ASYNCHRONY, PROMOTIVE INTERACTION, AND TRUSTWORTHINESS
IN COMPUTER-MEDIATED COOPERATIVE LEARNING

By

Amy T. Peterson

A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

Educational Psychology and Educational Technology—Doctor of Philosophy

2020

ABSTRACT

ASYNCHRONY, PROMOTIVE INTERACTION, AND TRUSTWORTHINESS
IN COMPUTER-MEDIATED COOPERATIVE LEARNING

By

Amy T. Peterson

The positive effects of cooperative learning are well-documented in face-to-face environments, but its efficacy in asynchronous online environments remains unclear. Recent experimental research suggests that, compared to face-to-face and synchronous versions of cooperative learning, motivation, achievement, and cooperative perceptions all decrease under asynchronous online conditions (e.g., Peterson & Roseth, 2016; Roseth et al., 2011; Saltarelli & Roseth, 2014). This raises questions about how and why this occurs. The purpose of this dissertation study was to clarify this issue by testing whether asynchrony decreases reciprocity, operationalized as promotive interaction and trustworthiness, and moderates the association between cooperative goals and cooperative outcomes. More specifically, this study used a repeated-measures experimental–control design to compare the effects of two types of media (synchronous and asynchronous text) on two reciprocal processes (trustworthiness and promotive interaction) associated with cooperative learning and its outcomes (perceived interdependence, peer relationships, psychological health). Results indicate that asynchrony affects promotive interaction in a way that disrupts the processes that occur in cooperative learning. Results inform theory by providing a more fine-grained analysis of the effect of asynchrony on social interdependence, demonstrating that the positive relationships found between variables in face-to-face cooperative learning are also found in asynchronous cooperative learning, although in some cases, asynchrony changed the way they relate to each other over time by decreasing the relationship over time. Results also inform practice by indicating that the effects of asynchrony generalize to an actual online

course in which students work together on multiple cooperative discussions over a semester

in a cooperative discussion activity that uses outcomes interdependence.

ACKNOWLEDGEMENTS

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

The continued growth of online instruction highlights the need to ensure the efficacy of this form of education. As of 2017, 17.6% of students took some online courses (Ginder et al., 2018) and one in six (16.67%) postsecondary students were enrolled exclusively online. In total, this constitutes an online student population of over 6.5 million students.

Cooperative learning, defined as students working together in small groups to help each other learn, has a deep and rich empirical literature supporting its positive effects on motivation and achievement, interpersonal relationships, and psychological health (Johnson & Johnson, 2005). These effects are well-documented in face-to-face cooperative learning, but the efficacy of asynchronous online cooperative learning is less clear. Recent experimental research suggests that, compared to face-to-face and synchronous versions of cooperative learning, motivation, achievement, and cooperative perceptions all decrease under asynchronous online conditions (Peterson & Roseth, 2016; Roseth et al., 2011; Saltarelli & Roseth, 2014). These findings suggest that asynchrony decreases the efficacy of cooperative learning.

How might asynchronous online media make some cooperative activities less successful than others? One explanation involves the way asynchrony affects *reciprocity,* defined as the process of mutual beneficial exchange that regulates interpersonal interactions and leads participants to information sharing and self-disclosure (Burgoon et al., 1993). Indeed, one of the most fundamental questions in communication research is how different types of synchrony affect reciprocity, which is known to be susceptible to different contextual factors. For example, in asynchronous online communities, research indicates that reciprocal patterns of exchange can influence promotive interaction and perceived trustworthiness, both of which play critical roles in cooperative learning (e.g., Balliet & Van Lange, 2013; Crocker & Canevello, 2008; Johnson & Johnson, 2005).

According to Deutsch (1985), *promotive interaction*, defined as individuals facilitating each others' goal achievement, has a reciprocal relationship with cooperation because one promotive act both confirms cooperative perceptions and begets further promotive interaction. For example, in synchronous cooperative learning, one student might ask a question related to the cooperative task, to which a second student responds by sharing helpful information. This response prompts the first student to respond with both a 'thank you' and a helpful suggestion for how this information applies to other aspects of the task. Simply put: reciprocating helpfulness is thought to prompt continued helping in the future.

How might this scenario change under asynchronous online conditions? One explanation is that the time lag between promotive interaction (e.g., requesting help, providing help, responding gratefully) changes perceptions of *trustworthiness*, an antecedent of trust that refers to a truster's expectations of a trustee (Mayer et al., 1995). Theory suggests that trustworthiness has a reciprocal relationship with cooperation because it increases individuals' willingness to cooperate with each other, which in turn also increases trustworthiness (Deutsch, 1958; 1960). But in asynchronous online settings, the time lag between asking for help and reciprocation might also stimulate uncertainty about trustworthiness because, as time passes without a response, more and more evidence accrues of non-reciprocated help (Jarvenpaa & Leidner, 1999; Sarker & Sahay, 2004), making students less willing to cooperate in the future.

Purpose of the Study and Conceptual Framework

Advancing prior research, this dissertation is the first to examine the effect of asynchronous online communication on promotive interaction *and* perceived trustworthiness. So doing, this study goes beyond general hypotheses about 'changes in reciprocity' and examines specific behaviors (promotive interaction) and social perceptions (trustworthiness) thought to underly asynchrony's effects on cooperative learning.

More specifically, this dissertation uses an experimental design to address the broad research question: Does asynchronous communication decrease reciprocity in online cooperative learning in the form of promotive interaction and perceived trustworthiness? Specific hypotheses are derived from theories in computer-mediated communication (CMC), cooperative learning, and trust literatures.

Clarifying the way asynchrony affects online cooperative learning has the potential to contribute to theory and practice in at least four ways. First, the dissertation goes beyond the more common ways that past research has operationalized reciprocity in asynchronous contexts (e.g., self-disclosure, information sharing, social capital, message length) by testing whether hypothesized effects on reciprocity manifest themselves in measures of promotive interaction and trustworthiness.

Second, the dissertation also has the potential to extend cooperative learning theory and research by clarifying how online asynchrony affects promotive interaction and trustworthiness. This is important because promotive interaction and trustworthiness have long been theorized to be important within the *face-to-face* cooperative learning literature but have never been examined in online asynchronous cooperative learning.

Third, this dissertation will also be the first to describe the specific types of promotive interaction that occur in synchronous and asynchronous cooperative learning. This is important because researchers and practitioners need to know how students actually behave when working together on cooperative tasks under synchronous and asynchronous conditions. It is also important because different patterns of behavior may suggest specific strategies for increasing the efficacy of asynchronous cooperative learning.

Finally, fourth, this dissertation extends prior research by testing whether asynchrony's effects on cooperative learning outcomes (e.g., social interdependence, psychological health, and interpersonal relationships) generalize to a novel form of online

cooperative learning – an ongoing discussion activity in which students discuss and then integrate their individual ideas into a single cooperative response.

LITERATURE REVIEW

To provide a framework for the problem of cooperation in asynchrony, this literature review begins with a brief overview of the attributes of computer-mediated communication (CMC) and social information processing theory. I then review theory and research on the way promotive interaction and trustworthiness relate to asynchrony and cooperation. Finally, I describe cooperative learning outcomes and their relationship to promotive interaction and trustworthiness. Figures A1-A6 in Appendix A provide a conceptual summary of the hypothesized way that asynchrony affects trustworthiness, promotive interaction, and cooperative learning outcomes.

Computer-mediated Communication (CMC)

In asynchronous online settings, interaction takes place via CMC in the form of email, text chatting, discussion forums, social media, and/or interaction in virtual worlds, which are different mediums offering different behavioral options and communication processes than are available in synchronous contexts. Indeed, the huge variability in CMC technology (e.g., email, text messaging, social media, discussion forums) and the incredible speed with which these technologies evolve requires that users adopt whatever form of media best serves their communication needs (Walther, 2009). As a result, research on the effects of different CMC technologies tends to focus on the technological affordances of different media rather than specific technologies (Walther, 2009).

One way to classify the different affordances of CMC technology is by using Clark and Brennan's (1991) eight-part typology. Referring to the primary temporal aspects of the medium are cotemporality, simultaneity, and sequentiality. *Cotemporality* exists when the message is sent and received without a delay. This concept contributes to the immediacy of feedback, which is how rapidly a participant can respond to a message (Dennis, 2009). *Simultaneity* and *sequentiality* contribute to the immediacy of feedback as well. The ability

for all participants to send and receive messages at the same time is simultaneity, and sequentiality indicates that the participants take turns, do not get out of sequence, and are not interrupted by different conversations. Media that provide all three affordances are synchronous, and those that do not are asynchronous (Kraut et al., 2002). Synchronous, or real-time, communication allows participants to verify understanding quickly and avoid misunderstandings (Maruping & Agarwal, 2004), and can be text-based (e.g., instant messenger, texting), audio-based (e.g., conference calls, audio-only web-conference), or video-based (e.g., video-conferencing, Skype, GoogleHangout). Asynchronous communication involves a slower rate of communication than face-to-face contexts (Walther, 1992), which decreases copresence compared to synchronous contexts (Nowak et al., 2009). However, asynchronous CMC also affords more time to carefully craft and review messages before sending them (Clark & Brennan, 1991; Berry, 2011).

Focusing on the temporal aspects of CMC, Walther's (1992) social information processing (SIP) theory posits that the nature of asynchronous message exchange is slower than synchronous, and the rate at which participants form impressions of each other also occurs more slowly. However, given time and the accumulation of messages, asynchronous participants can still achieve levels of relational development that are similar to synchronous participants. SIP theory also contends that participants adapt to the affordances of the media by conveying nonverbal relational and emotional cues (e.g., emoticons) in their text-based messages (Ramirez et al., 2007; Walther, Bunz & Bazarova, 2005; Walther, Loh, & Granka, 2005).

According to SIP, *chronemics*, timing cues in conversations, are used to exchange social information (Walther, 2002) and influence impressions formation (Kalman & Rafaeli, 2011; Sheldon et al., 2006). One timing aspect in particular, length of pauses, is of interest for this dissertation because the length of pauses is associated with responsiveness (Kalman et

al., 2013). Walther and Tidwell (1995) demonstrated that delays in responses affect perceptions of intimacy and affection. Participants conveyed more intimacy and affection in social exchanges than in task-related exchanges, and longer response delays resulted in greater intimacy in social exchanges but decreased intimacy in task-related exchanges.

In short, this literature suggests that both time (e.g., time lag, length of pauses) and the purpose of communication (e.g., task, social) moderate the effects of different forms of CMC. Consequently, SIP indicates that rather than attribute different outcomes to different CMC affordances, what is truly determinant is whether users have "sufficient" time to adapt their use of one type of CMC (e.g., asynchronous) to achieve the same results as another. What remains unclear, however, is what constitutes "sufficient time," particularly in the context of online cooperative learning activities that take place during a semester-length online course. In this real-world context, instructors set different expectations for when to respond to messages, and different students tend to have different views about what constitutes sufficient time – e.g., having 48 hours to respond to a classmates' post may be sufficient for some students but not others, depending on the way they manage their time and/or the number of other demands on their time (e.g., a job, children, etc.). Indeed, one might argue that both having *and* utilizing sufficient time to communicate in a way that overcomes the constraints of asynchronous CMC (e.g., crafting a response, using emoticons to express emotional cues) may be more the exception than the rule in real-life online learning because online students must self-regulate how and when they use their time (Kreijns et al., 2013).

For this dissertation study, what this literature suggests is that the effects of asynchrony on trustworthiness and promotive interactions should be understood within the real-world context in which they occur. While it may be the case that providing students with "sufficient" time changes the way asynchrony affects promotive interaction, in the field it is

also reasonable to assume that what constitutes having and utilizing sufficient time is likely to vary across students. As a result, examining promotive interaction and trustworthiness in the real-world context of an actual semester-length online course will provide much needed information about the way specific synchronous and asynchronous contexts affect reciprocity in online cooperative learning.

Reciprocity

Reciprocity refers to the social norm of responding in kind to the benefits one individual receives in an exchange with another (Gouldner, 1960). In its universal form, reciprocity follows two precepts: individuals should reciprocate the help they have received, and they should not harm those who have helped them. Defined this way, reciprocity suggests a direct exchange between individuals, but it can also refer to indirect exchange in which the reciprocation is delayed or occurs in a unit larger than a dyad (Molm, 2010). For example, in a three-person group, one person might provide a benefit to a second person. But rather than reciprocate the benefit directly to the first person, the second person might provide a benefit to a third person, resulting in an indirect or generalized reciprocation. Qualitative differences in prosocial behavior also affect the quality of reciprocal response. For example, research suggests that, early in a relationship, the likelihood that one individual will reciprocate help depends on the perceived utility of the help (Molm, 2008), such that superficial help is less likely to beget reciprocation.

In communication, reciprocity is defined as an adaptive behavioral process in which the messages exchanged are of similar functional value (Burgoon et al., 1993). In this process, each communication partner directs behaviors at the other, and both partners exhibit behavioral change caused by each other's behavior. Although the behaviors may be different, the functional value of the message (e.g. information sharing, affection, conversation management) is assumed similar.

Reciprocity serves as a stabilizing function in communication, especially at the outset of group interaction. Failure to reciprocate is viewed negatively, which makes it a strong motivator of behavior, even in online environments (Gao et al., 2010; Matschke et al., 2014). For example, in Pai and Tsai's (2016) study of an online consumer recommendation community, they found that the norm of reciprocity was positively related to information sharing behavior. Chiu et al. (2006) found similar results in an online IT-professional community in which the norm of reciprocity had a significant effect on the quantity of information shared.

Promotive Interaction

As noted earlier, one form of reciprocation thought to be particularly important in cooperative learning is *promotive interaction,* which is defined as individuals facilitating each others' goal achievement (Deutsch, 1985) and includes both *academic support,* which refers to ways that one student enhances another student's academic success (e.g., sharing information, providing help and feedback), and *personal support,* which refers to ways that students can provide each other with personal encouragement. According to research in cooperative learning, these two forms of promotive interaction have a powerful effect on students' motivation, psychological health, and relationships (Johnson & Johnson, 1989). This study extends prior work by examining the effects of asynchrony on promotive interaction.

Promotive interaction and asynchrony. Fahy (2003) identified that students use a variety of support strategies in asynchronous communication, although individuals vary considerably in what strategies they use and the extent to which they use them. In Kreijns et al.'s (2003) literature review of promotive interaction in asynchronous environments, they identify two pitfalls: (a) interaction patterns do not automatically occur because the technology allows for interaction, and (b) lack of opportunity for social interaction will limit

the functioning of the group. Although cooperative learning requires interaction focused on the task and the team, research has found that team-focused, personal interaction is far less frequent in asynchronous communication (Schellens & Valcke, 2005) and varies based on the events (e.g., term breaks, exams) occurring in the course (Abedin et al., 2014). These findings suggest that asynchrony may affect academic support and personal support differently. Specifically, personal support may be less sensitive to a lack of reciprocity because students expect it to ebb and flow based on the events occurring in the course.

Within the communications literature, studies suggest that asynchrony may interfere with promotive interaction. For example, in a retrospective study, Lewandowski et al. (2011) explored the effect of communication medium on the effectiveness of social support that military personnel received during a negative event. Subjects identified a negative event, the person from whom they received the most social support, and the form of communication used to provide the support (i.e., face-to-face or asynchronous CMC). The authors found that individuals who received face-to-face support felt less disruption from the negative event compared to those who received CMC support. Although this study did not examine social support within a cooperative learning activity, it suggests that social support may be affected by asynchronous CMC.

Hypothesis 1.1: *Asynchrony will result in lower levels of promotive interaction than synchrony* (Figure A2).

Promotive interaction and cooperation. Within the cooperation literature, reciprocation strategies have been shown to elicit cooperation (Van Lange et al., 2013). Indeed, Deutsch (1985) hypothesizes that cooperative perceptions and promotive interaction are reciprocally related, forming a "benign spiral" in which promotive interaction (e.g., helping, sharing) increases cooperative perceptions and, in turn, promotive interaction. Likewise, Deutsch (1985) also hypothesizes that competitive perceptions induce a

"destructive spiral" in which oppositional interaction (e.g., obstructing progress, restricting resources) increase competitive perceptions, which further induce oppositional interaction.

Cooperation requires groupmates to communicate in a way that goes beyond mere interaction or discussion. In cooperation, individuals facilitate others' efforts by using promotive interaction to provide help, feedback, and information. They also challenge each other's ideas, influence each other, and stimulate cognitive processing (Johnson & Johnson, 1989). Promotive interaction, therefore, provides several benefits to students: it strengthens students' understanding of material by explaining and rehearsing information; it increases mastery by requiring students to explain, elaborate, and summarize; and it asks individuals to engage in perspective taking which helps students understand and retain information and reasoning.

While decades of research on face-to-face cooperation indicate that cooperative experiences lead to more personal and academic support than competitive and individualistic experiences (Johnson & Johnson, 1989, 2005), few prior studies have examined promotive interaction in online cooperative learning, treating it instead as an assumed process rather than a variable that has the potential to moderate outcomes. One notable exception is a study by Weidman and Bishop (2009) that used a qualitative case study design to examine undergraduate and graduate students' experiences in an asynchronous online version of the cooperative learning activity, *Jigsaw.* Results showed that most students' online postings in an asynchronous cooperative assignment lacked interaction and that several students lacked the social skills to resolve conflicts, which led to a breakdown in promotive interaction over time. In fact, during each Jigsaw activity, only half of the students completed all of the requirements, often skipping the components that involved cooperation. Results also showed that only one of the study's many discussion groups achieved "rich" social interaction.

It follows from this research that even though theory suggests that promotive interaction increases cooperative perceptions, asynchrony may interact with this process in a way that still diminishes promotive interaction over time.

Hypothesis 1.2: Promotive interaction will correlate positively with cooperative perceptions, but asynchrony will still decrease promotive interaction over time (Figure A2).

Trustworthiness

A second type of reciprocal process, trustworthiness, also plays a central role in cooperative learning. *Trustworthiness* is an antecedent of trust and refers to a truster's expectations of a trustee. Mayer et al. (1995) conceptualized 3 components of trustworthiness: ability, benevolence, and integrity. *Ability* is an assessment of the trustee's skills and competencies. *Benevolence* is an affective assessment in which the trustor assesses the trustee's willingness to put aside personal motives to help the group. And *integrity* refers to an assessment of whether the trustee will adhere to principles that the trustor accepts. The basic premise is that high ability, benevolence, and integrity increase an individual's level of trustworthiness, which in turn increases others' willingness to place their trust in that individual.

