, for example, yields a 120 token return while investing 60 tokens yields a 180 token return, as long as one's partner also invests 60 tokens. If one's partner invests less than one does (i.e. the partner "defects"), the partner will make more money. A random market fluctuation of plus or minus three tokens, as well as a 200 token bonus for the player who earned the most at the end of each five investment rounds, further encouraged defection by masking the financial consequences of defection and by promoting personal gains (respectively). If players notice these defections based on the report of their earning, there may be a breakdown of trust wherein players invest fewer or none of their tokens, resulting in lower earnings for both players. After every five investment rounds, participants are able to chat with each other via IM for up to 5 min. During this time, they are able to strategize or discuss the game. In all, there are five chat sessions and 28 investment rounds per pair.

In conclusion, the rules of the game were structured so as to reward the maintenance of trust within the team with high financial earnings for the team (both players), as well as to tempt each member of the team to increase their individual earnings by betraying the trust of their partner and not sticking to the agreement they reached in their chat-sessions. Accordingly, the quantitative measure of trust which is commonly used in this experiment is the average amount of earnings the team achieved in the five investment rounds which follow each chat session (Rocco, 1998). Higher average group earnings are indicative of achieving increased trust during the chat session, while reduced group earnings are evidence of decreased trust within the team. Note that this measure of trust is obtained unobtrusively. The players are not aware of the fact that the researchers are interested in measuring the level of interpersonal trust in the team.

The five chat sessions of each pair were time-stamped and recorded. The two players were also able to refer questions to a

Line	Timestamp	Player	Posted text	Interpost pause (seconds)
1	11:00:40 AM	A	Have you been investing large or small amounts?	-
2	11:00:48 AM	B	small	8
3	11:01:03 AM	B	and you?	15
4	11:01:16 AM	A	mostly small also	13
5	11:01:28 AM	A	but i was expecting you to pay out small	12
6	11:01:41 AM	B	i was expecting the same of you	13
7	11:02:25 AM	A	We could agree to the same amount	44
8	11:02:46 AM	A	Did you get the bonus?	21

Fig. 1. An eight line sample extracted from a chat session with two players. Each line represents a sent message. Interpost pause is calculated in the right hand column.

“regulator” who followed the chat session and answered game related questions in the chat window. Idle sessions of more than 60 s were flagged by the system which prompted the players to either resume the game or continue the conversation.

2.3. Variables

Previous chronemic research focused on chronemic cues which reflect the rhythm of the conversation (e.g., pauses between messages), as well as variables such as day of the week and time of day (e.g., Avrahami & Hudson, 2006; Walther & Tidwell, 1995). The latter two variables are not expected to reflect personal and dyadic information, since the timing of the experiment was not set by the participants. The chronemic variable that was used in this study is one which reflects the rhythm of the conversation, “interpost pause”. For each posting made by each of the two players, the interpost pause is the pause between that posting and the previous posting made in the forum by any of the participants (including by the regulator). Interpost pause is the most salient chronemic measure of a conversation: it represents the rhythm of the conversation from the point of view of each of the two members of the team, and it represents both the response times of the users, as well as their personal rhythm. Two additional related chronemic measures were also studied: switching pause (the interval between each player's last posting and the other player's first posting) and personal rhythm (the interval between each player's postings). Section 3 focuses on interpost pause, and switching pause and personal rhythm are discussed briefly. All chronemic variables were measured, in seconds, within each of the five chat rounds, but not between the chat rounds. Fig. 1 presents a time stamped sample of eight postings from a chat session, with the interpost pause assigned to that post, and to the player who wrote that post. Because of the highly skewed distribution of human pauses, the natural log of the pause was used to normalize the distribution. The timestamp of each posting is created at the moment the message is posted.

In addition to the chronemic variable, we measured the Big Five personality traits, (extraversion, agreeableness, openness, neuroticism, and conscientiousness) using the 44-item Big-Five Inventory (BFI-44) (John & Srivastava, 1999), and message length (measured in total number of characters and spaces in the message). Since longer messages are expected to take, on average, a longer time to type, message length was used as a control variable.

As previously described, the measure of trust was average team earnings: the average amount of earnings the team achieved in the five investment rounds which follow each chat session (Rocco, 1998). As explained in Bos et al. (2002) this measure is an operationalization of Mayer, Davis and Schoorman's (1995) integrative model which defines trust as “the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party” (p. 712). These earnings reflect the level of trust that existed during the chat session that preceded the investment rounds. Unlike the personality variables which are constant for each player, the trust level can vary during the game, so there are five trust measures for each pair: Each one of the five represents the level of interpersonal trust which followed the chat session.