Although reciprocity is necessary for trust, it does not guarantee the development of trust (Serva et al., 2005). Kunnel and Quandt (2016) suggest that actual or perceived reciprocity both benefit from the development of trust, such that even the expectation of reciprocal trust predicts trusting behavior (see e.g., Dunning et al., 2014).

Trust is especially important during early interaction when participants form initial impressions of one another. During initial interaction, participants are uncertain of how their communication partners will interact, so they seek to increase the predictability of each other's behavior and, so doing, increase trustworthiness (De Jong et al., 2016). Crisp and Jarvenpaa (2013) conducted a quasi-experimental study in which undergraduate and graduate

students spent eight weeks cooperatively developing a business plan using email, a listserv, and chat tools. They found that early trusting beliefs gave participants the confidence to engage in normative actions such as discussing interaction expectations and monitoring one another's performance.

Trustworthiness and asynchrony. Early research in trustworthiness in CMC asked the question of whether trustworthiness could even exist in asynchronous CMC. To address this issue, Jarvenpaa and Leider (1999) used a case study method to identify the behaviors that elicit trust in global teams of graduate students who used email to complete three cooperative projects over six weeks. The authors measured trustworthiness after the groups had been working together for two weeks and again at the end of the six weeks. Results showed that trustworthiness could be developed and maintained with predictable communication and substantial and timely responses. This suggests that trustworthiness is definitely possible in asynchronous CMC, but is nonetheless susceptible to the effects of the medium because group members can misinterpret others' behavior (e.g., slow responses) and messages (Bergiel et al., 2008), and so doing limit both promotive interaction and cooperation (Hsu et al., 2011; Johnson & Johnson, 1996).

Research also suggests that longer response delays are associated with lower trustworthiness (Kalman et al., 2010; Porter & ten Brinke, 2010; Vrij et al., 2008), and responsiveness is correlated with higher levels of trust (Ridings et al., 2002). For example, in Vrij et al.'s (2008) face-to-face laboratory experiment, participants who adopted the role of liar spoke more slowly, hesitated more, and made more speech errors than those who adopted the role of truth teller, which are all behavioral indicators of being untrustworthy. Likewise, Kalman et al.'s (2010) laboratory study examined the time elapsed between instant message posts in a dyad. They found a correlation between low trust and longer response times but did not identify the causal relationship. Ridings et al. (2002) conducted a descriptive field study,

collecting survey data from users of electronic bulletin boards. They found that trustworthiness was correlated to self-reported perceptions of responsiveness.

To accelerate effective asynchronous interaction behaviors and increase trust in ad hoc online groups, Walther and Bunz (2005) tested a set of rules to structure communication and quickly establish norms in a quasi-experiment. Students who adhered to the rules reported higher levels of trust, respect, and liking for others in the group. Three of the rules (communicating frequently, being explicit, and sticking to deadlines) were the most influential in predicting trust, respect, and liking, although the authors note that mere rule-following may be beneficial.

A meta-analysis and a descriptive, social network study also suggest that trustworthiness may affect asynchronous cooperation. First, in a recent meta-analysis of 52 studies of trustworthiness in teams, Breuer et al. (2016) compared mixed synchrony and face-to-face teams and found that documentation of interaction moderated the relationship between trustworthiness and team performance. The authors attribute this result to the perception of reduced risk on the part of the trustor who can reprocess information with the documented interaction. This suggests that asynchrony's effect on the relationship between trustworthiness and cooperation increases when participants do not have access to interaction documentation. As detailed further below, this is often the case in online learning contexts where students do not have access to interaction documentation.

In a descriptive study, Sarker et al. (2011) examined the relationship between trustworthiness and cooperation in asynchronous contexts, focusing specifically on the relationship between trust and performance in virtual teams. Taking a social network perspective, the researchers used degree centrality as an indicator of team members' trust and communication and tested three models (additive, interaction, and mediator) of how trust and

communication work together to predict performance. The results supported a mediated model in which trust mediated the relationship between communication and performance.

Collectively, these studies suggest that trust plays a critical role in CMC and promotive interaction and that longer response times (i.e., the pauses present in asynchronous communication) are associated with lower levels of trust. However, the generalizability of these findings to online cooperative learning remains unclear, particularly because the time-lag between interactions is so highly variable in the field. Also, because these lab-based studies focused on the early interaction of strangers, it remains unclear whether they generalize to an online learning setting where cooperative learning activities can be extended over several weeks during an online course. This dissertation study therefore extends the literature by examining the role of trustworthiness in cooperative learning in a field-based study.

Hypothesis 2.1: *Asynchrony will result in lower levels of trustworthiness than synchrony (Figure A3).*

Trustworthiness and cooperation. Trustworthiness is closely related to cooperation and promotive interaction because it reduces ambiguity and uncertainty (Dirks & Ferrin, 2001; Johnson & Johnson, 1989) and, so doing, increases participants' willingness to engage in risk-taking (Jarvenpaa & Leidner, 1998; Mayer et al., 1995), presumably by creating the perception that there is reciprocity between the participants (Kunnel & Quandt, 2016). As noted previously, trustworthiness also has a reciprocal relationship with cooperation, with trustworthiness facilitating cooperation and, in turn, increased cooperation facilitating greater trustworthiness (Deutsch, 1985; Ferrin et al., 2008).

Trustworthiness also supports information exchange, which is an important part of promotive interaction. High levels of trustworthiness are correlated with sharing ideas because students feel they can discuss their ideas openly in trusting environments (De Hoyos

Guevara, 2004; Ridings et al., 2002; Staples & Webster, 2008). Trustworthiness also helps to reduce uncertainties, which allows team members to work together more effectively. A meta-analysis of student and work teams found that the relationship between trust and team performance was higher in high interdependence (DeJong et al., 2016), and trust uniquely predicts performance beyond the team's past performance with each other.

Within the cooperative learning literature, research has shown that trustworthiness relates to cooperative processes in multiple ways. For example, Hsu et al. (2007) surveyed participants in 39 virtual communities and found that trust predicted information exchange. Hsu et al. (2011) also conducted a field study of undergraduate students who worked collaboratively on case studies in an asynchronous web-based system, finding that trust in team members and norms of collaboration predict helping behaviors.

Ennen et al. (2015) investigated whether trust was associated with group outcomes in synchronous and asynchronous psychology courses. They found that high levels of trust predicted higher levels of achievement, group satisfaction, and motivation in cooperative learning. But midway through the course, asynchronous online groups had lower levels of trust than face-to-face groups, although this difference disappeared by the end of the course. These findings suggest that trust may develop more slowly in asynchronous CMC than face-to-face communication.

Taken together, these studies suggest that trust supports cooperative learning by increasing information exchange and helping behaviors, but asynchronous CMC may diminish the link between trust and cooperation early on.

Hypothesis 2.2: Perceptions of trustworthiness will correlate positively with cooperation, but asynchrony will diminish the magnitude of this correlation early in the semester (Figure A3).

Cooperative Learning Outcomes

Testing the generalizability of prior research, this study utilizes a cooperative learning activity based on a different form of positive interdependence than other studies on online cooperative learning. To understand this distinction, however, it is first necessary to review Deutsch's theory of social interdependence.

According to Deutsch (1949, 1985; see also Johnson & Johnson, 1989, 2005), the extent to which individuals' actions influence each other determines both the quality and outcome of those interactions. Cooperation occurs when *positive interdependence* exists and individual actions positively influence others. Competition occurs when *negative interdependence* exists and individual actions negatively influence others. And individualism occurs when no social interdependence exists and individual actions have no impact on others. Literally hundreds of experimental studies have documented the differential effects of cooperation, competition, and individualism on achievement, motivation, and psychological health (for meta-analytic reviews, see e.g., Johnson & Johnson, 1989, 2005; Johnson et al., 2014, Roseth et al., 2008).

It follows from social interdependence theory that if asynchrony changes students' perceptions of cooperation, competition, and individualism, then the outcome of cooperative learning methods should also change. Supporting this view, several experimental studies have shown that asynchronous online versions of cooperative learning increased individualistic perceptions (Roseth et al., 2011; Saltarelli & Roseth, 2014) and competitive perceptions (Saltarelli, 2012) and reduced motivation and achievement compared to face-to-face and synchronous CMC versions.

The present study extends this line of research by testing whether the same pattern of results emerges when using a different form of cooperative learning. Examining this issue is important because theory and research suggest that different forms of positive

interdependence also result in qualitatively different forms of cooperation and, in turn, outcomes (Johnson & Johnson, 1989). For example, the cooperative learning activity *Jigsaw* (Roseth, Lee, and Saltarelli, 2019; Weidman & Bishop, 2009) involves *means interdependence,* which is a form of positive interdependence structured by distributing unique resources to each member of a cooperative group. When means interdependence exists, individuals must acquire each others' resources to achieve their goal, which stimulates a limited form of cooperation in which individuals strive to gain access to each other's resources but minimize the extent to which they share their own (Roseth, Lee, & Saltarelli, 2019). As a result, means interdependence tends to stimulate mixed motives for cooperation, competition, and individualistic efforts as students seek to benefit personally from others but have no real stakes in each other's success.

In contrast, cooperative learning activities like the one used in this study involve *outcome interdependence,* which exists when group members share the same goal or reward for completing the activity. When outcome interdependence exists, students are motivated to promote their groupmates' success because they know it will also benefit themselves (Bertucci et al., 2011). After all, whether one individual achieves the goal and/or receives the reward depends on the success of others. Supporting this view, research comparing asynchronous and synchronous students engaged in an outcomes interdependence activity found no difference in interdependence perceptions between the groups (Peterson et al., 2018; Peterson & Roseth, 2016).

Jigsaw (e.g., Weidman & Bishop, 2009), which involves means interdependence, and *Constructive Controversy,* which involves a mix of competitive and cooperative motives (e.g., Roseth et al., 2011; Saltarelli & Roseth, 2014) have found higher competitive and individualistic perceptions in asynchronous students. These studies may conflate asynchrony's effects with mixed-motive activities that are particularly vulnerable to the

effects of time lags. To clarify these mixed findings, this dissertation study used a cooperative learning activity that solely involves outcome interdependence to avoid eliciting mixed motives. In addition, this study's cooperative learning activity also provided students with specific behavioral directions to encourage promotive interaction, which is highly recommended in the communications literature (Walther & Bunz, 2005) but not utilized in prior research on online cooperative learning.

Hypothesis 3.1a: Asynchrony will result in lower levels of cooperation than synchrony.

Hypothesis 3.1b Asynchrony will result in higher levels of competition than synchrony.

Hypothesis 3.1c Asynchrony will result in higher levels of individualism than synchrony (Figure A4).

Deepening the investigation into asynchrony's effect on cooperative learning, this study also explored whether asynchrony diminishes the method's expected positive effect on students' sense of belonging and psychological health.

Belonging. According to theory (Deutsch, 1949, 1985; Johnson & Johnson, 1989, 2005) and research (Roseth et al., 2008; Saltarelli & Roseth, 2014), cooperation increases students' sense of belonging as the positive feelings associated with achieving one's goal generalize to those that you helped you do so. *Belongingness* refers to frequent, positive interaction with others that occurs within the context of an enduring relationship of mutual caring (Baumeister & Leary, 1995). Prior research focusing specifically on online cooperative learning also links asynchrony to lower levels of belonging (Bedell, 2016; Saltarelli & Roseth, 2014).

Hypothesis 3.2: Asynchrony will result in lower levels of belonging than synchrony (Figure A5).

The results of two descriptive studies also link promotive interaction to students' sense of belonging (Meeuwisse et al., 2010; Zumbrumm et al., 2014). For example, in a study of first-year university students, Meeuwisse et al. (2010) identified both formal and informal peer interaction (including, help, feedback, and social support) as antecedents of belonging. As such, another way that asynchrony may diminish cooperative learning's outcomes is by diminishing the hypothesized link between promotive interaction and students' sense of belonging.

Hypothesis 3.3 Promotive interaction will correlate positively with belonging, but asynchrony will decrease the magnitude of this correlation over time (Figure A5).

Theory and research also indicate that perceived trustworthiness contributes to a sense of belonging within a group (Haines, 2014). For example, in an exploratory study of undergraduate students, Dumitru and Schoop (2016) identified a correlation between trustworthiness and sense of belonging to a team. In a similar study of first-year students working in prescribed learning communities, Brouwer and Jansen (2019) found a correlation between trustworthiness and belonging in the learning communities. Thus, another way that asynchrony may affect cooperative learning's outcomes is by changing the nature of the hypothesized link between trustworthiness and students' sense of belonging over time by decreasing belonging when trustworthiness is not reciprocated due to time delays. In the absence of theory or prior research, this study explores the magnitude of this change without making a specific directional hypothesis.

Hypothesis 3.4: Trustworthiness will correlate positively with belonging, but asynchrony will change this association over time (Figure A5).

Psychological health. *Psychological health* refers to the ability to create and adapt interdependent relationships to achieve goals (Johnson & Johnson, 1989). Cooperative perceptions have a positive relationship with a wide variety of psychological health

indicators, include self-esteem, personal identity, and lower levels of stress and high-risk behaviors such as alcohol and tobacco use (Van Ryzin & Roseth, 2018a) and bullying and victimization (Van Ryzin & Roseth, 2018b. This dissertation explores two psychological health outcomes: emotion and stress. The first outcome, *emotion*, is defined as a short-lived, specific feeling that has a specific cause (Schunk et al., 2014) and can be positively (e.g., enthusiastic, happy, pleased) or negatively valenced (e.g., annoyed, anxious, frustrated, bored). In general, cooperation elicits positive emotions and inhibits negative emotions (Zschocke et al., 2015). The second outcome, *stress*, is defined as the tension created by circumstances or events that cause distress (Johnson & Johnson, 1999). In cooperation, participants solve problems together and provide social support, which helps them cope with stress (Van Ryzin & Roseth, 2018b).

No prior research has examined students' emotions or stress in an asynchronous online environment. But it follows from the discussion above that if asynchrony changes students' perceptions of cooperation, competition and individualism, then we would expect lower levels of positive emotions and higher levels of negative emotions and stress compared to synchronous forms of cooperative learning.

Hypothesis 3.5 Asynchrony will result in lower levels of positive emotions and higher levels of negative emotions and stress compared to synchrony (Figure A6).

Promotive interaction has also been linked to well-being. For example, in a study of university students working online in small groups, Xu et al. (2014) found that promotive interaction helped students manage their emotions. In particular, providing feedback and supporting one another were positively correlated with down-regulating negative emotions and up-regulating positive emotions. Promotive interaction's effect extends beyond emotion management and is correlated with positive emotions. Lawler et al. (2008) conducted a laboratory experiment with undergraduate students. They found that promotive interaction

produces positive emotions and satisfaction. Together these studies suggest that promotive interaction will correlate with students' well-being but the effect of asynchrony on this relationship remains unclear. In absence of theory or literature, the investigation into the effect is therefore exploratory.

Hypothesis 3.6 Promotive interaction will positively correlate with positive emotion, but asynchrony will change the way promotive interaction relates to positive emotions over time (Figure A6).

Trustworthiness has a reciprocal relationship with emotions. Positive emotions can support trust development, and positive emotions develop as emotions develop. Negative emotions can hinder trust development, and individuals can feel anger when expectations of trust are not met (Lewicki, et al., 2006; Lewis & Weigert, 1985). In a qualitative study of online university students, Allan & Lawless (2003) found a correlation between low trustworthiness and stress. Certain positive emotions (i.e., happiness and gratitude) are correlated with higher levels in semi-synchronous online activities (Scissors et al., 2009), and high levels of trust are associated with a greater use of positive emotion words when interacting in a game with a computer partner (Khawaji et al., 2013). Findings suggest the trustworthiness will be positively correlated with positive emotions. What remains unclear is whether asynchrony moderates this association. In absence of theory or literature, the investigation into the effect is exploratory.

Hypothesis 3.7 Trustworthiness will positively correlate with positive emotion, but asynchrony will change the way trustworthiness relates to positive emotions over time (Figure A6).

The Present Dissertation

In summary, while there is empirical evidence that asynchronous communication diminishes the link between cooperative goals and cooperative outcomes, less is known about

the social-psychological processes by which this occurs. Accordingly, this dissertation study contributes to theory by examining one possible mechanism underlying this diminished link. Specifically, this study tests whether asynchrony affects reciprocity, operationalized as promotive interaction and trustworthiness.

Because differences in students' motivation may affect how they use their available time in asynchronous discussions, it also important to control for differences in motivation in order to isolate the effect of asynchrony in this study. In this study, I therefore included interest, value, and self-efficacy as covariates in all analyses. Specifically, I controlled for *interest*, the psychological state of being fully engaged in an activity or task, and *value,* the perceived usefulness of the activity (Hulleman et al., 2008) based on prior research linking students cooperative perceptions to both variables (Bedell, 2016; Klautke, 2015; Wu et al., 2013). I also controlled for *self-efficacy,* defined as ones' belief that they can be successful at a task in a specific situation (Schunk, 1991), based on research also linking it to cooperation (Chu et al., 2014; Kerr & Kaufman-Gilliland, 1994; Pan & Wu, 2013).

METHOD

This study compared the effects of two types of media (synchronous and asynchronous text) on two reciprocal processes (trustworthiness and promotive interaction) associated with cooperative learning and its outcomes (perceived interdependence, belonging, and psychological health). The study used a repeated-measures experimental–control design in which participants were randomly assigned to experimental and control conditions. Participants remained in these conditions throughout the 16-week term of the experiment. Dependent measures were collected twice during the term, first at Week 8 and then again at Week 14.

Participants

The study was conducted in an asynchronous online education course at a public Midwestern university. Participants included 112 students (33 male, 69 female, 10 did not answer) from 2 online classrooms. Students were predominantly white (69%) and their ages ranged from 18-24 (2% were 25 or older). Most of the course participants were non-education majors (86%).

The course was taught by one instructor and 3 teaching assistants. Participants were recruited by the course instructor and teaching assistants through an announcement in the course's announcement section in the learning management system (LMS). Participants received extra credit for participation, and they had the option to earn the same amount of extra credit through an alternate assignment. In all, 91% of recruited students agreed to participate in the study (n = 65 synchronous, n = 47 asynchronous).