2.4. Analysis

The chronemic variables were converted to a natural logarithmic scale, to compensate for and normalize the highly skewed distributions (see Section 1.2). A correlation matrix of all independent and control variables (Table 1) was examined to identify collinearity before proceeding with the multilevel analysis. No statistically

significant correlations at or above an absolute value of 0.4 were detected. The reliability scores (Cronbach's alpha) for the five personality traits were acceptable (extraversion: 0.89, agreeableness: 0.81, conscientiousness: 0.86, neuroticism: 0.87, openness: 0.87).

A multilevel modeling approach (also known as mixed effects modeling) was used to address the fact that the data occur at several levels and exhibit numerous dependencies between observations. The lowest level unit of analysis is the message ($n = 3554$), which is nested within chat sessions (five chat sessions), which are nested within participants, who are nested within dyads.

Model development began with a baseline model of the dependent variable and random components were added in subsequent models where model fit was assessed using the likelihood-ratio test. All models used the restricted maximum likelihood (REML) estimation technique.

The primary response variable explored is the (log) interpost pause (additional models were developed for response variables for (log) switching pause and (log) personal rhythm). The predictor variables were recorded at several levels. The message level (level 1) included message length (the number of characters). This was included as a control variable to capture the fact that longer messages likely take more time to type. The chat sessions level (level 2) included the measure of trust – the group earnings that were achieved in the investments which followed each chat session. The individual level (level 3) included predictors for all five of the individual personality traits. No predictors were included at the dyadic level; however, the dyadic level was included in the models to completely account for the nested structure of the data.

3. Results

The results are presented in Table 2. The mean log interpost pause was 1.92. The analyses identified three predictor variables that have a statistically significant association with log interpost pause: extraversion and trust, as well as the control variable message length. The pauses of participants who scored higher on extraversion were shorter; and, the pauses of participants before investment rounds in which the level of trust was higher were shorter. As expected, the pauses of participants who typed longer messages were also longer.

No second order interactions were detected between the personality variables and trust. The same models were developed for two other chronemic variables and led to similar results as the model for log interpost pause: For log personal rhythm (the interval between each player's postings), an identical pattern of results was found. For log switching pause (the interval between each player's last posting and the other player's first posting) led to an identical pattern of results except that the fixed effect for extraversion did not quite reach significance ($p = .053$).

4. Discussion

4.1. User personality influences CMC chronemics

Users who scored higher on extraversion exhibited shorter interpost pauses, supporting H1. We conclude that chronemics co-vary with extraversion. Since personality is a stable set of traits, it is possible to interpret the association as a causal relationship and say that user personality influences CMC chronemics.

The finding that users who scored higher on the extraversion scale exhibited shorter pauses online is consistent with the findings that extraverted people have a higher speech rate, show less hesitation, and exhibit shorter pauses and response latencies in FtF communication (Dewaele & Furnham, 2000; Feldstein & Sloan, 1984; Gocsál, 2009; Mairesse et al., 2007).

Table 1
Pairwise correlations of the study's variables.

	1	2	3	4	5	6	7	8
1 Extraversion	1.00							
2 Agreeableness	0.30	1.00						
3 Conscientiousness	0.35	0.32	1.00					
4 Neuroticism	-0.16	-0.35	-0.23	1.00				
5 Openness	0.31	0.33	0.32	-0.17	1.00			
6 Trust	-0.11	0.12	-0.19	-0.05	0.26	1.00		
7 Message length	-0.14	0.06	0.23	-0.07	-0.01	-0.06	1.00	
8 Interpost pause	-0.06	0.07	0.02	-0.09	0.02	-0.09	0.33	1.00

Note. Correlations above ± 0.1 are statistically significant (p<.0001).

Table 2
Multilevel model for log interpost pause.

Term	Estimate (SE)	[95% confidence interval]	
<i>Level 1 fixed effects (message)</i>			
Intercept	3.1377 (.3193)***	2.5119	3.7636
Message length	.0104 (.0005)***	.0094	.0115
<i>Level 2 fixed effects (chat session)</i>			
Trust	-.0034 (.0006)***	-.0046	-.0021
<i>Level 3 fixed effects (individual)</i>			
Extraversion	-.0773 (.0267)**	-.1296	-.0249
Agreeableness	.0160 (.0333)	-.0494	.0813
Conscientiousness	-.0197 (.0289)	-.0763	.0369
Neuroticism	-.0157 (.0229)	-.0606	.0291
Openness	.0163 (.0375)	-.0571	.0897
<i>Random effects</i>		<i>Variance (SE)</i>	
Dyad		.0747 (.0203)***	
Participant		.0175 (.0099)***	
Round		.0148 (.0086)†	
Level-1 residual ($\hat{\sigma}^2$)		.7196 (.0182)	

Note. The restricted maximum likelihood (REML) method is used for estimation. Entries for reported p-values for the random components were obtained by testing the null hypothesis that the particular variance component is zero. Tests were performed using the likelihood-ratio test between models that included the lower-level variance components or the baseline model.