Procedure

The study took place during a semester-length (16-week) online education course. After individual students were randomly placed in course sections that were randomly assigned to asynchronous or synchronous cooperative learning conditions, the students were

24

then assigned to small groups of three to four students via stratified random assignment in the synchronous condition and random assignment in the asynchronous condition. Stratification within the synchronous condition was determined by availability for synchronous meetings. The group size of three to four students was chosen based on research that found that group size needs to be small (two to four members) to obtain meaningful interaction (Hill et al., 2009; Johnson & Johnson, 1999). Except for the synchronous group work within the synchronous condition, all other course activities were asynchronous.

All conditions. Beginning in Week 3 of the semester, students worked in their small groups using PrimaryPad to complete a cooperative learning assignment. Midway through the term (Week 9), students were randomly assigned to a new three- to four-person groups within the same course section and the same condition of synchrony.

Across the semester, students completed five cooperative activities in one small group and then were randomly assigned to a second group for another six cooperative activities. At the end of each group (i.e., after five activities for group one, and six activities for group two), students took a web-based survey about their experiences in that group. Appendix B shows the timeline of the cooperative activities and survey administration.

For each group assignment, all students were asked to post a response individually to a discussion prompt and then complete a cooperative learning activity involving information sharing and perspective taking within their small groups. This activity was structured in accordance with Johnson and Johnson's (1989) conditions that support effective cooperative learning. That is, positive outcome interdependence was structured by indicating that all group members must meaningfully participate to be successful (goal interdependence) and all group members will receive the same grade (reward interdependence). Individual accountability was maintained by keeping the groups size small (3-4 students) and observation of participation frequency by the teaching assistants. Promotive interaction was

encouraged in the group work instructions. Appendix C provides an example of an individual posting prompt and the corresponding instructions for cooperation.

In an effort to follow best practice, all students in all conditions were also instructed to follow three of Walther and Bunz's (2005) rules for supporting effective communication and enhancing trustworthiness within small groups. Specifically, students were instructed to (1) communicate frequently, (2) be explicit, and (3) stick to deadlines.

Finally, all students accessed identical course materials (e.g., readings, videos) in D2L. All students will also use PrimaryPad (Appendix D) to facilitate synchronous and asynchronous interaction within small groups. Students were given the same interaction guidelines for their group work (be explicit in what you are thinking or doing, communicate frequently, and set deadlines and stick to them), which are based in SIP theory. All students in all conditions received examples of how to operationalize these guidelines. Appendix E contains the instructions that students received for each of the two conditions.

Media conditions. In the synchronous text condition, students used PrimaryPad to meet synchronously for one hour each week, and those in the asynchronous text condition used the same software to meet asynchronously over the course of a week.

Measures

This dissertation assessed five categories of variables: control variables, promotive interaction, trustworthiness, and cooperative learning outcomes. With the exception of stress, all variables were based on scale items ranging from 1 (not at all) to 5 (very much so). Stress was based on scale items ranging from 0 (never) to 4 (very often). Tables F1-F6 in Appendix F show the specific items.

Covariates. To control for individual differences in student motivation, three motivation variables were assessed: situational interest, value, and self-efficacy. Situational interest ($\alpha = .91$) and value ($\alpha = .89$) were assessed using 5 items each (Hulleman et al.,

2008). Academic efficacy (5-items; $\alpha = .84$), competition was assessed using the Academic Efficacy scale of the Patterns of Adaptive Learning Survey (PALS) (Midgley et al., 1996).

Promotive interaction. Perceptions of promotive interaction were assessed using student academic support (4-items; Time 1 $\alpha = .86$; Time 2 $\alpha = .85$) and student personal support (5-items; Time 1 $\alpha = .93$; Time 2 $\alpha = .96$) subscales of the Classroom Life Instrument (Johnson et al., 1983). The items were modified to focus on the students' perceptions of their home group peers rather than the whole class.

Trustworthiness. Trustworthiness was assessed with 3 subscales (17 items) of Mayer and Davis' (1999) trustworthiness scale: ability (6 items; Time 1 $\alpha = .94$; Time 2 $\alpha = .95$), benevolence (5 items; Time 1 $\alpha = .87$; Time 2 $\alpha = .89$), and integrity (6 items; Time 1 $\alpha = .86$; Time 2 $\alpha = .81$).

Cooperative learning outcomes. Perceptions of social interdependence were assessed with the Social Interdependence Scale (Johnson & Norem-Hebeisen, 1977): cooperation (5-items; Time 1 $\alpha = .81$; Time 2 $\alpha = .84$), competition (5-items; Time 1 $\alpha = .87$; Time 2 $\alpha = .86$), and individualism (3-items; Time 1 $\alpha = .88$; Time 2 $\alpha = .93$). Student perceptions of belonging (Time 1 $\alpha = .87$; Time 2 $\alpha = .85$) consisted of six items ("When I was with my group members in this class, I felt like I belonged.") adapted from Furrer and Skinner's (2003) measure. Student perceptions of positive emotion (Time 1 $\alpha = .88$; Time 2 $\alpha = .90$) consisted of three items and negative emotion (Time 1 $\alpha = .74$; Time 2 $\alpha = .79$) consisted of four items ("While working with my group, I generally felt annoyed.") adapted from Linnenbrink's (2005) measure. Student perceptions of stress (Time 1 $\alpha = .85$; Time 2 $\alpha = .85$) consisted of four items ("In the last month, how often have you felt confident about your ability to handle your personal problems?") from Cohen et al.'s (1983) Perceived Stress scale.

Data Analyses

Following this study's repeated-measures experimental-control design, I used a series of linear mixed models (LMMs) to compare conditions while controlling for student motivation. Traditional methods of longitudinal data analysis such as repeated measures multivariate ANOVAs (MANOVAs) are not optimal for missing data, which is likely to occur when collecting data over a semester (Long & Pelligrini, 2003). LMMs accommodate missing data and data structures in which the number of observations varies for individuals. Additionally, LMMs accommodate dynamic covariates (e.g., changing levels of cooperation over time), which was important for this study as I expected time-varying interactions between variables. Thus, the present study used LMM to test the hypotheses.

For the hypotheses regarding asynchrony's effects on reciprocal processes and cooperative outcomes (H1.1, 2.1, 3.1, 3.2, and 3.5), LMMs were used to compare synchronous and asynchronous conditions. For the hypotheses regarding asynchrony's effects on the relationships between dependent variables over time (H1.2, 2.2, 3.3, 3.4, 3.6, and 3.7), LMMs were also used to examine the change over time of the covariates excluding interactions (i.e., Model 1) and including two- and three-way interactions (i.e., Model 2). For all LMMs, I used a "top-down" strategy for model building (West et al., 2007) that started with a model that included fixed effects for all of the covariates (including interactions between the covariates) and then using significance tests to determine if some fixed effect may be removed from the model. To estimate parameters and test statistics for the LMMs, I used the restricted maximum likelihood method (REML), the Kenward and Roger (1997) method for degrees of freedom, and a significance level, alpha =.05.

RESULTS

The results have been organized by the study's hypotheses and descriptive statistics are reported in Tables 1 and 2. To simplify the presentation of the results, I report the complete results in the tables and only the significant βs in the text.

Promotive Interaction

Synchrony. First, in Hypothesis 1.1, I predicted that asynchrony would result in lower levels of promotive interaction than synchrony. Results supported this hypothesis, as the asynchrony slopes for academic support ($\beta_5 = -.24$) and personal support ($\beta_5 = -.41$) were both negative and significant (Table 3), controlling for motivation and time.

Promotive interaction, cooperation, and moderation. I further hypothesized that promotive interaction would correlate positively with cooperative perceptions, but asynchrony would interact with this process in a way that diminishes promotive interaction over time (H1.2). Results partially supported this hypothesis for academic support, showing a statistically significant three-way interaction between asynchrony, cooperation, and time ($\beta_9 = -.32$, Table 4), controlling for motivation. As illustrated in Figure 1, this indicated that asynchrony's negative effect on academic support was moderated by cooperation and time. Specifically, initial levels of academic support varied dramatically as a function of cooperation, with above-average levels of cooperation being associated with higher levels of academic support, particularly among asynchronous students. But over time, asynchronous students also reported *lower* levels of academic support compared to synchronous students, with those asynchronous students reporting above-average levels of cooperation also reporting the steepest rate of decline in academic support.

Somewhat different results were found for personal support, with evidence of a statistically significant two-way interaction between asynchrony and cooperation ($\beta_8 = -.52$,

Table 4), controlling for motivation. As illustrated in Figure 2, this indicated that asynchrony's negative effect on personal support varied as a function synchrony and cooperative perceptions but not time. Specifically, only synchronous students reporting above-average levels of cooperation reported higher levels of personal support, with all other conditions reporting similar levels over time.

Taken together, the results (summarized in Figure 3) for promotive interaction provided only partial support for my hypotheses and suggest that synchrony interacts with cooperation differently for academic and personal support.

Trustworthiness

Synchrony. Next, in Hypothesis 2.1, I predicted that asynchrony would result in lower levels of trustworthiness than synchrony. Results partially supported the hypothesis for the main effect of asynchrony on the benevolence ($\beta_5 = -.40$) component of trustworthiness, but not for the ability or integrity components (Table 5). Specifically, results indicated that students in the asynchronous condition reported lower levels of the benevolence component of trustworthiness than those in the synchronous condition, but there was no evidence that the ability and integrity components of trustworthiness differed between synchronous and asynchronous conditions.

Trustworthiness, cooperation, and moderation. Next, I predicted that trustworthiness would correlate positively with cooperative perceptions, but asynchrony would interact with this process in a way that diminishes trustworthiness early on (H2.2). Results partially supported this hypothesis showing evidence of a positive relation between all forms of trustworthiness and cooperative perceptions (ability $\beta_4 = 0.54$, benevolence $\beta_4 = 0.62$, integrity $\beta_4 = 0.47$; Table 6), but no evidence of interaction between asynchrony, cooperation, or time. Thus, while there was evidence that trustworthiness correlated positively cooperative perceptions, the results (summarized in Figure 4) failed to support the

30

hypothesis that asynchrony changes the way promotive interaction relates to cooperative perceptions over time.

Cooperative Learning Outcomes

Social interdependence and synchrony. In the third set of hypotheses I tested whether asynchrony, compared to synchrony, decreased students' perceptions of cooperation and increased perceptions of competition and individualism (H3.1a-c). However, the results failed to support this hypothesis (Table 7 and Figure 5).

Belonging and synchrony. I also predicted that asynchronous students would report lower levels of belonging than synchronous students (H3.2). Results supported this hypothesis ($\beta_{6} = -.32$, Table 8), with students in the asynchronous condition reporting lower levels of belonging than those in the synchronous condition.

Belonging, promotive interaction, and moderation. I expected promotive interaction would correlate positively with belonging, but asynchrony would change the way promotive interaction relates to belonging over time (H3.3). As predicted, belonging was positively correlated to both forms of student support (academic, $\beta_{4} = .57$, and personal, $\beta_{4} = .40$; Table 9). And for academic support, there was also evidence of a two-way interaction between asynchrony and belonging ($\beta_{8} = -.26$). As illustrated in Figure 6, this indicated that asynchrony's negative effect on belonging was moderated by academic support and time. Specifically, above-average levels of belonging were associated with higher *initial* levels of academic support among both synchronous *and* asynchronous students, with asynchronous students reporting the highest initial levels of academic support regardless of belongingness. Over time, however, asynchronous students reported decreasing academic support while synchronous students reported increasing levels, regardless of belongingness, suggesting that belongingness enhanced overall levels of academic support but did not change the pattern of asynchronous decline over time.

31

There was no evidence of any interactions between belonging, time, and asynchrony for personal support, which suggests that asynchrony interacts with belonging differently for academic and personal support.

Belonging, trustworthiness, and moderation. I also predicted that trustworthiness would correlate positively with belonging, but asynchrony would change the way trustworthiness relates to belonging over time (H3.4). Controlling for motivation (efficacy, interest, value), there was evidence that belonging correlated positively with all three components of trustworthiness (ability, $\beta_4 = .61$, benevolence, $\beta_4 = .72$, and integrity, $\beta_4 = .62$; Table 10), but there was no evidence of interaction between synchrony, trustworthiness, and time (Table 10). Contradicting my hypothesis, this suggests that asynchrony did not affect the way trustworthiness relates to belonging over time. Figure 7 provides a conceptual summary of the results of asynchrony's effects on belonging.

Psychological outcomes and synchrony. In Hypothesis 3.5, I predicted that asynchronous interaction would result in lower levels of positive emotions and higher levels of negative emotions and stress. Results only partially supported this hypothesis, however, as asynchrony increased stress ($\beta_5 = .53$; Table 11) but had no significant effect on positive (Table 12) or negative emotions (Table 13).

Emotion, promotive interaction, and moderation. In Hypothesis 3.6, I predicted that promotive interaction would correlate positively with positive emotion, but asynchrony would change the way promotive interaction relates to positive emotion over time. Supporting this view, positive emotion correlated positively with both types of student support (academic, $\beta_4 = .34$, and personal, $\beta_4 = .34$; Table 14). For academic support there was a statistically significant three-way interaction between asynchrony, positive emotion, and time ($\beta_9 = -.44$), controlling for motivation. As illustrated in Figure 8, these results indicate that asynchrony's effect on positive emotions varied as a function of academic support.

32

Specifically, initial levels of academic support varied dramatically as a function of positive emotions, with above-average levels of positive emotions being associated with higher levels of academic support, particularly among asynchronous students. But over time, asynchronous students also reported *lower* levels of academic support compared to synchronous students, with those asynchronous students reporting above-average levels of positive emotions also reporting the steepest rate of decline in academic support.

Somewhat different results were found for personal support, with evidence of a significant two-way interaction between asynchrony and positive emotions ($\beta_8 = -.19$), controlling for motivation. As illustrated in Figure 9, this indicated that asynchrony's effect on positive emotions varied as a function of personal support but not time. Specifically, asynchronous students reported lower levels of personal support over time compared to synchronous students, but above-average levels of positive emotions were associated with higher levels of personal support among all students.

Emotion, trustworthiness, and moderation. In Hypothesis 3.7, I predicted that trustworthiness would correlate positively with positive emotion, but asynchrony would change this association over time. As predicted, positive emotion correlated positively to all three components of trustworthiness (ability, $\beta_4 = .29$, benevolence, $\beta_4 = .30$, and personal, $\beta_4 = .23$; Table 15). Results also indicated a three-way interaction between asynchrony, time, and positive emotion for ability ($\beta_9 = -.23$) and integrity ($\beta_9 = -.24$), but there was no evidence of an interaction for the benevolence component.

As illustrated in Figures 10 and 11, these results indicate that asynchrony's effect on the ability and integrity components of trustworthiness varied as a function of time and level of positive emotions. Specifically, initial levels of both ability and integrity trustworthiness varied as a function of positive emotions, with students reporting above-average levels of positive emotions also reporting above-average levels of ability and integrity trustworthiness.

33

But over time, asynchronous students also reported *lower* levels of both forms of trustworthiness compared to synchronous students, with those asynchronous students reporting above-average levels of positive emotions reporting the steepest rate of decline over time. Taken together, these findings support the hypothesis that asynchrony changes the way that trustworthiness relates to positive emotion over time. Figure 12 provides a conceptual summary of the results examining asynchrony's effects on positive emotions.

Finally, it is important to note that pattern of results for the way asynchrony's effect on trustworthiness was moderated by positive emotions and time were also found for the way asynchrony interacts over time with academic support and cooperation, academic support and belonging, and academic support and positive emotions (see Figures 1, 6, and 8, respectively). This suggests that (1) while cooperation, belonging, and positive emotions are all associated with higher-levels of promotive interaction, and positive emotions are associated with higher levels of ability trustworthiness, (2) asynchrony affects both initial and decreasing levels of academic support and trustworthiness (both ability and integrity) over time.

DISCUSSION AND SUMMARY

Although there is empirical evidence that asynchronous communication diminishes the link between cooperative goals and cooperative outcomes, less is known about the social-psychological processes by which this occurs. This dissertation therefore examined one possible mechanism by which this occurs by investigating whether asynchronous communication decreases reciprocity in online cooperative learning in the form of promotive interaction and perceived trustworthiness.

Promotive Interaction

The first set of hypotheses examined the effect of asynchrony on promotive interaction. I predicted that asynchrony would have deleterious effects on promotive interaction (H1.1) and change the way promotive interaction relates to cooperative perceptions over time (H1.2). Supporting Hypothesis 1.1, results showed that students in the asynchronous condition reported lower levels of both academic and personal forms of promotive interaction than students in the synchronous condition. These results are consistent with research reporting that asynchrony interferes with social support (Lewandowski et al., 2011) and suggest the same processes generalize cooperative learning situations.

Supporting Hypothesis 1.2, results also indicated that students reporting above-average levels of cooperative perceptions were especially susceptible to the effects of asynchronous interaction (Figures 1 and 2). That is, cooperation and academic support were similarly positively related among synchronous and asynchronous students (i.e., students reporting above-average levels of cooperation also reported above-average levels of academic support). But over time, asynchrony changed this association such that academic support decreased over time among asynchronous students, particularly among those reporting above-average levels of cooperation. In comparison, the differences in personal support between students reporting above-average levels of cooperation and those reporting

35

below-average levels were slight, and those levels did not decrease over time. This finding is consistent with research indicating that task and non-task focused interaction patterns differ from one another (Abedin et al., 2014; Schellens & Valcke, 2005). These results should be replicated to better understand whether they generalize to other settings and student population. The different patterns of academic and personal support will be revisited below in the discussion for belonging. These findings refine Weidman and Bishop's (2009) argument that asynchronous cooperative learning simply decreases promotive interaction and suggest that this process also depends on cooperative perceptions. These findings also suggest that simply encouraging promotive interaction by way of instructing students to follow effective communication practices (Walther & Bunz, 2005) may not be enough to prevent lower levels of promotive interaction in asynchronous cooperative learning.

What remains unclear from the study's results is why promotive interaction decreased most dramatically among asynchronous students reporting above-average levels of cooperative perceptions? One explanation is that asynchronous students reporting above-average levels of cooperative perceptions were posted most frequently at Time 1, which made them especially sensitive to a lack of responses, making them more likely to skip promotive interaction during subsequent interactions and solely focus on task completion. This explanation is in keeping with social information processing theory's argument that, given sufficient time, individuals adapt to the affordances of the medium. Specifically, social information processing theory suggests that, over time, students in the asynchronous group would have realized that promotive interaction was not being reciprocated and therefore shift their activity and attention away from engaging in promotive interaction and toward focusing solely on completing the task. Although these students perceived above-average levels of cooperation despite below-average levels of promotive interaction, social interdependence theory suggests that the lower levels of promotive interaction have other consequences, such

as poorer peer relationships and psychological health. The explanation of skipping future promotive interaction due to a lack of reciprocity is also in keeping with Maruping and Agarwal's (2004) task-technology fit perspective, which identifies the important role immediacy of feedback early in a group's development to support the group in motivating each other. This theory suggests that asynchrony may have prevented the reciprocation of early attempts at promotive interaction, thus discouraging students from engaging in promotive interaction later in the course. Future research could test this unreciprocated early promotive interaction explanation by reviewing chat transcripts for task and support messages to determine whether there are differences in the conditions. In addition, the analysis of chat transcripts could determine whether support messages were reciprocated.

Another possible explanation involves the way promotive interaction was conceptually and operationally defined. For this study, the promotive interaction variable was operationalized as self-reported perceptions of peer academic and social support rather than actual behavioral observations of promotive interaction exchanged between students. Future research should use other methods of operationalizing promotive interaction such as chat transcripts to test the generalizability of this study's findings.

Trustworthiness

Another way of operationalizing reciprocity is in terms of trustworthiness. In the second set of hypotheses, I examined asynchrony's effect on trustworthiness, predicting that asynchrony would result in lower levels of trustworthiness (H2.1). Results partially supported this prediction, which supports research reporting that trustworthiness is susceptible to the affordances of asynchronous CMC (Bergiel et al., 2008). Interestingly, the lower levels of the benevolence component of trustworthiness in the asynchronous groups occurred despite the fact that this study implemented two research-supported methods for encouraging trust into the study – namely, Walter and Bunz's (2005) rules to establish norms and Breuer et al.'s

(2016) documentation of interaction. The benevolence component is the trustor's assessment of the trustee's want to do good regardless of the reward. This study's findings therefore raise questions about why these methods for encouraging trust in asynchronous settings did not affect the benevolence component of trustworthiness.

Unexpectedly, the results did not support my hypotheses regarding asynchrony's effect on the way trustworthiness relates to perceptions of cooperation over time (H2.2). That is, while the results indicated a correlation between all the components of trustworthiness and cooperation, there was no evidence that the main effect of asynchrony depended on the amount of time to get to know one another or the level of cooperative perceptions. This finding contradicts Ennen et al.'s (2015) finding that trust builds over time in asynchronous CMC. One could speculate that the explanation for these results lies in the guidance for the activity. Specifically, the assignment instructions set goal interdependence, expectations for responsibilities, and types of interaction that would be rewarded. This guidance may have encouraged students to perceive trustworthiness regardless of the level of responsiveness or reciprocation. Supporting this possibility, the mean level of trust in both the synchronous and asynchronous groups was above three on a five-point scale, suggesting that students were able to achieve a sufficient level of trust regardless of the medium. Future research should test whether the presence of instructions for goal interdependence affect perceptions of trust in this way, as this would advance social interdependence theory and give practitioners a way to enhance asynchronous cooperative learning. Future research should also compare levels of trust in online and face-to-face communication to determine whether the theoretical relationship between trust and cooperation differs in online and face-to-face contexts.

Cooperative Learning Outcomes

The third and final set of hypotheses concerned the way asynchrony affects cooperative learning outcomes. For social interdependence perceptions, I predicted that

asynchrony would result in lower levels of cooperation, higher levels of competition, and higher levels of individualism (H3.1a-c). Results did not support my hypotheses, however, which was surprising because prior research has found asynchrony to increase individualistic and competitive perceptions (e.g., Roseth et al., 2011; Saltarelli & Roseth, 2014). One explanation for the null findings is that the cooperative learning activity examined in this study differed in psychologically important ways from the activities used in prior studies. Specifically, prior studies of online cooperative learning involved means interdependence (the type that involves distributing unique resource to each group member), which conflated the effect of asynchrony with the effect of cooperative activities that elicit mixed motives (i.e., a mix of cooperation, competition, and individualistic efforts), while the present study only involved outcome interdependence. In the prior studies involving means-interdependent situations (Peterson et al., 2018; Peterson & Roseth, 2016), students most likely sought to benefit personally from other students, such that time delays introducing uncertainty and a lack of responsiveness heightened competitive and individualistic perceptions. Future research should clarify this issue by comparing means and outcome interdependence in asynchronous cooperative learning.

Looking at asynchrony's effect on the way cooperative learning affects interpersonal relationships, results supported the hypothesis (H3.2) that asynchrony would result in lower levels of belonging. In H3.3, I predicted that promotive interaction would positively correlate with belonging, but asynchrony would change the nature of this relation over time. The results partially supported this hypothesis by indicating that promotive interaction was positively correlated to belonging. This finding supports prior research indicating the correlation between promotive interaction and belonging (Meeuwisse et al., 2010; Zumbrumm et al., 2014). Results also indicated that asynchrony changed this association such that academic support, which students in the asynchronous condition initially reported

as higher than the those in the synchronous condition, decreased over time among asynchronous students (Figure 6). In contrast to the results for academic support, there was no evidence for personal that asynchrony changes the way promotive interaction relates to belonging over time. The different patterns of academic and personal support will be revisited below in the discussion for positive emotion. Walther and Tidwell's (1995) study on chronemics in relational communication suggest that these different findings for academic and personal support could be attributed to the ways that students interpret time delays in task-related exchanges differently from social exchanges. Specifically, slow replies to task-related messages signaled less intimacy and affection than social messages. Future research should test this explanation for academic and personal support.

As predicted in H3.4, results replicated prior research indicating that trustworthiness perceptions were positively associated with belonging (Dumitru & Schoop, 2016; Brouwer & Jansen, 2019). Contrary to my hypothesis, asynchrony did not change the way these variables related to each other over time. As the effect of asynchrony on this correlation had not been investigated in prior research, this finding extends the literature by identifying that asynchrony does not negatively affect the relationship between trustworthiness and belonging. One explanation for the null findings is that students adapted to the affordances of the medium to develop social bonds (Walther, 2009). Future research should test this explanation by measuring trustworthiness prior to interaction in the synchronous and asynchronous conditions.

In the investigation of emotions, results indicated that asynchrony did not result in lower levels of positive emotions and higher levels of negative emotions, but it did result in higher levels of stress compared to synchrony (H3.5). Research indicates that stress can be triggered by uncertainty (Pekrun, 2006), and the uncertainty caused by communication delays may explain these results. Future research should explore this explanation by manipulating

communication delays to identify their effect on stress levels. This finding contributes to the literature because prior research had not examined students' emotions or stress in asynchronous cooperative learning.

Although results did not yield significant differences between synchronous and asynchronous conditions for emotion, the literature suggests there is a relationship between emotion and reciprocal processes (i.e., promotive interaction and trustworthiness) that may be affected by asynchrony, which informed the last two hypotheses of this study. I predicted that asynchrony would change the relationship between promotive interaction and positive emotions over time (3.6). The correlation between promotive interaction and positive emotion indicated in the results is consistent with prior research (Lawler et al., 2008). Results also indicated that asynchrony changed this association such that academic support, which students in the asynchronous condition initially reported as higher than the those in the synchronous condition, decreased over time among asynchronous students (Figure 8). As the academic support in the asynchronous group declined over time, it remained stable in the synchronous group. The results for personal support illustrated a much different pattern. Positive emotion and personal support were similarly positively related among synchronous and asynchronous students (i.e., students reporting above-average levels of positive emotion also reported above-average levels of personal support), although the personal support differences between above- and below-average levels were negligible for asynchronous students (Figure 9). In both the synchronous and asynchronous groups, the relationship between positive emotion and personal support remained stable over time. As this hypothesis was exploratory and results also showed that the asynchronous condition moderated the relationship between promotive interaction and positive emotion, future research should confirm these results.

Results partially supported my hypothesis that trustworthiness would positively correlate with positive emotion, but asynchrony would change the way that trustworthiness relates to positive emotion over time (H3.7). Results indicated that students reporting above-average levels of positive emotion were especially susceptible to the effects on asynchronous interaction (Figures 10 and 11). That is, cooperation and the ability and integrity components of trustworthiness were similarly positively related among synchronous and asynchronous students (i.e., students reporting above-average levels of positive emotion also reported above-average levels of trustworthiness). But over time, asynchrony changed this association such that trustworthiness (ability and integrity), which students in the asynchronous condition initially reported as higher than the those in the synchronous condition, decreased over time among asynchronous students. The relationship between trustworthiness and positive emotion is consistent with prior research (Khawaji et al, 2013; Lewicki et al., 2006; Scissors et al., 2009). Although the effect of asynchrony on this correlation had not been investigated previously, this hypothesis was exploratory and future research should confirm these results.

In looking at promotive interaction, the results showed that both academic and personal support had significant relationships with cooperation, belonging, and positive emotions. Similarly, the three components of trustworthiness had positive relationships with these three outcomes. These relationships are comparable to those identified in face-to-face cooperative learning (Brouwer & Jansen, 2019; Kunnel & Quandt, 2016; Johnson &Johnson, 2005; Lawler & Thye, 2008; Lewicki et al., 2006; Van Lange et al., 2013; Zumbrunn et al., 2014), and therefore extend the generalizability of the findings to asynchronous cooperative learning.

Limitations

This dissertation is not without limitations, one of which is the lack of control of time in both the synchronous and asynchronous conditions. SIP suggests that asynchronous CMC

will achieve the same outcomes as synchronous CMC provided participants are given sufficient time. The literature does not indicate how much time is sufficient, nor does this dissertation address that question. This limitation is balanced by the value of generalizing the findings of this study to asynchronous cooperative learning that is used in online courses. Sufficient time may not be available to all students, and this study investigated how asynchronous affects cooperative learning when student use their available time.

As another limitation, this study focuses on text-based cooperation and does not explore audio or video technologies. This decision was based on prior research showing that these affordances do not affect cooperative outcomes (Roseth et al., 2011), but nonetheless limit the study's generalizability. Another limitation is the stratified random assignment of synchronous groups based on students' availability. I chose this assignment method to accommodate students' schedules because the students in synchronous groups do not have the flexibility of time to do their work afforded to the asynchronous students. However, it remains unclear whether students who choose one meeting time (e.g., mid-afternoon during the week) are systematically different from students who choose another time (e.g., late-night Saturday), and how these differences might relate to cooperative learning processes and outcomes. This stratified random assignment procedure may also increase the similarity of synchronous group members compared to asynchronous groups, which research suggests enhances communication, cooperation, and perceptions of trustworthiness (Lusher et al., 2014; Ruef et al., 2003).

Implications

Notwithstanding these limitations, the present study contributes to theory and practice in three ways. First, the dissertation goes beyond the more common ways that past research has operationalized reciprocity (e.g., message length, similar language usage) in asynchronous contexts and identified asynchronous communication's effects on reciprocity

as they manifest themselves in measures of promotive interaction and trustworthiness. So doing, the study provides a much more fine-grained analysis of the way asynchrony disrupts cooperative learning processes. Of particular interest was the finding that the academic support component of promotive interaction was more susceptible to the effects of asynchrony, with academic support decreasing among asynchronous students over time, particularly among those reporting above-average levels of cooperation, belonging, and positive emotion. In contrast, there was only evidence of slight differences in personal support between the asynchronous students reporting above- and below-average levels of cooperation, belonging, and positive emotion, and those differences did not change over time. These distinct patterns for academic and personal support are consistent with research indicating that patterns differ between task and non-task focused interactions (Abedin et al., 2014; Schellens & Valcke, 2005; Walther & Tidwell, 1995). One could speculate that students may not think their personal support needs to be reciprocated, because they expect their peers to be busy with their lives outside of the classroom and not have time to socialize. In contrast, academic support may be more sensitive to lack of reciprocation because it represents efforts intended to contribute to the shared work, and unreciprocated efforts may therefore be interpreted as unequal efforts toward the shared goal. Likewise, when students post messages of academic support in an asynchronous condition, they may be more likely to interpret a lack of timely response as a lack of reciprocation, which makes them less likely to offer academic support in the future because they do not expect it to be reciprocated. To test this explanation, future research should target approaches to bolster academic support specifically given its apparent increased susceptibility to the effects of asynchrony over time.

Second, this study extends prior cooperative learning research by testing the correlations between cooperative learning outcomes (e.g., social interdependence, psychological health, and interpersonal relationships) in asynchronous contexts, which had

not been investigated in prior research. These results provide evidence that the known positive relationships found between these variables in face-to-face cooperative learning are also found in asynchronous cooperative learning and, in some cases, change over time. For example, this study confirmed the positive relationship between academic support and belonging, but asynchrony decreased the magnitude of this relationship over time. This same pattern occurred in academic support's relationships with cooperation and positive emotion. Although synchronous and asynchronous students had similar levels of cooperation, the asynchronous students' lower levels of promotive interaction also had other consequences, namely poorer peer relationships and psychological health. As described above, one explanation for these findings is that lack of reciprocity in the asynchronous condition discourages students from engaging in promotive interaction over time. When they offer feedback or provide help and they do not receive a timely response, they may avoid engaging in future promotive interaction. Without sufficient promotive interaction, belonging and positive emotion do not develop as they would in synchronous cooperative learning. Future research should investigate this explanation by manipulating communication delays within an experimental design to identify their direct (rather than indirect) effects on promotive interaction, peer relationships, and psychological health.

Third, this study's results inform practice by testing whether the effects of asynchrony generalize to an actual online course in which students work together on multiple cooperative discussions over a semester. It also extends prior research by testing whether the effects of asynchrony generalize beyond Constructive Controversy and Jigsaw cooperative learning activities which use means interdependence to a cooperative discussion activity that uses outcomes interdependence. This too is important because the outcomes interdependence activity resulted in no evidence of differences between cooperative, competitive, and individualistic perceptions, which suggests that instructors may be more successful in

eliciting cooperative perceptions in asynchronous cooperative learning by using activities designed with outcomes interdependence.

Finally, the implications of this dissertation's results extend to educators who have to shift their face-to-face classrooms into hybrid or online modalities. Even when the modality shift is temporary, educators cannot assume that the same pedagogy will work in the same way as it does in the face-to-face classroom. Instead, they need to assume that task characteristics will interact with social psychological processes and technological affordances in ways that change how and what students learn.

Conclusion

In conclusion, the study's results revealed a more complicated picture of asynchrony's effects on cooperative learning. Specifically, asynchrony changes the way that students interact in cooperative learning in that they engage in lower levels of promotive interaction, have lower levels of belonging, and have higher levels of stress. Additionally, asynchrony affects academic and personal support differently and diminishes the well-established correlations between cooperative outcomes over time. These findings have implications for social interdependence and CMC theories and practice by providing more detail about the role of promotive interaction in asynchronous cooperative learning and identifying that outcomes interdependence may elicit different cooperative outcomes than cooperative learning activities involving means interdependence.

Table 1

Descriptive Statistics for the Dependent Variables

Dependent variables	Synchronous		Asynchronous	
	M	SD	M	SD
Promotive interaction				
Academic time 1	3.80	0.74	3.69	0.78
Academic time 2	3.74	0.77	3.40	0.79
Personal time 1	3.33	0.84	3.15	0.77
Personal time 2	3.29	0.94	2.96	0.68
Trustworthiness				
Ability time 1	3.96	0.71	3.73	0.97
Ability time 2	3.82	0.73	3.48	0.9
Benevolence time 1	3.41	0.9	2.96	0.79
Benevolence time 2	3.32	0.84	2.80	0.92
Integrity time 1	3.68	0.70	3.39	0.77
Integrity time 2	3.52	0.62	3.18	0.76
Social interdependence				
Cooperation time 1	3.58	0.68	3.69	0.66
Cooperation time 2	3.53	0.75	3.47	0.73
Competition time 1	2.45	1.00	2.67	0.79
Competition time 2	2.52	0.99	2.76	0.77
Individualism time 1	3.33	1.16	3.14	0.98
Individualism time 2	3.39	1.15	3.55	1.04
Other				
Belonging time 1	4.12	0.58	3.80	0.73
Belonging time 2	3.83	0.63	3.55	0.72
Positive emotion time 1	2.92	1.06	2.76	0.99
Positive emotion time 2	2.61	1.18	2.72	0.99
Negative emotion time 1	1.89	0.73	1.82	0.57
Negative emotion time 2	2.13	0.80	2.38	1.04
Stress time 1	2.54	0.66	3.04	0.74
Stress time 2	2.52	0.84	2.91	0.80