† p < .10.
* p < .05.
** p < .01.
*** p < .001.

Another variable for which a statistically significant impact was detected is message length. It was expected that messages which require more keystrokes would increase the pause that precedes the post, and that is the reason it was added as a control variable. The impact of keystrokes on the interpost pause can be used to illustrate the average linear impact of personality on the chronemic variables. In Table 2, we can see that an increase of one point on the extraversion scale decreases interpost pause by as much as the time saved by typing about seven characters less. This illustrates the subtle effect of user personality on the chronemics of chat.

4.2. Shorter pauses are associated with increased trust

The interpost pauses of users in pairs in which decreased interpersonal trust was measured were longer, and H2, that users who exhibit lower levels of interpersonal trust in their dyad will have longer interpost pauses, was supported. Unlike personality, where the causal direction from personality to chronemics is clear, the association we identified between decreased pauses and increased levels of trust in the online dyad should be interpreted with more care, since there are several potential explanations for the link between chronemics and trust. The first possible explanation is that the increase in cognitive load associated with deception led to

the longer pauses that characterize deception in FtF communication (Buller et al., 1996; Porter & Brinke, 2010; Rockwell et al., 1997; Vrij et al., 2008). This association is the one that H2 was based on. Nevertheless, there are additional possible explanations for this association. For example, it is possible that the longer pauses are a result of the increased cognitive load and hesitation of the team member who suspects deception by the other team member, and who considers his or her possible reaction. A third possible explanation is that increased pauses by one team member negatively impact the impression the other team member has of his or her partner, leading to reduced trust. The negative effect of hesitancy and pausing is long established in FtF interaction (e.g., Boltz et al., 2010; McLaughlin & Cody, 1982), and several studies have demonstrated the negative impact of longer pauses and of silence in online communication (e.g., Kalman & Rafaeli, 2011; Ridings et al., 2002).

It is difficult to tease apart the role of these three possible explanations since they are not mutually exclusive and since participants in conversation are influenced by the prosodic components of their partner's speech and adjust their own rhythm to match their partner's (Campbell, Cothren, & Burg, 2010; Kanashiro, Kobayashi, & Kitamura, 2009; Riordan, Markman, & Stewart, 2012). This difficulty should be addressed in future studies. Regardless of the possible explanations, the key finding is the demonstration that decreased trust is associated with longer pauses not only when the pauses are modified experimentally (e.g., Kalman & Rafaeli, 2011; Sheldon et al., 2006; Walther & Tidwell, 1995), but also when they vary naturally.

4.3. Implications for CMC theory

The current study follows up on SIP theory oriented studies which demonstrated that CMC users are sensitive to the chronemic variables that a medium affords (Kalman & Rafaeli, 2011; Sheldon et al., 2006; Walther & Tidwell, 1995). Individuals in the studies sensed the chronemic changes introduced by the experimenters, and these influenced the impressions they formed of online conversational partners. Although these SIP studies have shown the influence of chronemics on impression formation, they have not provided evidence for the more overarching claim of SIP theory that online communicators exchange social information through chronemic cues. Specifically, these studies have not shown that online chronemics are capable of conveying relevant information about the online participants or the online situation. This study aimed to explore this question by asking whether a "lean" chronemic variable, interpost pause, can faithfully reflect a personal attribute of users, their extraversion, and a situational variable of the online interaction, interpersonal trust.

Our findings provide support to SIP theory by demonstrating how a simple variable such as the length of the pause between postings in a synchronous text chat session covaries with user extraversion, as well as with the level of interpersonal trust in

the dyad. Moreover, the findings show alignment between the influence of trust and of extraversion in traditional FtF communication, and their influence in this experiment.

The findings of this study also underline the complex nature of cues in general, and of CMC cues in particular. It shows that one variable, in this case interpost pause, is sensitive to at least the two variables which were identified in this study. If the same cue is longer when the user types more words, and is shorter when the user scores higher on extraversion or when the level of trust is higher, then it is impossible to use this cue on its own when forming impressions. Like other nonverbal cues, CMC cues too need to be interpreted in the context of other cues, both verbal and nonverbal. Any simplistic interpretation of a single cue as communicating a specific message would be misguided.

4.4. Implications for practice

Online chat is often used for applied purposes such as distance education and online customer service. It is important that users of online chat and other online communication tools be aware of the fact that the timeliness of their responses is an important aspect of the ongoing conversation. For example, as we have shown in this study, an increase in the response time could indicate a drop in the level of trust between the users. Nevertheless, the key practical implication of this study in this regard is one of caution. We have shown that similar changes in the same chronemic variables could have different causes. For example, we have not only shown that shorter pauses could reflect a higher level of dyadic trust, but also that shorter pauses could reflect the fact that users are more extraverted. Thus, as we have already learned from nonverbal cues in traditional communication (Knapp & Hall, 2009), any interpretation of subtle nonverbal cues needs to be carried out with caution, taking into account the many other verbal and nonverbal components of the message. As applications are developed to monitor online interactions for variables that reflect sentiment, trust, etc., care should be taken to avoid simplistic algorithms which ignore context.

4.5. Limitations and future research

This study showed how variations in fundamental personal and situational attributes such as personality and trust are reflected in increased or decreased pauses during synchronous chat. These relationships between chronemic cues and specific variables need to be tested in additional contexts. Our experiment enforced time limits, did not allow for multitasking, and incentivized users to trust one another in order to do well in the game. Future research could test the generalizability of our findings to contexts other than an online social dilemma game. For example, researchers could verify whether communicators who score higher on extraversion tend to produce shorter pauses in other online situations and in other online media. Second, the causal direction of our findings on trust and chronemics is uncertain and merits further investigation. Future research could focus on teasing apart the three possible explanations for the association between longer pauses and decreased trust.

In addition, future research should continue exploring the implications of this study on CMC theory. Communicators who use online tools incorporate many available cues to form an impression of the person they are communicating with (Hancock & Dunham, 2001). This study adds to the mounting evidence that chronemic cues are easily conveyed by even the simplest of CMC media, and that they impact impression formation (Walther, 2011). The finding that differences in personality traits are reflected in variance in the pauses between text-chat postings may justify the use of pauses as evidence for the personality of the

otherwise invisible partner on the other side of the chat screen. On the other hand, it is evident that since pause length is a unidimensional measure, and since other personal and situational variables influence these pauses in both directions and to a varying extent, it would be wrong to make any inference based solely on this variable. Like other nonverbal cues, we should assume that chronemics can only be interpreted in conjunction with the many other verbal and nonverbal cues available to the user. For example, the research by Scissors et al. (2009) showed an association between the verbal cues that linguistic similarity conveys and trust outcomes. Future research should continue exploring how these different variables are integrated by users who are forming an impression of the person they are communicating with. The relatively straightforward setup of the chat mediated social dilemma game provides a simple experimental setting which can effectively measure actual conversational outcomes in real time.

This study explored the conveyance of social and emotional information in CMC. It focused on only two aspects of this information: a personality trait of the user, and the level of interpersonal trust within the dyad. Additional research is required to explore the ability of chronemic cues to reflect additional forms of social and emotional information such as immediacy or stress.

An additional open question that is raised is whether our findings that personality and trust are communicated via subtle chronemic cues, imply that chronemic cues are more reliable than other cues, such as verbal cues, that might be easier to manipulate? The answer might be that chronemic cues are just as easy to manipulate as other cues. For example, shorter pauses might be an effective way to express a higher level of extraversion and trust. Alternatively, it might be that it is difficult to manipulate these subtle chronemic cues in a consistent manner, and it is possible that incongruence between the chronemic cues and other cues alerts users to a possible manipulation attempt.

Finally, this study, which set out to explore whether chronemic cues could serve as reliable conduits for information about personality and trust, is only one additional step towards the confirmation of the assumption made by SIP theory about how chronemic cues mediate social and emotional information between users. We have shown, for example, that chronemic cues reflect aspects of the user's personality, but that is not enough in order to prove that impressions formed by chronemic cues reflect the actual personality of the user. Further studies are required in order to establish the full sequence that leads to the formation of impressions.