Table 2

Correlations of Dependent Variables

Correlations of Dependent Variables

	Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Promotive Interaction																								
1 Academic Support	1																							
2	2	.59**																						
3 Personal Support	1	.73**	.46**																					
4	2	.60**	.78**	.64**																				
Trustworthiness																								
5 Truat Ability	1	.46**	.42**	.41**	.44**																			
6	2	.53**	.54**	.42**	.46**	.69**																		
7 Trust Benevolence	1	.62**	.46**	.68**	.51**	.58**	.39**																	
8	2	.46**	.51**	.55**	.61**	.41**	.47**	.62**																
9 Trust Integrity	1	.59**	.59**	.61**	.56**	.74**	.61**	.72**	.57**															
10	2	.59**	.63**	.52**	.57**	.57**	.71**	.54**	.69**	.62**														
Social Interdependence																								
11 Cooperation	1	.61**	.35**	.47**	.37**	.50**	.39**	.53**	.26*	.51**	.37**													
12	2	.40**	.43**	.36**	.46**	.41**	.56**	.39**	.45**	.44**	.54**	.62**												
13 Competition	1	-.04	.07	.12	.07	-.16	-.15	-.01	.03	.00	-.09	-.12	.03											
14	2	-0.1	.04	.10	.17	-.05	.00	.07	.20*	.08	.03	-.14	.17	.68**										
15 Individualism	1	-.40**	-.07	-.26**	-.14	-.26**	-.13	-.34**	-.06	-.31**	-.05	-.68**	-.44**	.15	.10									
16	2	-.25*	-.31**	-.25*	-.35**	-.20	-.24*	-.26*	-.22*	-.21*	-.22*	-.54**	-.60**	-.11	-.11	.62**								
Cooperative Outcomes																								
17 Belonging	1	.68**	.48**	.51**	.48**	.57**	.53**	.59**	.48**	.65**	.51**	.64**	.40**	-.19	-.14	-.44**	-.29**							
18	2	.52**	.62**	.39**	.52**	.41**	.57**	.39**	.55**	.48**	.63**	.50**	.58**	-.07	-.11	-.29**	-.47**	.64**						
19 Positive Emotion	1	.51**	.35**	.52**	.44**	.44**	.31**	.53**	.40**	.56**	.34**	.63**	.44**	-.02	.02	-.52**	-.33**	.54**	.37**					
20	2	.37**	.37**	.41**	.47**	.257*	.28**	.34**	.33**	.31**	.25*	.47**	.42**	.13	.05	-.22*	-.43**	.36**	.42**	.63**				
21 Negative Emotion	1	-.37**	-.26*	-.41**	-.40**	-.39**	-.27**	-.37**	-.43**	-.47**	-.29**	-.42**	-.37**	.06	-.00	.38**	.32**	-.48**	-.32**	-.50**	-.34**			
22	2	-.34**	-.39**	-.33**	-.39**	-.42**	-.48**	-.27**	-.22*	-.46**	-.37**	-.35**	-.33**	.13	.14	.26*	.40**	-.40**	-.45**	-.36**	-.37**	.54**		
23 Stress	1	-.26**	-.22*	-.15	-.22*	-0.05	.03	-.27**	-.25*	-.11	-.07	-.17	-.03	-.10	-.09	.26**	.10	-.30**	-.11	-.23*	.00	.17	-.03	
24	2	-.19	-.36**	-.15	-.32**	.03	.03	-.23*	-.27**	-.10	-.13	-.01	-0.12	-.04	-.06	.14	.06	-.21*	-.23*	-.19	-.11	.23*	.07	.64**

a. *p* <0.05, ** *p* <0.01

Table 3

Promotive Interaction: LMM Results

Parameter	Promotive Interaction	
	Academic Support	Personal Support
Intercept, β_0	2.60*** (0.52)	2.24*** (0.63)
Self-efficacy (T1), β_1	0.09 (0.11)	-0.06 (0.14)
Interest (T1), β_2	0.07 (0.09)	0.09 (0.12)
Value (T1), β_3	0.20 (0.11)	0.26 (0.14)
Time, β_4	-0.21** (0.08)	-0.03 (0.07)
Asynchrony, β_5	-0.24* (0.12)	-0.41** (0.14)

a. For synchrony: asynchronous = 1, synchronous = 0.
b. *p <0.05, ** p <0.01, ***p <0.001

Table 4

Academic and Personal Promotive Interaction: LMM Results

Parameter / Model	Academic Support		Personal Support	
	1	2	1	2
Intercept, β_0	1.37*** (0.43)	1.01* (0.47)	1.46* (0.61)	0.61 (0.63)
Self-efficacy (T1), β_1	0.03 (0.09)	0.03 (0.09)	-0.10 (0.13)	-0.05 (0.12)
Interest (T1), β_2	-0.05 (0.07)	-0.06 (0.07)	0.02 (0.11)	0.00 (0.10)
Value (T1), β_3	0.15 (0.09)	0.13 (0.09)	0.23 (0.13)	0.17 (0.13)
Cooperation, β_4	0.57*** (0.06)	0.65*** (0.08)	0.36*** (0.07)	0.62*** (0.10)
Time, β_5	-0.15* (0.07)	-0.02 (0.09)	0.01 (0.06)	0.00 (0.08)
Asynchrony, β_6	-0.23** (0.09)	-1.01 (0.97)	-0.40** (0.13)	1.44** (0.57)
Asynch * Time, β_7		0.88 (0.55)		-0.01 (0.12)
Asynch * Cooperation, β_8		0.33 (0.26)		-0.52** (0.14)
Asynch * Time * Coop β_9		-0.32* (0.15)		

Note. For asynchrony: asynchronous = 1, synchronous = 0.

p <0.05, ** *p* <0.01, ***p* <0.001

Table 5

Trustworthiness: LMM Results

	Trustworthiness		
	Ability	Benevolence	Integrity
Intercept, β_0	2.47** (0.63)	2.37** (0.73)	2.68*** (0.57)
Self-efficacy (T1), β_1	0.02 (0.14)	0.09 (0.16)	0.04 (0.12)
Interest (T1), β_2	-0.25* (0.12)	0.12 (0.13)	-0.04 (0.10)
Value (T1), β_3	0.62*** (0.14)	0.04 (0.16)	0.26* (0.13)
Time, β_4	-0.19** (0.07)	-0.09 (0.09)	-0.18** (0.07)
Asynchrony, β_5	-0.26 (0.15)	-0.40* (0.17)	-0.22 (0.13)

For asynchrony: asynchronous = 1, synchronous = 0.

a. *p* <0.05, ** *p* <0.01, ***p* <0.001

Table 6

Trustworthiness and Cooperation: LMM Results

Parameter / Model	Ability		Benevolence		Integrity	
	1	2	1	2	1	2
Intercept, β_0	1.30* (0.55)	0.97 (0.61)	1.02 (0.64)	0.66 (0.70)	1.63** (0.50)	1.75*** (0.55)
Self-efficacy (T1), β_1	-0.03 (0.11)	-0.02 (0.12)	0.02 (0.13)	0.04 (0.13)	0.00 (0.10)	-0.01 (0.11)
Interest (T1), β_2	-0.36** (0.10)	-0.36*** (0.10)	0.00 (0.11)	-0.01 (0.11)	-0.14 (0.09)	-0.13 (0.09)
Value (T1), β_3	0.57*** (0.12)	0.55*** (0.12)	-0.01 (0.14)	-0.05 (0.14)	0.22* (0.11)	0.23* (0.11)
Cooperation, β_4	0.54*** (0.07)	0.63*** (0.10)	0.62*** (0.08)	0.76*** (0.12)	0.47*** (0.07)	0.44*** (0.09)
Time, β_5	-0.13 (0.07)	-0.11 (0.10)	-0.01 (0.08)	-0.04 (0.11)	-0.11 (0.07)	-0.14 (0.09)
Asynchrony, β_6	-0.26* (0.12)	0.74 (1.07)	-0.41** (0.14)	-0.78 (1.22)	-0.22* (0.11)	-0.3 (1.00)
Asynch * Time, β_7		-0.21 (0.59)		0.87 (0.67)		-0.09 (0.56)
Asynch * Cooperation, β_8		-0.26 (0.29)		0.08 (0.25)		0.00 (0.27)
Asynch * Time * Coop β_9		0.04 (0.16)		-0.23 (0.18)		0.04 (0.15)

Note. For asynchrony: asynchronous = 1, synchronous = 0.

*p <0.05, ** p <0.01, ***p <0.001

Table 7

Social Interdependence: LMM Results

Parameter	Cooperation	Competition	Individualism
Intercept, β_0	2.20** (0.56)	3.71*** (0.72)	4.33*** (0.87)
Self-efficacy (T1), β_1	0.10 (0.12)	-0.08 (0.16)	-0.04 (0.19)
Interest (T1), β_2	0.20 (0.10)	0.08 (0.13)	-0.43** (0.16)
Value (T1), β_3	0.09 (0.12)	-0.30 (0.16)	0.11 (0.19)
Time, β_4	-0.12 (0.07)	0.07 (0.08)	0.21* (0.10)
Asynchrony β_5	-0.01 (0.13)	0.27 (0.17)	0.11 (0.20)

Note. For asynchrony: asynchronous = 1, synchronous = 0.

*p < 0.05, ** p < 0.01, ***p < 0.001

Table 8

Belonging: LMM Results

Parameter	Belonging
Intercept, β_0	1.78** (0.51)
Self-efficacy (T1), β_1	0.33** (0.11)
Interest (T1), β_2	0.12 (0.09)
Value (T1), β_3	0.16 (0.11)
Time, β_4	-0.27*** (0.06)
Asynchrony, β_5	-0.32** (0.12)

Note. For asynchrony: asynchronous = 1, synchronous = 0.

*p < 0.05, ** p < 0.01, ***p < 0.001

Table 9

Promotive Interaction and Belonging: LMM Results

Parameter / Model	Academic Support		Personal Support	
	1	2	1	2
Intercept, β_0	1.56** (0.43)	0.85 (0.50)	1.55** (0.59)	1.02 (0.66)
Self-efficacy (T1), β_1	-0.09 (0.09)	-0.12 (0.09)	-0.19 (0.13)	-0.21 (0.13)
Interest (T1), β_2	0.01 (0.07)	0.01 (0.07)	0.04 (0.11)	0.04 (0.11)
Value (T1), β_3	0.11 (0.09)	0.11 (0.09)	0.19 (0.13)	0.19 (0.13)
Belonging, β_4	0.57*** (0.07)	0.71*** (0.09)	0.40*** (0.08)	0.54*** (0.11)
Time, β_5	-0.06 (0.08)	0.13 (0.10)	0.07 (0.07)	0.11 (0.09)
Asynchrony, β_6	-0.05 (0.10)	1.51** (0.58)	-0.28* (0.13)	0.85 (0.67)
Asynch * Time, β_7		-0.39** (0.15)		-0.08 (0.13)
Asynch * Belonging, β_8		-0.26* (0.13)		-0.27 (0.15)

Note. For asynchrony: asynchronous = 1, synchronous = 0.

*p <0.05, ** p <0.01, ***p <0.001

Table 10

Trustworthiness and Belonging: LMM Results

| Parameter / Model	Ability		Benevolence		Integrity	
	1	2	1	2	1	2
Intercept, β_0	1.40 (0.54)**	1.28* (0.62)	1.03 (0.62)	0.50 (0.71)	1.55 (0.46)**	1.63** (0.53)
Self-efficacy (T1), β_1	-0.18 (0.12)	-0.19 (0.12)	-0.14 (0.13)	-0.16 (0.13)	-0.16 (0.10)	-0.16 (0.10)
Interest (T1), β_2	-0.33 (0.10)**	-0.32 ** (0.10)	0.04 (0.11)	0.04 (0.11)	-0.11 (0.08)	-0.12 (0.08)
Value (T1), β_3	0.52 (0.12)***	0.52*** (0.12)	-0.07 (0.13)	-0.06 (0.13)	0.17 (0.10)	0.16 (0.10)
Belonging, β_4	0.61 (0.08)***	0.63*** (0.11)	0.72 (0.09)***	0.86*** (0.13)	0.62 (0.07)***	0.59*** (0.10)
Time, β_5	-0.03 (0.07)	0.03 (0.10)	0.11 (0.08)	0.17 (0.12)	-0.01 (0.07)	0.00 (0.09)
Asynchrony, β_6	-0.07 (0.12)	1.33 (1.05)	-0.18 (0.14)	1.46 (1.22)	-0.04 (0.10)	-0.47 (0.95)
Asynch * Time, β_7		-0.87 (0.57)		-0.44 (0.66)		0.14 (0.52)
Asynch * Belonging, β_8		-0.32 (0.26)		-0.40 (0.31)		0.12 (0.24)
Asynch * Time * Belonging, β9		0.20 (0.15)		0.09 (0.17)		-0.04 (0.14)

Note. For asynchrony: asynchronous = 1, synchronous = 0.

*p <0.05, ** p <0.01, ***p <0.001

Table 11

Stress: LMM Results

Parameter	Stress
Intercept, β_0	2.98*** (0.64)
Self-efficacy (T1), β_1	-0.15 (0.14)
Interest (T1), β_2	-0.11 (0.12)
Value (T1), β_3	0.17 (0.14)
Time, β_4	-0.08 (0.07)
Asynchrony, β_5	0.53*** (0.15)

Note. For asynchrony: asynchronous = 1, synchronous = 0.
*p <0.05, ** p <0.01, ***p <0.001

Table 12

Positive Emotions: LMM Results

Parameter	Positive Emotion
Intercept, β_0	0.88 (0.85)
Self-efficacy (T1), β_1	0.07 (0.19)
Interest (T1), β_2	0.38** (0.16)
Value (T1), β_3	0.1 (0.19)
Time, β_4	-0.16 (0.10)
Asynchrony, β_5	-0.2 (0.19)

Note. For asynchrony: asynchronous = 1, synchronous = 0.

p <0.05, ** *p* <0.01, ***p* <0.001

Table 13

Negative Emotions: LMM Results

Parameter	Negative Emotion
Intercept, β_0	2.93*** (0.71)
Self-efficacy (T1), β_1	-0.04 (0.15)
Interest (T1), β_2	0.03 (0.13)
Value (T1), β_3	-0.31* (0.16)
Time, β_4	0.33*** (0.09)
Synchrony, β_5	0.20 (0.16)

Note. For asynchrony: asynchronous = 1, synchronous = 0.

p <0.05, ** *p* <0.01, ***p* <0.001

Table 14

Promotive Interaction and Positive Emotion: LMM Results

Parameter / Model	Academic Support		Personal Support	
	1	2	1	2
Intercept, β_0	2.44*** (0.48)	1.73** (0.49)	2.02** (0.55)	1.69** (0.58)
Self-efficacy (T1), β_1	0.07 (0.10)	0.11 (0.10)	-0.08 (0.12)	-0.05 (0.12)
Interest (T1), β_2	-0.01 (0.09)	-0.03 (0.09)	-0.01 (0.10)	-0.03 (0.10)
Value (T1), β_3	0.18 (0.10)	0.17 (0.10)	0.23 (0.12)	0.23 (0.12)
Positive Emotion, β_4	0.21*** (0.05)	0.34*** (0.6)	0.26*** (0.05)	0.34*** (0.07)
Time, β_5	-0.18* (0.08)	-0.02 (0.10)	0.01 (0.07)	0.05 (0.09)
Asynchrony, β_6	-0.20 (0.11)	-0.52 (.055)	-0.35** (0.13)	0.27 (0.36)
Asynch * Time, β_7		0.79* (0.32)		-0.08 (0.13)
Asynch * Pos Emotion, β_8		0.34 (0.18)		-0.19* (0.10)
Asynch * Time * Pos Emo β_9		-0.44*** (0.11)		

Note. For asynchrony: asynchronous = 1, synchronous = 0.

*p <0.05, ** p <0.01, ***p <0.001

Table 15

Trustworthiness and Positive Emotion: LMM Results

Parameter / Model	Ability		Benevolence		Integrity	
	1	2	1	2	1	2
Intercept, β_0	2.29** (0.60)	1.99** (0.62)	2.09** (0.66)	1.70** (0.69)	2.48*** (0.52)	2.21*** (0.54)
Self-efficacy (T1), β_1	0.00 (0.13)	0.02 (0.13)	0.07 (0.14)	0.10 (0.14)	0.03 (0.11)	0.04 (0.11)
Interest (T1), β_2	-0.35** (0.11)	-0.36** (0.11)	0.01 (0.12)	-0.01 (0.12)	-0.13 (0.10)	-0.14 (0.10)
Value (T1), β_3	0.59*** (0.13)	0.59*** (0.13)	0.01 (0.15)	0.01 (0.14)	0.24* (0.12)	0.23* (0.11)
Positive Emotion, β_4	0.24*** (0.05)	0.29*** (0.07)	0.30*** (0.06)	0.39*** (0.08)	0.23*** (0.05)	0.30*** (0.06)
Time, β_5	-0.16* (0.07)	-0.07 (0.10)	-0.04 (0.09)	0.03 (0.12)	-0.14* (0.07)	-0.09 (0.09)
Asynchrony, β_6	-0.21 (0.14)	-0.57 (0.60)	-0.35* (0.15)	-0.37 (0.71)	-0.18 (0.12)	-0.65 (0.55)
Asynch * Time, β_7		0.46 (0.34)		0.40 (0.40)		0.56 (0.31)
Asynch * Pos Emotion, β_8		0.23 (0.20)		0.07 (0.23)		0.22 (0.18)
Asynch * Time * Pos Emo β_9		-0.23* (0.11)		-0.19 (0.13)		-0.24* (0.10)

Note. For asynchrony: asynchronous = 1, synchronous = 0.