5. Conclusions

Synchronous text-based online communication is often considered one of the leaner communication media, limited in its ability to convey nonverbal cues and subtleties. Despite this purported limitation, it has long been known that chronemics influence impressions formed during text-based CMC. In our study of 310 chat sessions created by 62 teams who played a social dilemma investment game, we measured how a single chronemic variable, interpost pause, covaried with a user personality trait, and with the trust developed during the game. The multilevel analysis showed that, when controlling for message length and for the five main personality traits, the interpost pauses were influenced by participant extraversion and were associated with the level of trust during the game: more extraverted players exhibited shorter pauses, and longer pauses were associated with decreased team trust. The relationship between extraversion and shorter pauses is not new, and has been observed in other communication forms. In relation to the covariance between interpersonal trust and the pauses, we suggest three non-mutually exclusive explanations for the association between longer pauses and trust: (1) the longer

pauses are the result of the increased cognitive load on the player who is carrying out the deception; (2) the longer pauses are the result of the increased cognitive load on the player who is suspecting that he or she is being deceived by the other player; and, (3) the longer pauses cause the decrease in trust. We point to the increased complexity that dyadic entrainment introduces into this already complicated picture.

The study demonstrates that a lean chronemic variable such as interpost pause covaries with personal and situational variables which are important for online impression formation. This finding complements studies which have demonstrated the influence of experimentally manipulated chronemics on users' impression formation. It provides evidence that chronemic variance can be a conduit for important information about online users, and thus further strengthens SIP theory.

Acknowledgements

We wish to thank Zwi Kalman for his assistance with the data analysis. Previous versions of this manuscript were presented at MCIS 2010 and ICA 2012. We wish to thank the two anonymous reviewers for their constructive feedback. This work was funded, in part, by National Science Foundation grants #0705901 and #0953943.