*p <0.05, ** p <0.01, ***p <0.001

Figure 1

Predicted Rate Trajectories for Student Academic Support by Cooperation
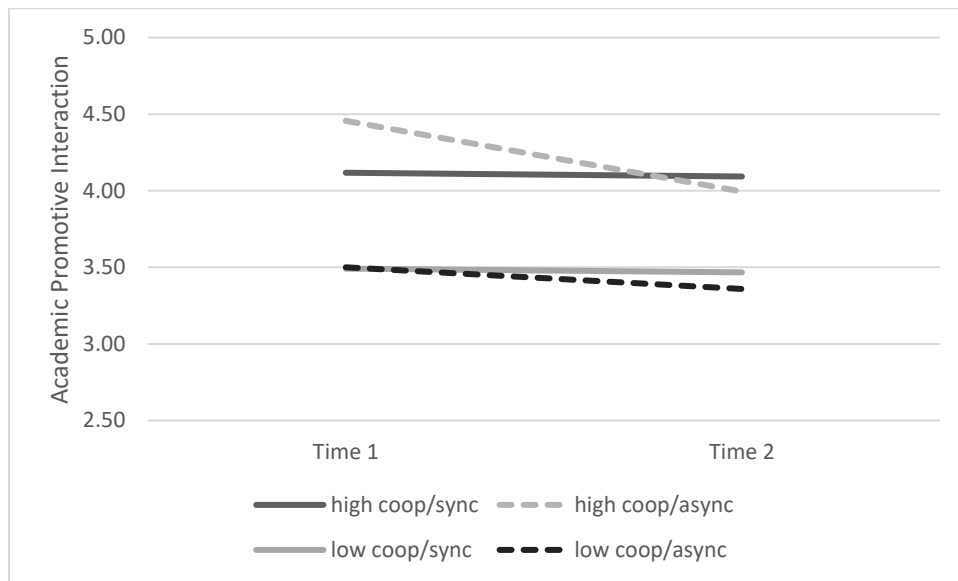
High coop = high cooperative group; Low coop = low cooperative group. Cooperation dichotomized based on third quartile of student-rated cooperation. Output in Table 4 used to construct predicted equations for log expected rates of student academic support
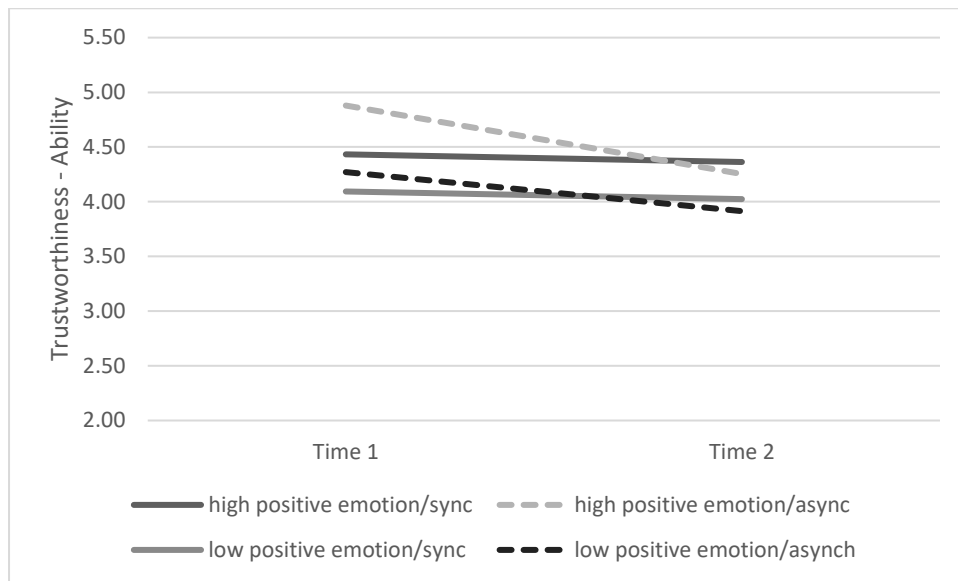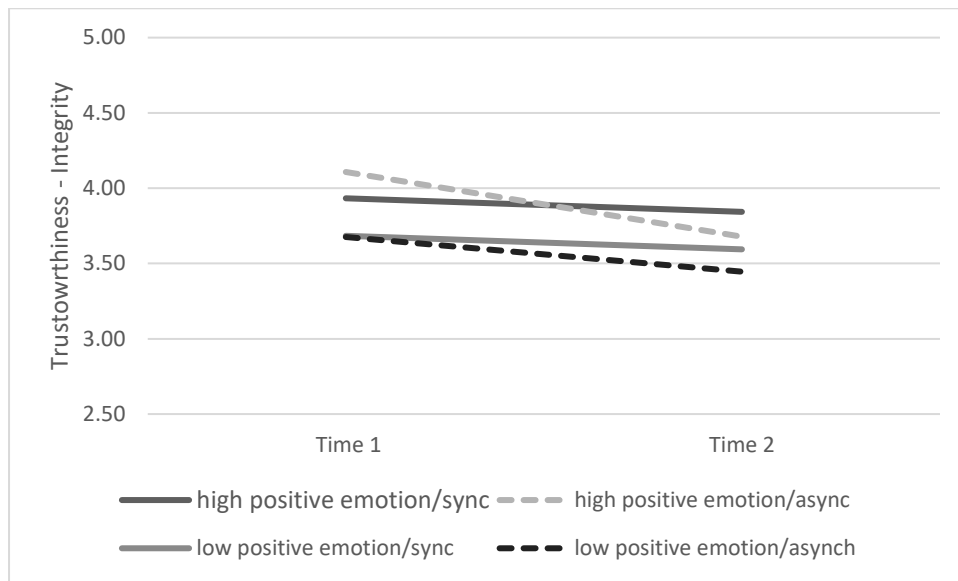
Figure 2

Predicted Rate Trajectories for Student Personal Support by Cooperation
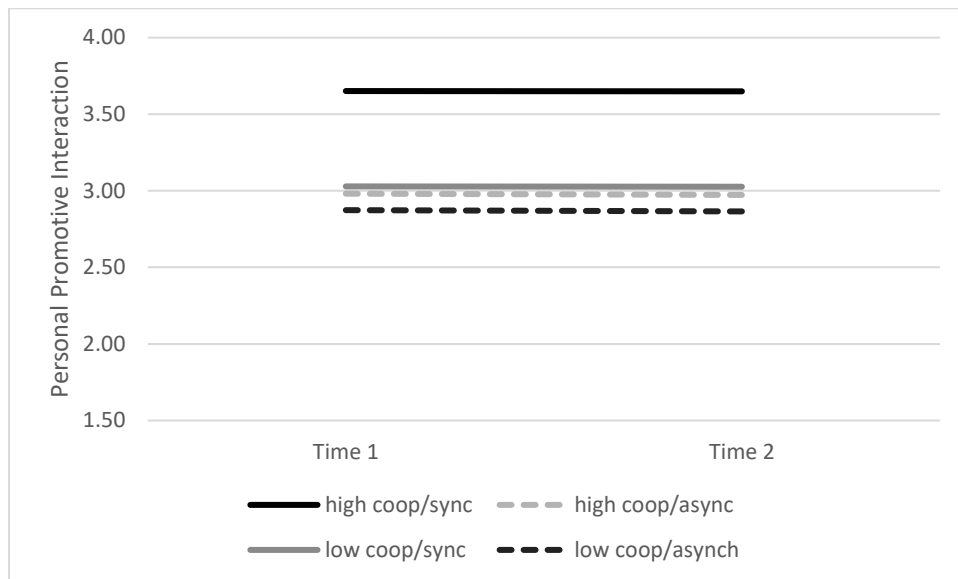
High coop = high cooperative group; Low coop = low cooperative group. Cooperation dichotomized based on third quartile of student-rated cooperation. Output in Table 4 used to construct predicted equations for log expected rates of student personal support

Figure 3

Summary Results of Hypotheses 1.1 and 1.2
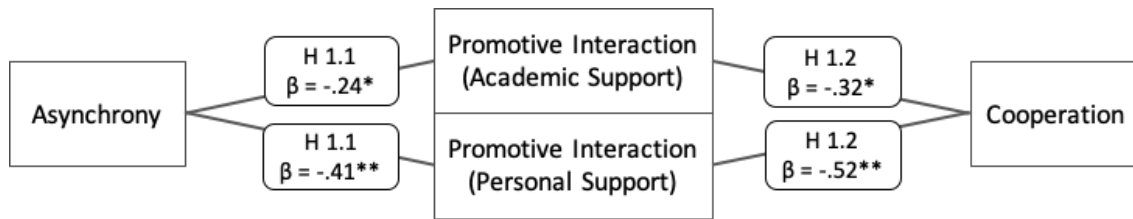
Note: the results are listed in this conceptual model are for display purposes only readers should not interpret this display as a structural model.

Figure 4

Summary Results of Hypotheses 2.1 and 2.2
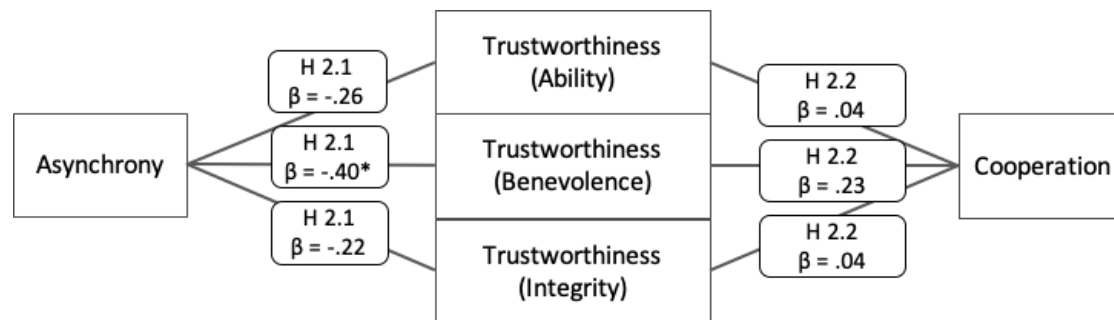
Note: the results are listed in this conceptual model are for display purposes only. Readers should not interpret this display as a structural model.

Figure 5

Summary results of Hypothesis 3.1
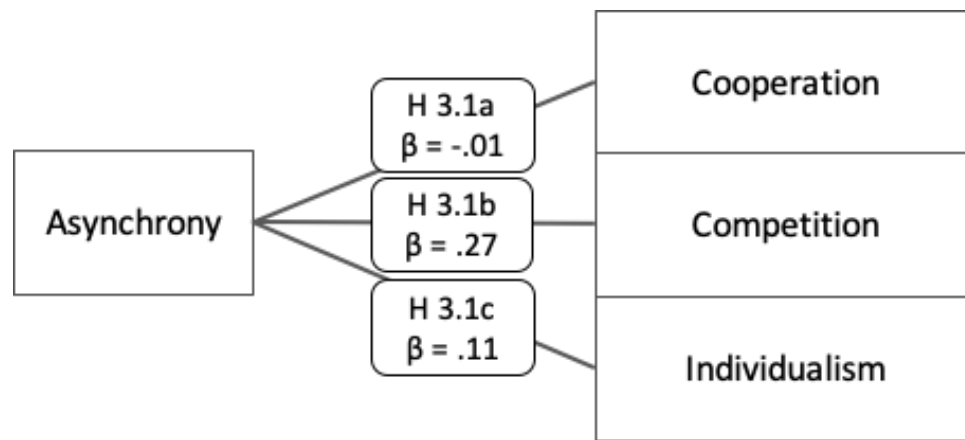
Note: the results are listed in this conceptual model are for display purposes only. Readers should not interpret this display as a structural model.

Figure 6

Predicted Rate Trajectories for Student Academic Support by Belonging
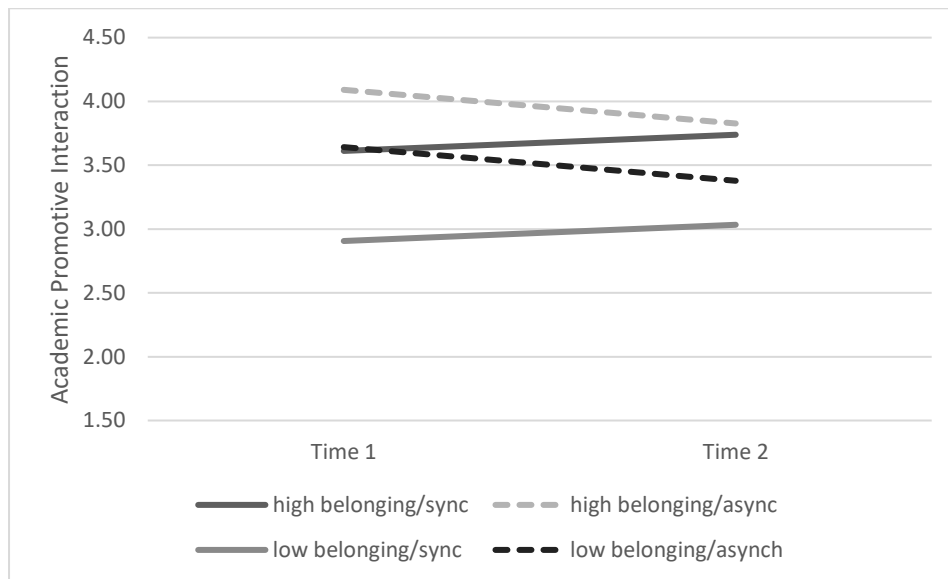
Belonging dichotomized based on third quartile of student-rated belonging. Output in Table 9 used to construct predicted equations for log expected rates of student academic support.

Figure 7

Summary Results of Hypotheses 3.2, 3.3, and 3.4
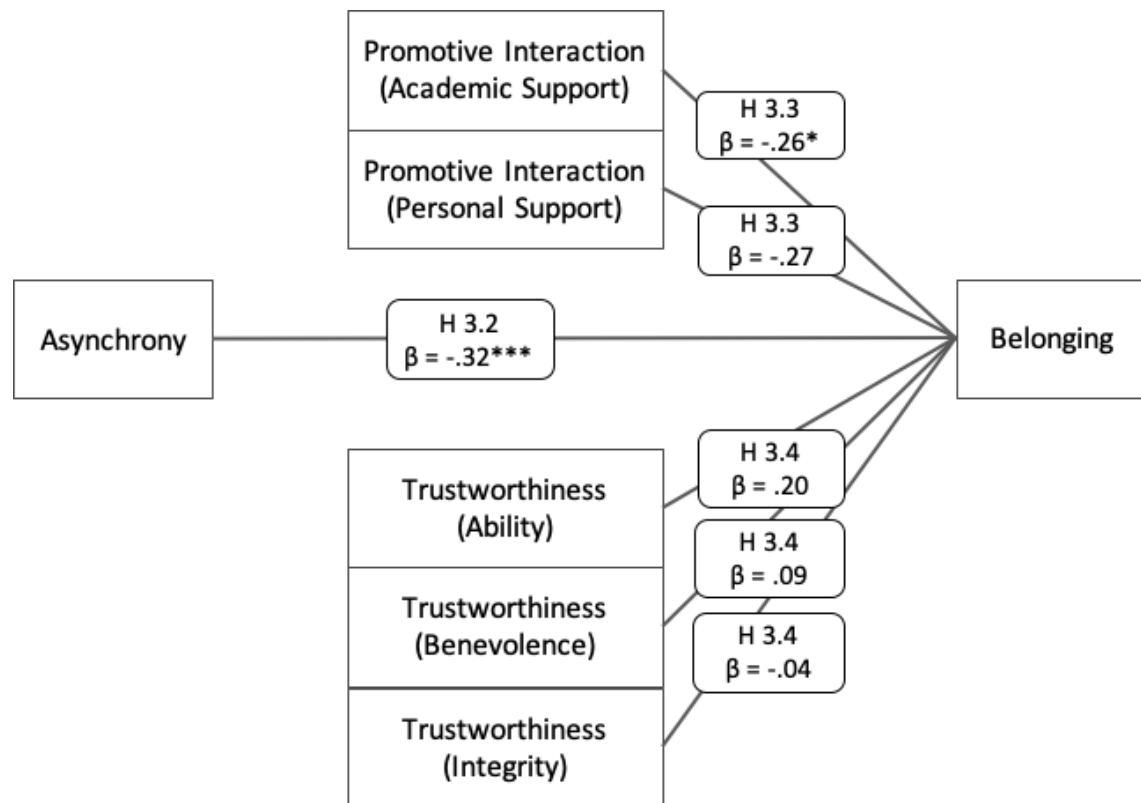
Note: the results are listed in this conceptual model are for display purposes only. Readers should not interpret this display as a structural model.

Figure 8

Predicted Rate Trajectories for Student Academic Support by Positive Emotion
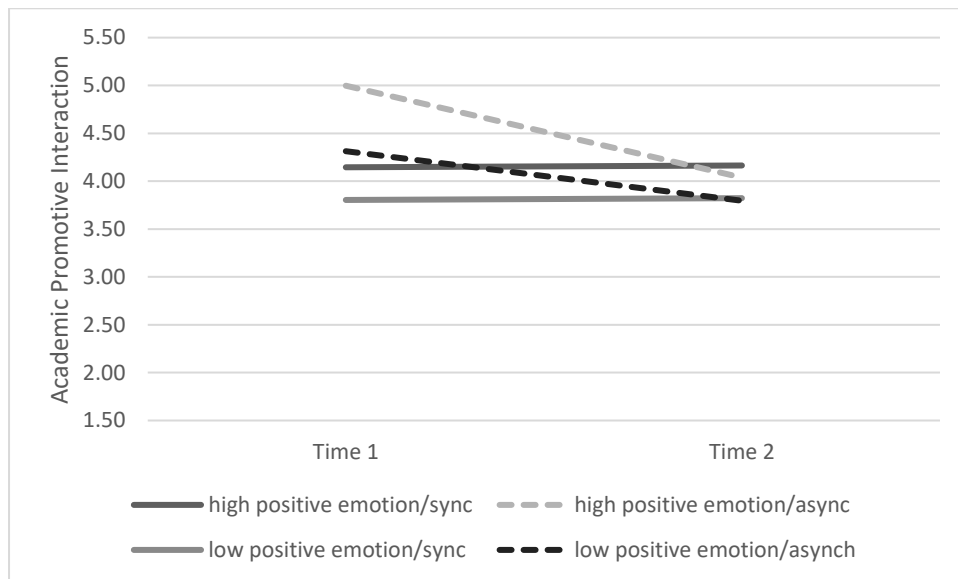
Positive emotion dichotomized based on third quartile of student-rated positive emotion. Output in Table 14 used to construct predicted equations for log expected rates of student academic support.

Figure 9

Predicted Rate Trajectories for Student Personal Support by Positive Emotion
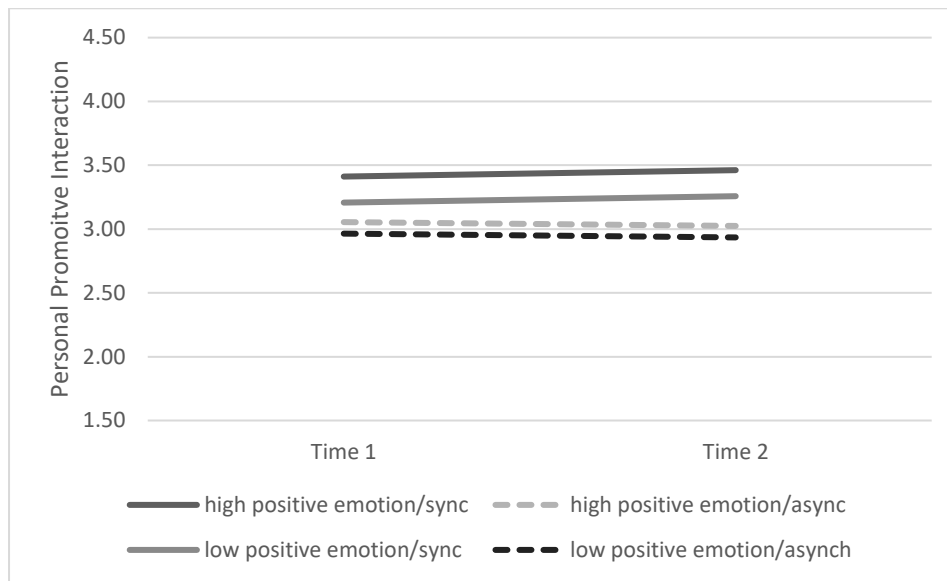
Positive emotion dichotomized based on third quartile of student-rated positive emotion. Output in Table 14 used to construct predicted equations for log expected rates of student personal support.