References

- Avrahami, D., & Hudson, S. E. (2006). Responsiveness in instant messaging: Predictive models supporting inter-personal communication. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '06)*, pp. 731–740. New York: ACM Press. <http://dx.doi.org/10.1145/1124772.1124881>
- Ballard, D. I., & Seibold, D. R. (2004). Organizational members' communication and temporal experience: Scale development and validation. *Communication Research*, 31(2), 135–172. <http://dx.doi.org/10.1177/0093650203261504>.
- Benbasat, I., Gefen, D., & Pavlou, P. A. (2008). Special issue: Trust in online environments. *Journal of Management Information Systems*, 24(4), 5–11. <http://dx.doi.org/10.2753/MIS0742-1222240400>.
- Boltz, M. G., Dyer, R. L., & Miller, A. R. (2010). Jo are you lying to me? Temporal cues for deception. *Journal of Language and Social Psychology*, 29(4), 458–466. <http://dx.doi.org/10.1177/0261927X10385976>.
- Bos, N., Olson, J., Gergle, D., Olson, G., & Wright, Z. (2002). Effects of four computer-mediated communications channels on trust development. *Proceedings of the SIGCHI conference on human factors in computing systems (CHI '02)*, pp. 135–140. New York: ACM Press. <http://dx.doi.org/10.1145/503376.503401>.
- Buller, D. B., Burgoon, J. K., Buslig, A., & Roiger, J. (1996). Testing interpersonal deception theory: The language of interpersonal deception. *Communication Theory*, 6(3), 268–289. <http://dx.doi.org/10.1111/j.1468-2885.1996.tb00129.x>.
- Burke, M., Joyce, E., Kim, T., Anand, V., & Kraut, R. (2007). Introductions and requests: Rhetorical strategies that elicit response in online communities. *Proceedings of the third international conference on communities & technologies*, pp. 21–39. London: Springer. http://dx.doi.org/10.1007/978-1-84628-905-7_2.
- Campbell, J., Cothren, D., & Burg, A. (2010). The perpetuation of entrained behavior during computer-mediated communication. *Social Influence*, 5(1), 59–73. <http://dx.doi.org/10.1080/15534510903286129>.
- Campbell, A., & Rushton, J. P. (1978). Bodily communication and personality. *The British Journal of Social and Clinical Psychology*, 17(1), 31–36. <http://dx.doi.org/10.1111/j.2044-8260.1978.tb00893.x>.
- Carment, D. W., Miles, C. G., & Cervin, V. B. (1965). Persuasiveness and persuasibility as related to intelligence and extraversion. *The British Journal of Social and Clinical Psychology*, 4, 1–7. <http://dx.doi.org/10.1111/j.2044-8260.1965.tb00433.x>.
- Costa, P. T., & McCrae, R. R. (1992). *Neo PI-R professional manual*. Odessa, FL: Psychological Assessment Resources.
- Dabbish, L.A., Kraut, R.E., Fussell, S., & Kiesler, S. (2005). Understanding email use: Predicting action on a message. *Proceedings of the SIGCHI conference on human factors in computing systems (CHI '05)*, pp. 691–700. New York: ACM Press. <http://dx.doi.org/10.1145/1054972.1055068>.
- Daft, R. L., & Lengel, R. H. (1986). Organizational information requirements, media richness and structural design. *Management Science*, 32(5), 554–571. <http://dx.doi.org/10.1287/mnsc.32.5.554>.
- Daft, R. L., Lengel, R. H., & Trevino, L. K. (1987). Message equivocality, media selection, and manager performance: Implications for information systems. *MIS Quarterly*, 11(3), 355–366. <http://dx.doi.org/10.2307/248682>.
- Dewaele, J. M., & Furnham, A. (2000). Personality and speech production: A pilot study of second language learners. *Personality and Individual Differences*, 28(2), 355–365. [http://dx.doi.org/10.1016/S0191-8869\(99\)00106-3](http://dx.doi.org/10.1016/S0191-8869(99)00106-3).
- Döring, N., & Pöschl, S. (2008). Nonverbal cues in mobile phone text messages: The effects of chronemics and proxemics. In R. Ling & S.W. Campbell (Eds.), *The reconstruction of space and time: Mobile communication practices* (Vol. 109). New Brunswick, NJ: Transaction Publishers.
- Feldstein, S., & Sloan, B. (1984). Actual and stereotyped speech tempos of extraverts and introverts. *Journal of Personality*, 52(2), 188–204. <http://dx.doi.org/10.1111/j.1467-6494.1984.tb00352.x>.
- Feng, J., Lazar, J., & Preece, J. (2004). Empathy and online interpersonal trust: A fragile relationship. *Behaviour & Information Technology*, 23(2), 97–106. <http://dx.doi.org/10.1080/01449290310001659240>.
- Geffen, D. (2002). Reflections on the dimensions of trust and trustworthiness among online consumers. *ACM SIGMIS Database*, 33(3), 38–53. New York: ACM Press. <http://dx.doi.org/10.1145/569905.569910>.
- Gifford, R., & Hine, D. W. (1994). The role of verbal behavior in the encoding and decoding of interpersonal dispositions. *Journal of Research in Personality*, 28(2), 115–132. <http://dx.doi.org/10.1006/jrpe.1994.1010>.
- Gill, A.J., Nowson, S., & Oberlander, J. (2009). What are they blogging about? Personality, topic and motivation in blogs. *Proceedings of the third international ICWSM conference*, pp.18–25. AAAI
- Gill, A. J., Oberlander, J., & Austin, E. (2006). Rating e-mail personality at zero acquaintance. *Personality and Individual Differences*, 40(3), 497–507. <http://dx.doi.org/10.1016/j.paid.2005.06.027>.
- Gocsál, Á. (2009). Female listeners' personality attributions to male speakers: The role of acoustic parameters of speech. *Pollack Periodica*, 4(3), 155–165. <http://dx.doi.org/10.1556/Pollack.4.2009.3.14>.
- Hancock, J. T., & Dunham, P. J. (2001). Impression formation in computer-mediated communication revisited. *Communication Research*, 28(3), 325–347. <http://dx.doi.org/10.1177/009365001028003004>.
- Jaffe, J., & Feldstein, S. (1970). *Rhythms of dialogue*. Academic Press.
- Jiang, J. J., Klein, G., & Carr, C. L. (2002). Measuring information system service quality: SERVQUAL from the other side. *MIS Quarterly*, 26(2), 145–166. <http://dx.doi.org/10.2307/4132324>.
- John, O.P., & Srivastava, S. (1999). The big-five trait taxonomy: History, measurement, and theoretical perspectives. In L. A. Pervin, & O. P. John (Eds.), *Handbook of personality* (2nd ed., pp. 102–138). New York, NY: The Guilford Press.
- Kalman, Y. M., & Rafaeli, S. (2011). Online pauses and silence: Chronemic expectancy violations in written computer-mediated communication. *Communication Research*, 38(1), 54–69. <http://dx.doi.org/10.1177/0093650210378229>.
- Kalman, Y. M., Ravid, G., Raban, D. R., & Rafaeli, S. (2006). Pauses and response latencies: A chronemic analysis of asynchronous CMC. *Journal of Computer Mediated Communication*, 12, 1–23. <http://dx.doi.org/10.1111/j.1083-6101.2006.00312.x>.
- Kanashiro, I., Kobayashi, K., & Kitamura, Y. (2009). Entrainment in human-agent text communication. *Agent Computing and Multi-Agent Systems*, 268–277. http://dx.doi.org/10.1007/978-3-642-01639-4_23.
- Kiesler, S., & Sproull, L. (1992). Group decision making and communication technology. *Organizational Behavior and Human Decision Processes*, 52(1), 96–123. [http://dx.doi.org/10.1016/0749-5978\(92\)90047-B](http://dx.doi.org/10.1016/0749-5978(92)90047-B).
- Knapp, M. L., & Hall, J. A. (2009). *Nonverbal communication in human interaction*. Wadsworth Publishing Company.
- Koole, S. L., Jager, W., van den Berg, A. E., Vlek, C. A. J., & Hofstee, W. K. B. (2001). On the social nature of personality: Effects of extraversion, agreeableness, and feedback about collective resource use on cooperation in a resource dilemma. *Personality and Social Psychology Bulletin*, 27(3), 289–301. <http://dx.doi.org/10.1177/0146167201273003>.
- Lea, M., & Spears, R. (1992). Paralinguistic and social perception in computer-mediated communication. *Journal of Organizational Computing*, 2(3&4), 321–341. <http://dx.doi.org/10.1080/10919399209540190>.
- Mairesse, F., Walker, M. A., Mehl, M. R., & Moore, R. K. (2007). Using linguistic cues for the automatic recognition of personality in conversation and text. *Journal of Artificial Intelligence Research*, 30(1), 457–500.
- Malmgren, R. D., Stouffer, D. B., Campanharo, A., & Amaral, L. A. N. (2009). On universality in human correspondence activity. *Science*, 325(5948), 1696. <http://dx.doi.org/10.1126/science.1174562>.
- Malmgren, R. D., Stouffer, D. B., Motter, A. E., & Amaral, L. A. N. (2008). A Poissonian explanation for heavy tails in e-mail communication. *Proceedings of the National Academy of Sciences*, 105(47), 18153–18158. <http://dx.doi.org/10.1073/pnas.0800332105>.
- Matthews, G., Deary, I. J., & Whiteman, M. C. (2003). *Personality traits*. Cambridge, MA: Cambridge University Press.
- Mayer, R. C., Davis, J. H., & Schoorman, F. D. (1995). An integrative model of organizational trust. *Academy of Management Review*, 709–734.
- McCroskey, J. C., & Richmond, V. P. (1990). Willingness to communicate: A cognitive view. *Journal of Social Behavior & Personality*, 5, 19–37. <http://dx.doi.org/10.1080/10417949009372817>.
- McLaughlin, M. L., & Cody, M. J. (1982). Awkward silences: Behavioral antecedents and consequences of the conversational lapse. *Human Communication Research*, 8(1), 299–316. <http://dx.doi.org/10.1111/j.1468-2958.1982.tb00669.x>.
- Mehl, M. R., Gosling, S. D., & Pennebaker, J. W. (2006). Personality in its natural habitat: Manifestations and implicit folk theories of personality in daily life. *Journal of Personality and Social Psychology*, 90(5), 862–877. <http://dx.doi.org/10.1037/0022-3514.90.5.862>.
- Mount, M. K., Barrick, M. R., & Stewart, G. L. (1998). Five-factor model of personality and performance in jobs involving interpersonal interactions. *Human Performance*, 11(2), 145–165. <http://dx.doi.org/10.1080/08959285.1998.9668029>.
- Newman, M. E. J. (2005). Power laws, Pareto distributions and Zipf's law. *Contemporary Physics*, 46(5), 323–351. <http://dx.doi.org/10.1080/00107510500052444>.