Figure 10

Predicted Rate Trajectories for Trustworthiness Ability by Positive Emotion

Positive emotion dichotomized based on third quartile of student-rated positive emotion. Output in Table 15 used to construct predicted equations for log expected rates of trustworthiness ability.

Figure 11

Predicted Rate Trajectories for Trustworthiness Integrity by Positive Emotion

Positive emotion dichotomized based on third quartile of student-rated positive emotion. Output in Table 21 used to construct predicted equations for log expected rates of trustworthiness integrity.

Figure 12

Summary Results of Hypotheses 3.5, 3.6, and 3.7
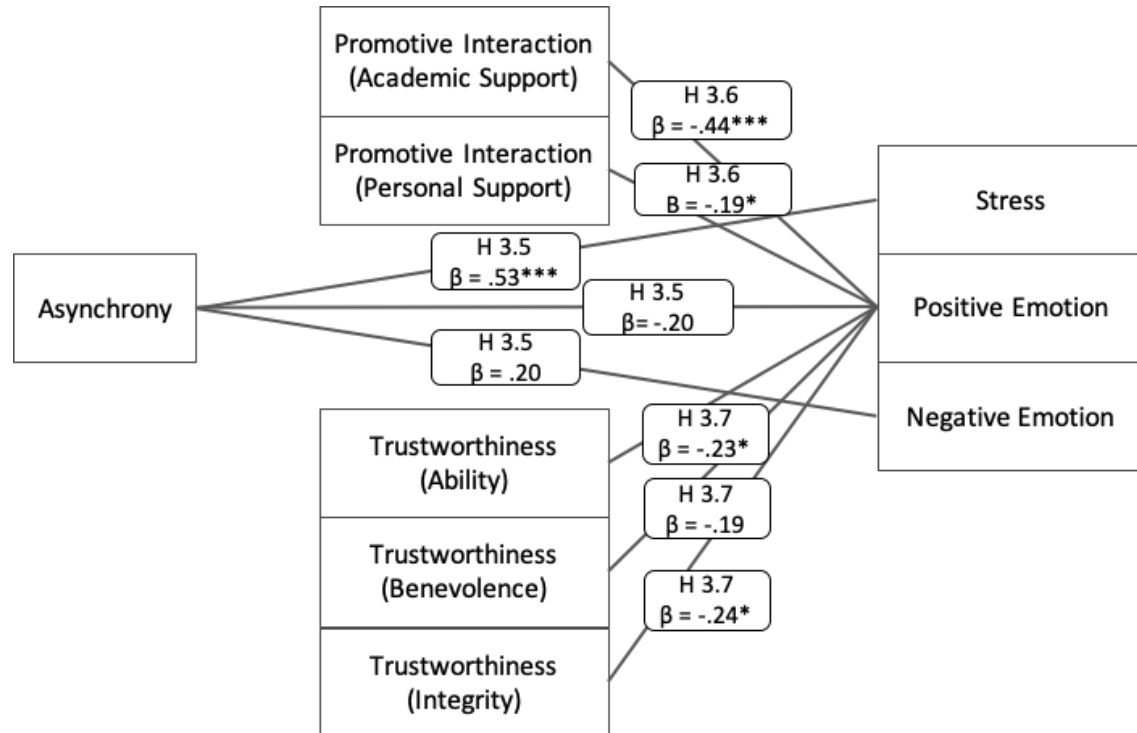
Note: the results are listed in this conceptual model are for display purposes only. Readers should not interpret this display as a structural model.

APPENDICES

Figure A1

Conceptual Framework
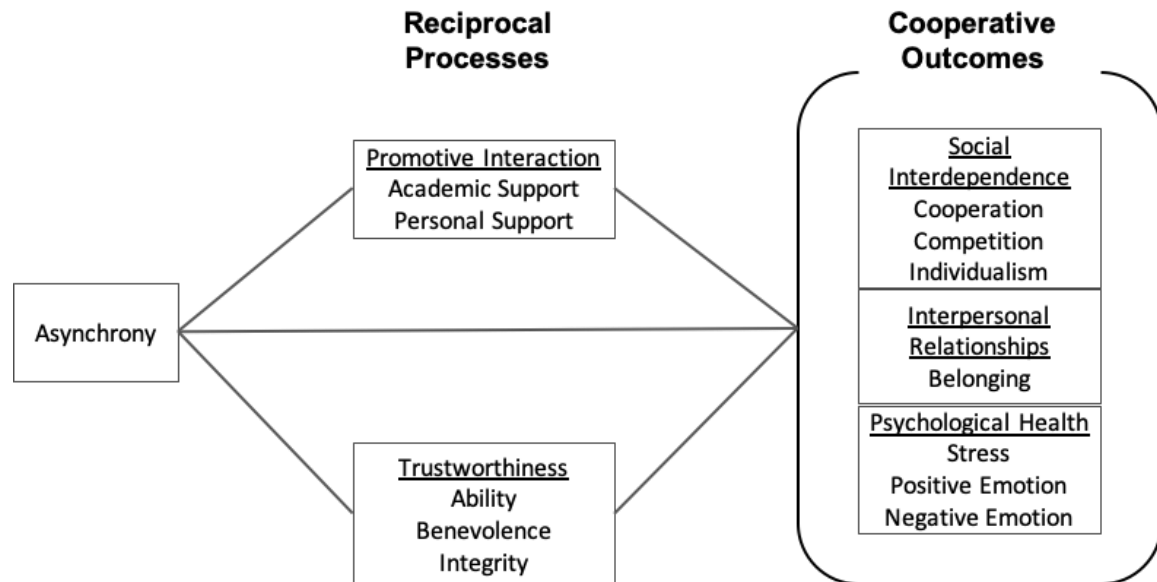
Figure A2

Conceptual Framework: Detail of Hypotheses 1.1 and 1.2
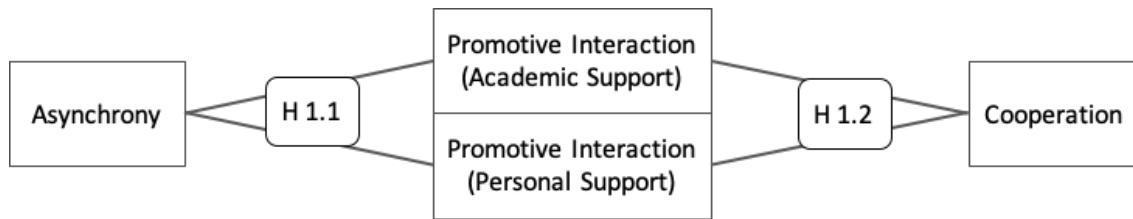
Figure A3

Conceptual Framework: Detail of Hypotheses 2.1 and 2.2
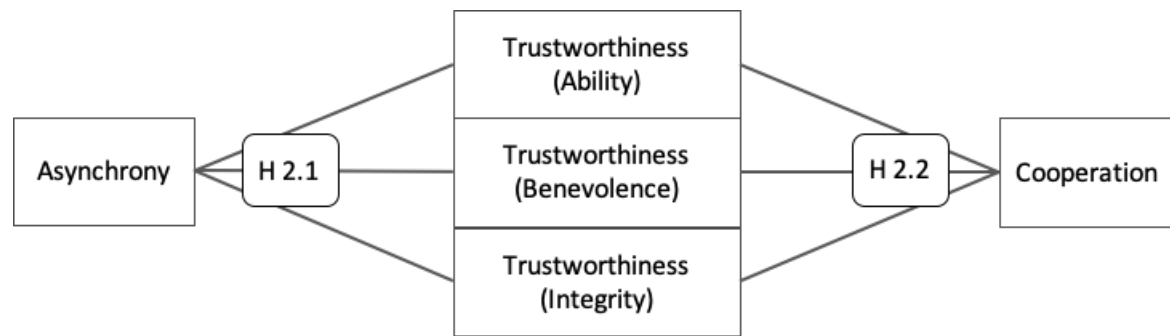
Figure A4

Conceptual Framework: Detail of Hypothesis 3.1
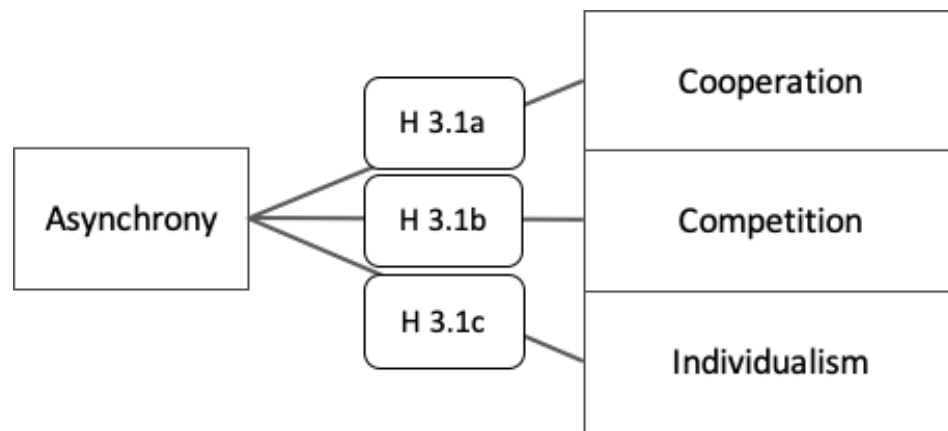
Figure A5

Conceptual Framework: Detail of Hypotheses 3.2, 3.3, and 3.4
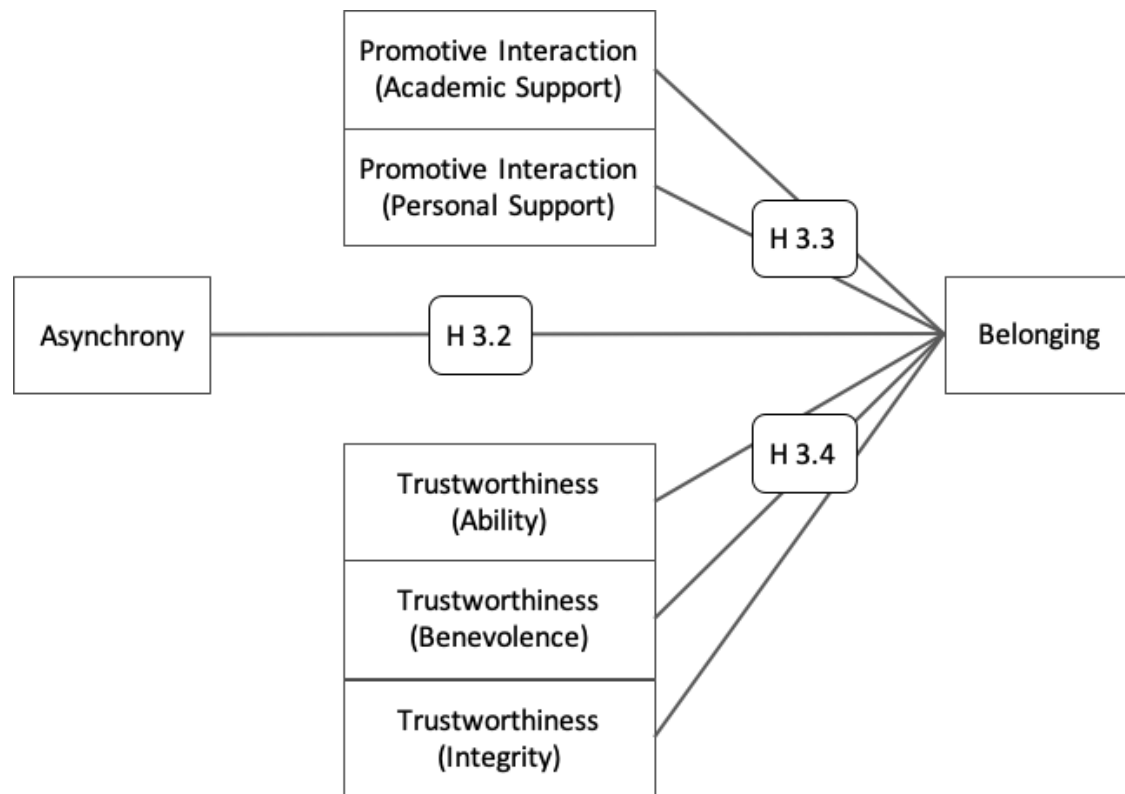
Figure A6

Conceptual Framework: Detail of Hypotheses 3.5, 3.6, and 3.7
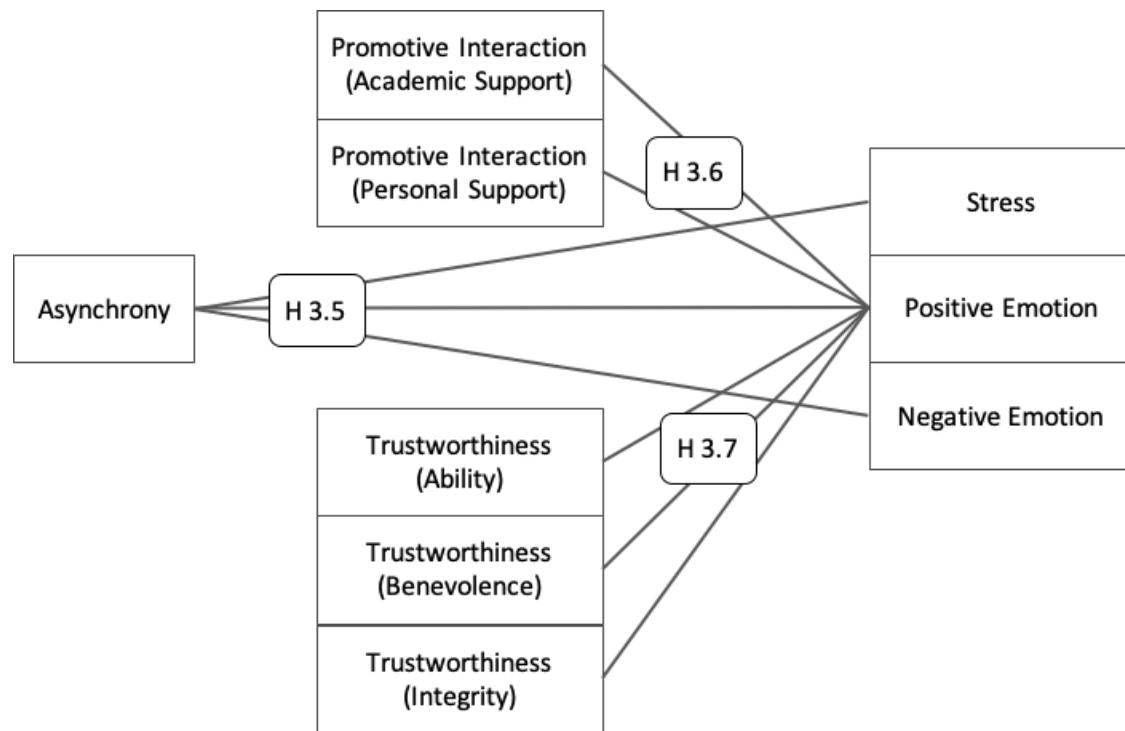
Timeline of Study

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Invitation & consent	X															
Assigned to groups		X														
Pre-survey	X	X														
Cooperative activity with 1st group			X	X	X	X	X	X	X	X	X	X	X	X		
Cooperative activity with 2nd group									X	X	X	X	X			
Survey administered								X	X					X	X	

APPENDIX C

Sample Discussion Posting Prompt

What does what you've been learning about memory say about courtroom testimony? Why do you think you answered the way you answered about the car crash? How might people be influenced in a courtroom?

Your response to this post will also be graded on:

-Length (do not be too far under or over 300 words)

-Your use of details and examples

-Good writing (style, grammar, and narrative flow)

Once you've posted your response here in the forum, you will discuss your responses with your home team.

Figure D1

PrimaryPad Example

APPENDIX E

Sample Cooperative Activity Instructions

BEFORE YOU MEET:
A. Copy and paste your Eye Witness Testimony post and your name in one of the slots.
B. Read your group-mates' posts; feel free to comment--You can use the chat box on the right to discuss. Everyone's writing will show up in a different color.

WHEN YOU MEET:
Discuss these questions as a group. There is no expected or right answer here. The goal is to think more deeply about these issues by talking about them with others. Carry out your discussion in the chat box to the right. Type a few notes under each question in the Primary Pad below about important ideas that come up in your discussion.

Your group will be graded on the thoughtfulness of your discussion, inclusion of terms and ideas about attention, connecting and building on one another's talk, and **meaningful participation by all group members.** Your success in the group activity is dependent on the success of everyone in the group, so encourage and support your team mates during the activity. Our focus in grading will be on your discussion in the PrimaryPad chat box, but there will be space in PrimaryPad for summarizing. Everyone in the group will receive the same group grade. If someone is absent for part or all of the discussion, however, that person will receive a reduced grade (0 if not present at all). Please refer to the Grading Guidelines for more details.

QUESTIONS
1. Can you think of examples when family or friends have disagreed about what happened during some shared experience in the past? Can you explain these disagreements based on what you've been learning about memory?
2. To what extent are your own childhood memories accurate records of what you actually experienced and to what extent are they constructed?
3. What are implications for child abuse cases based on children's testimony?

Guidelines for Synchronous Groups

Each week, there will be a home team group activity and discussion.

<div align="center">Home Team</div>

When you are assigned to your home team, you must determine a recurring meeting time to get together each week. Plan for 1 hour of synchronous (real-time) interaction per week. During the meeting time, your group will meet in PrimaryPad for discussion and to complete the activity.

<div align="center">Home Team Guidelines</div>

Guideline 1: Be explicit in what you are thinking or doing.

Examples: Explicitly respond when someone proposes an idea or a question. Let someone know that you're thinking or looking up something and you'll respond in a moment.

Guideline 2: Communicate frequently.