- Porter, S., & Brinke, L. (2010). The truth about lies: What works in detecting high stakes deception? *Legal and Criminological Psychology*, 15(1), 57–75. <http://dx.doi.org/10.1348/135532509X433151>.
- Postmes, T., Spears, R., & Lea, M. (2000). The formation of group norms in computer-mediated communication. *Human Communication Research*, 26(3), 341–371. <http://dx.doi.org/10.1111/j.1468-2958.2000.tb00761.x>.
- Ridings, C. M., Gefen, D., & Arinze, B. (2002). Some antecedents and effects of trust in virtual communities. *The Journal of Strategic Information Systems*, 11(3–4), 271–295. [http://dx.doi.org/10.1016/S0963-8687\(02\)00021-5](http://dx.doi.org/10.1016/S0963-8687(02)00021-5).
- Riordan, M. A., Markman, K. M., & Stewart, C. O. (2012). Communication accommodation in instant messaging: An examination of temporal convergence. *Journal of Language and Social Psychology*. <http://dx.doi.org/10.1177/0261927X12462695>.
- Rocco, E. (1998). Trust breaks down in electronic contexts but can be repaired by some initial face-to-face contact. *Proceedings of the SIGCHI conference on human factors in computing systems (CHI '98)*, pp. 496–502. New York: ACM Press. <http://dx.doi.org/10.1145/274644.274711>.
- Rockwell, P., Buller, D. B., & Burgoon, J. K. (1997). The voice of deceit: Refining and expanding vocal cues to deception. *Communication Research Reports*, 14(4), 451–459. <http://dx.doi.org/10.1080/08824099709388688>.
- Scherer, K. R., & Scherer, U. (1981). Speech behavior and personality. *Speech Evaluation in Psychiatry*, 115–135.
- Scissors, L.E., Gill, A.J., Geraghty, K., & Gergle, D. (2009). In CMC we trust: The role of similarity. *Proceedings of the SIGCHI conference on human factors in computing systems (CHI '09)*, pp. 527–536. New York: ACM Press. <http://dx.doi.org/10.1145/1518701.1518783>.
- Sheldon, O. J., Thomas-Hunt, M. C., & Proell, C. A. (2006). When timeliness matters: The effect of status on reactions to perceived time delay within distributed collaboration. *Journal of Applied Psychology*, 91, 1385–1395. <http://dx.doi.org/10.1037/0021-9010.91.6.1385>.
- Sproull, L., & Kiesler, S. (1986). Reducing social context cues: Electronic mail in organizational communication. *Management Science*, 32(11), 1492–1512.
- Tapasak, R. C., Roodin, P. A., & Vaught, G. M. (1978). Effects of extraversion, anxiety, and sex on children's verbal fluency and coding task performance. *The Journal of Psychology*, 100(1), 49–55.
- Thurlow, C., Lengel, L. B., & Tomic, A. (2004). *Computer mediated communication: Social interaction and the Internet*. Sage Publications Ltd.
- Toma, C. L. (2010). Perceptions of trustworthiness online: The role of visual and textual information. *Proceedings of the 2010 ACM conference on computer supported cooperative work (CSCW '10)*, pp. 13–22. New York: ACM Press. <http://dx.doi.org/10.1145/1718918.1718923>.
- Van Hiel, A., De Cremer, D., & Stouten, J. (2008). The personality basis of justice: The five factor model as an integrative model of personality and procedural fairness effects on cooperation. *European Journal of Personality*, 22(6), 519–539. <http://dx.doi.org/10.1002/per.691>.
- Vrij, A., Mann, S. A., Fisher, R. P., Leal, S., Milne, R., & Bull, R. (2008). Increasing cognitive load to facilitate lie detection: The benefit of recalling an event in reverse order. *Law and Human Behavior*, 32(3), 253–265.
- Walther, J. B. (1992). Interpersonal effects in computer-mediated interaction – A relational perspective. *Communication Research*, 19(1), 52–90. <http://dx.doi.org/10.1177/009365092019001003>.
- Walther, J. B. (2002). Time effects in computer-mediated groups: Past, present, and future. In P. Hinds & S. Kiesler (Eds.), *Distributed work* (pp. 235–257). Cambridge, MA: MIT Press.
- Walther, J. B. (2011). Theories of computer-mediated communication and interpersonal relations. In M. L. Knapp & J. A. Daly (Eds.), *The SAGE handbook of interpersonal communication* (4th ed., pp. 443–479). Thousand Oaks, CA: Sage.
- Walther, J. B., & Parks, M. R. (2002). Cues filtered out, cues filtered in. In M. L. Knapp & J. A. Daly (Eds.), *Handbook of interpersonal communication* (pp. 529–563). Thousand Oaks, CA: Sage.
- Walther, J. B., & Tidwell, L. C. (1995). Nonverbal cues in computer-mediated communication, and the effect of chronemics on relational communication. *Journal of Organizational Computing*, 5, 355–378. <http://dx.doi.org/10.1080/10919399509540258>.
- Wilson, J. M., Straus, S. G., & McEvily, B. (2006). All in due time: The development of trust in computer-mediated and face-to-face teams. *Organizational Behavior and Human Decision Processes*, 99(1), 16–33. <http://dx.doi.org/10.1016/j.obhdp.2005.08.001>.
- Yechiam, E., & Barron, G. (2003). Learning to ignore online help requests. *Computational & Mathematical Organization Theory*, 9(4), 327–339. <http://dx.doi.org/10.1023/B:CMOT.0000029054.93142.2b>.