Examples: Use the PrimaryPad chat feature to hold an engaged conversation with group members. Post in the chat frequently; you don't want to go longer than 5 minutes without posting.

Guideline 3: Set deadlines and stick to them.

Examples: Set a weekly meeting time and show up on time. Determine any necessary pre-work and make sure it's completed prior to the meeting.

Grading of Synchronous Group Activities and Discussions

Across the course, the home team activities and discussions constitute 15% of your grade. Your group will be graded on the thoughtfulness of your discussion, inclusion of course terms and ideas, connecting and building on one another's talk, adherence to the home team guidelines, and most importantly, meaningful participation by all group members. Your success in the group activity is dependent on the success of everyone in the group, so encourage and support your team mates during the activity. Our focus in grading will be on your discussion in the PrimaryPad chat box, but there will be space in PrimaryPad for summarizing.

For each discussion, everyone in your home team will received the same group grade (on a 10-point scale). If someone is absent for part or all of the discussion, however, that person will receive a reduced grade (0 if not present at all).

Grading of discussions will be determined by the following criteria:
-Frequent posting in the chat box
-Address or cite a specific part of your group mate's discussion
-Incorporate course readings and terminology
-Introduce new ideas or questions for discussion about the topic
-Use and cite a resource beyond those provided in the course
-Ask thoughtful questions of your group mates.

Guidelines for Asynchronous Groups

Each week, there will be a home team group activity and discussion.

Home Team

Your home team will interact in PrimaryPad for discussion and to complete the activity.

Home Team Guidelines

Guideline 1: Be explicit in what you are thinking or doing.
Examples: Explicitly respond when someone proposes an idea or a question.

Guideline 2: Communicate frequently.
Examples: Use the PrimaryPad chat feature to hold an engaged conversation with group members. Check for new messages and post in the chat frequently; try to check in every day, but definitely at least every other day during the posting period (Tuesday through Saturday). When you check PrimaryPad and there are no new messages, post that you've checked in.

Guideline 3: Set deadlines and stick to them.
Examples: Set deadlines for when you will make your first and subsequent postings. Let your group mates know when you'll be checking for new messages.

Grading of Asynchronous Group Activities and Discussions

Across the course, the home team activities and discussions constitute 15% of your grade. Your group will be graded on the thoughtfulness of your discussion, inclusion of course terms and ideas, connecting and building on one another's talk, adherence to the home team guidelines, and most importantly, meaningful participation by all group members. Your success in the group activity is dependent on the success of everyone in the group, so encourage and support your team mates during the activity. Our focus in grading will be on your discussion in the PrimaryPad chat box, but there will be space in PrimaryPad for summarizing.

For each discussion, everyone in your home team will received the same group grade (on a 10-point scale). If someone is absent for part or all of the discussion, however, that person will receive a reduced grade (0 if not present at all).

Grading of discussions will be determined by the following criteria:
- Frequent posting in the chat box
- Address or cite a specific part of your group mate's discussion
- Incorporate course readings and terminology
- Introduce new ideas or questions for discussion about the topic
- Use and cite a resource beyond those provided in the course
- Ask thoughtful questions of your group mates.

Measures

Table F1

Items to Measure Social Interdependence

Participants will indicate the degree to which they agree with each statement by using a 5-point Likert scale ranging from strongly disagree to strongly agree.

Perceptions of competition (Time 1 α = .87; Time 2 α = .86)
        I compete with the other student(s) to see who could do the best in my group.
        I believe competing with the other student(s) is a good way to work in my group.
        I want to do better than the other student(s) in my group.
        I was happiest when I felt like I was competing with the other students in my group.
        I work to do better than the other students in my group.

Perceptions of cooperation (Time 1 α = .81; Time 2 α = .84)
        I like sharing my ideas and materials with the other students in my group.
        I learn important things from the other students in my group.
        I believe working with other students my group is better than working alone.
        I like to help the other students learn in my group.
        I like working with other students in my group.

Perceptions of individualism (Time 1 α = .88; Time 2 α = .93)
        I wish we spent a lot more time working on our own in the course.
        I would rather work alone in the course than with other students.
        I wish we would work by ourselves in the course.

Table F2

Items to Measure Motivation

Participants will indicate the degree to which they agree with each statement by using a 5-point Likert scale ranging from strongly disagree to strongly agree.

Academic efficacy (α = .84)
   I can do even the hardest work in this course if I try.
   I'm certain I can master the skills taught in TE150 this semester.
   I can do almost all the work in TE150 if I don't give up.
   I'm certain I can figure out how to do the most difficult course work in TE150.
   Even if the work is hard in TE150, I can learn it.

Situational interest (α = .91)
   I think that TE150 is very interesting.
   I think the material in this course is boring.
   To be honest, I just don't find TE150 interesting.
   I think what we're learning in this class is fascinating.
   TE150 fascinates me.

Value (α = .89)
   What I am learning in TE150 is relevant to my life.
   I think that learning about TE150 could be helpful to me in the future.
   I think that what we are studying in TE150 is useful for me to know.
   I believe that learning about TE150 can be of some value to me.
   I think that studying TE150 is important to do.
   I felt accepted by my classmates in my group.
   I felt unimportant when I was with my group members. (reversed)

Table F3

Items to Measure Belonging

Participants will indicate the degree to which they agree with each statement by using a 5-point Likert scale ranging from strongly disagree to strongly agree.

Belonging (Time 1 α = .87; Time 2 α = .85)
       I felt accepted by my classmates in my group.
       I felt unimportant when I was with my group members. (reversed)
       When I was with my group members in this class, I felt comfortable.
       When I was with my group members in this class, I felt ignored. (reversed)
       When I was with my group members in this class, I felt like I belonged.
       I felt like an outsider with my group members. (reversed)

Table F4

Items to Measure Promotive Interaction

Participants will indicate the degree to which they agree with each statement by using a 5-point Likert scale ranging from strongly disagree to strongly agree.

Peer Academic Support (Time 1 α = .86; Time 2 α = .85)
       In this group other students want me to do my best schoolwork.
       In this group other students like to help me learn.
       In this group other students care about how much I learn.
       In this group other students want me to participate in the group.

Peer Social Support (Time 1 α = .93; Time 2 α = .96)
       In this group other students think it is important to be my friend.
       In this group other students like me the way I am.
       In this group other students care about my feelings.
       In this group other students like me as much as they like others.
       In this group other students really care about me.

Table F5

Items to Measure Psychological Health

Participants will indicate the degree to which they agree with each statement by using a 5-point Likert scale ranging from strongly disagree to strongly agree.

Positive Emotions (Time 1 α = .88; Time 2 α = .90)
      While working with my group, I generally felt enthusiastic
      While working with my group, I generally felt happy
      While working with my group, I generally felt pleased

Negative Emotions (Time 1 α = .74; Time 2 α = .79)
      While working with my group, I generally felt annoyed
      While working with my group, I generally felt anxious
      While working with my group, I generally frustrated
      While working with my group, I generally bored

Stress (Time 1 α = .85; Time 2 α = .85)
Participants will indicate the degree to which they agree with each statement by using a 5-point Likert scale ranging from never to very often.
      In the last month, how often have you felt that you were unable to control the important things in your life?
      In the last month, how often have you felt confident about your ability to handle your personal problems? (reversed)
      In the last month, how often have you felt that things were going your way? (reversed)
      In the last month how often have you felt difficulties were piling up so high that you could not overcome them?

Table F6

Items to Measure Trustworthiness

The following instructions will preface the scales. The headings for each construct will be omitted from the survey. Participants will indicate the degree to which they agree with each statement by using a 5-point Likert scale ranging from strongly disagree to strongly agree.

Think about your home team. For each statement, write the number that best describes how much you agree or disagree with each statement.

Trustworthiness-ability (Time 1 α = .94; Time 2 α = .95)
   My home team is very capable of performing its work.
   My home team is known to be successful at the things it tries to do.
   My home team has much knowledge about the work that needs done.
   I feel very confident about my home team's skills.
   My home team members have specialized capabilities that can increase our
      performance.
   My home team is well qualified.

Trustworthiness-benevolence (Time 1 α = .87; Time 2 α = .89)
   My home team is very concerned about my welfare.
   My needs and desires are very important to my home team.
   My home team would not knowingly do anything to hurt me.
   My home team really looks out for what is important to me.
   My home team will go out of its way to help me.

Trustworthiness-integrity (Time 1 α = .86; Time 2 α = .81)
   My home team has a strong sense of justice.
   I never have to wonder whether my home team will stick to its word.
   My home team tries hard to be fair in dealings with others.
   My home team's actions and behaviors are not very consistent. (reversed)
   I like my home team's values.
   Sound principles seem to guide my home team's behavior.

APPENDIX G

Hypotheses, Data Sources, and Instruments

Hypotheses	Data Source / Instruments
Promotive interaction	
Hypothesis 1.1: Asynchrony will result in lower levels of promotive interaction than synchrony.	<u>Source</u>: self-reported perceptions of promotive interaction <u>Instrument</u>: Classroom Life Instrument (Johnson, Johnson, & Anderson, 1983)
Hypothesis 1.2: Promotive interaction will correlate positively with cooperative perceptions, but asynchrony will still decrease promotive interaction over time.	<u>Source</u>: self-reported perceptions of promotive interaction and cooperation <u>Instrument</u>: Classroom Life Instrument (Johnson, Johnson, & Anderson, 1983); Social Interdependence Scale (Johnson & Norem-Hebeisen, 1977)
Trustworthiness	
Hypothesis 2.1: Asynchrony will result in lower levels of trustworthiness than synchrony.	<u>Source</u>: self-reported perceptions of trustworthiness. <u>Instrument</u>: Trustworthiness Scale (Mayer & Davis, 1999)
Hypothesis 2.2: Perceptions of trustworthiness will correlate positively with cooperation, but asynchrony will diminish	<u>Source</u>: self-reported perceptions of trustworthiness and cooperation. <u>Instrument</u>: Trustworthiness Scale (Mayer & Davis, 1999); Social

the magnitude of this correlation early in the semester.	Interdependence Scale (Johnson & Norem-Hebeisen, 1977)
Social Interdependence	
Hypothesis 3.1a: Asynchrony will result in lower levels of cooperation than synchrony.	<u>Source</u>: self-reported perceptions of cooperation. <u>Instrument</u>: Social Interdependence Scale (Johnson & Norem-Hebeisen, 1977)
Hypothesis 3.1b: Asynchrony will result in higher levels of competition than synchrony.	<u>Source</u>: self-reported perceptions of competition. <u>Instrument</u>: Social Interdependence Scale (Johnson & Norem-Hebeisen, 1977)
Hypothesis 3.1c: Asynchrony will result in higher levels of individualism than synchrony.	<u>Source</u>: self-reported perceptions of individualism. <u>Instrument</u>: Social Interdependence Scale (Johnson & Norem-Hebeisen, 1977)
Cooperative Outcomes	
Hypothesis 3.2: Asynchrony will result in lower levels of belonging than synchrony.	<u>Source</u>: self-reported perceptions of belonging <u>Instrument</u>: Relatedness Scale (Furrer & Skinner, 2003)
Hypothesis 3.3: Promotive interaction will correlate positively with belonging, but	<u>Source</u>: self-reported perceptions of promotive interaction and belonging

asynchrony will decrease the magnitude of this correlation over time.	Instrument: Classroom Life Instrument (Johnson, Johnson, & Anderson, 1983); Relatedness Scale (Furrer & Skinner, 2003)
Hypothesis 3.4: Trustworthiness will correlate positively with belonging, but asynchrony will change this association over time.	Source: self-reported perceptions of trustworthiness and belonging Instrument: Trustworthiness Scale (Mayer & Davis, 1999); Relatedness Scale (Furrer & Skinner, 2003)
Hypothesis 3.5 Asynchrony will result in lower levels of positive emotions and higher levels of negative emotions and stress compared to synchrony.	Source: self-reported emotions and stress Instrument: adapted positive and negative emotion scales (Linnenbrink, 2005); Perceived Stress Scale (Cohen, Kamarck, & Mermelstein, 1983)
Hypothesis 3.6: Promotive interaction will positively correlate with positive emotion, but asynchrony will change the way promotive interaction relates to positive emotions over time.	Source: self-reported emotions and promotive interaction Instrument: adapted positive and negative emotion scales (Linnenbrink, 2005); Classroom Life Instrument (Johnson, Johnson, & Anderson, 1983)
Hypothesis 3.7 Trustworthiness will positively correlate with positive emotion, but asynchrony will change the way	Source: self-reported emotions and trustworthiness Instrument: adapted positive and negative emotion scales (Linnenbrink, 2005);

| trustworthiness relates to positive emotions over time. | Trustworthiness Scale (Mayer & Davis, 1999) |

REFERENCES

REFERENCES

Abedin, B., Daneshgar, F., & D'Ambra, J. (2014). Pattern of non-task interactions in asynchronous computer-supported collaborative learning courses. *Interactive Learning Environments*, *22*, 18–34. https://doi.org/10.1080/10494820.2011.641676

Allan, J., & Lawless, N. (2003). Stress caused by on-line collaboration in e-learning: A developing model. *Education + Training*, *45*, 564–572. https://doi.org/10.1108/00400910310508955

Balliet, D., & Van Lange, P. A. M. (2013). Trust, conflict, and cooperation: A meta-analysis. *Psychological Bulletin*, *139*, 1090–1112. https://doi.org/10.1037/a0030939

Baumeister, R. F., & Leary, M. R. (1995). The need to belong: Desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin*, *117*, 497–529.

Bedell, K. V. (2016). *Online discussion forums and the effects of ostracism and synchronicity on psychological needs, social perceptions, and motivation*. Michigan State University. Retrieved from https://search-proquest-com.proxy2.cl.msu.edu/docview/1822218629?pq-origsite=summon

Bergiel, B. J., Bergiel, E. B., & Balsmeier, P. W. (2008). Nature of virtual teams: A summary of their advantages and disadvantages. *Management Research News*, *31*, 99–110.

Berry, G. R. (2011). A cross-disciplinary literature review: Examining trust on virtual teams. *Performance Improvement Quarterly*, *24*(3), 9–28. https://doi.org/10.1002/piq.20116

Bertucci, A., Johnson, D. W., Johnson, R. T., & Conte, S. (2011). The effects of task and resource interdependence on achievement and social support: an exploratory study of Italian children. *The Journal of Psychology*, *145*, 343–360. https://doi.org/10.1080/00223980.2011.574167

Breuer, C., Hüffmeier, J., & Hertel, G. (2016). Does trust matter more in virtual teams? A meta-analysis of trust and team effectiveness considering virtuality and documentation as moderators. *Journal of Applied Psychology*, *101*, 1151–77. https://doi.org/10.1037/apl0000113

Brouwer, J., & Jansen, E. (2019). Beyond grades: Developing knowledge sharing in learning communities as a graduate attribute. *Higher Education Research & Development*, *38*, 219–234. https://doi.org/10.1080/07294360.2018.1522619

Burgoon, J. K., Dillman, L., & Stem, L. A. (1993). Adaptation in dyadic interaction: Defining and operationalizing patterns of reciprocity and compensation. *Communication Theory*, *3*, 295–316. https://doi.org/10.1111/j.1468-2885.1993.tb00076.x

Chiu, C., Hsu, M., & Wang, E. (2006). Understanding knowledge sharing in virtual communities: An integration of social capital and social cognitive theories. *Decision Support Systems*, *42*, 1872–1888. https://doi.org/10.1016/j.dss.2006.04.001

Chu, H.-C., Hwang, G.-J., & Liang, Y.-R. (2014). A cooperative computerized concept-mapping approach to improving students' learning performance in web-based information-seeking activities. *Journal of Computers in Education*, *1*, 19–33. https://doi.org/10.1007/s40692-014-0001-2

Clark, H. H., & Brennan, S. E. (1991). Grounding in communication. In *Perspectives on Socially Shared Cognition* (pp. 127–149). American Psychological Association. Retrieved from http://www.cs.cmu.edu/~illah/CLASSDOCS/Clark91.pdf

Cohen, S., Kamarch, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior*, *24*, 385–396.

Crisp, C. B., & Jarvenpaa, S. L. (2013). Swift trust in global virtual teams: Trusting beliefs and normative actions. *Journal of Personnel Psychology*, *12*, 45–56. https://doi.org/10.1027/1866-5888/a000075

Crocker, J., & Canevello, A. (2008). Creating and undermining social support in communal relationships: The role of compassionate and self-image goals. *Journal of Personality and Social Psychology*, *95*, 555–575. https://doi.org/10.1037/0022-3514.95.3.555

De Hoyos Guevara, M. L. del C. (2004). *Assessment of teamwork in higher education collaborative learning teams: A validation study*. University of Texas at Austin. Retrieved from https://repositories.lib.utexas.edu/bitstream/handle/2152/1307/dehoyosguevaram67720.pdf

De Jong, B. A., Dirks, K. T., & Gillespie, N. (2016). Trust and team performance: A meta-analysis of main effects, moderators, and covariates. *The Journal of Applied Psychology*, *101*, 1–5. https://doi.org/10.1037/apl0000110

Dennis, A. R. (2009). Media richness theory. In *Encyclopedia of Communication Theory* (pp. 641–642). SAGE Publications.

Deutsch, M. (1949). An experimental study of the effects of cooperation and competition upon group process. *Human Relations*, *2*, 199–231. https://doi.org/0803973233

Deutsch, M. (1960). The effect of motivational orientation upon trust and suspicion. *Human Relations*, *13*, 123–139.

Deutsch, M. (1985). *Distributive justice: A social-psychological perspective*. New Haven, CT: Yale University Press.

Deutsch, M. (1958). Trust and suspicion. *The Journal of Conflict Resolution*, *2*, 265–279.

Dirks, K. T., & Ferrin, D. L. (2001). The role of trust in organizational settings. *Organization Science*, *12*, 450–467.

Dumitru, C. D., & Schoop, M. A. (2016). How does trust in teams, team identification, and organisational identification impact trust in organisations? *International Journal of Management and Applied Research*, *3*, 87–97.

Dunning, D., Anderson, J. E., Schlösser, T., Ehlebracht, D., & Fetchenhauer, D. (2014). Trust at zero acquaintance: More a matter of respect than expectation of reward. *Journal of Personality and Social Psychology*, *107*, 122–41. https://doi.org/10.1037/a0036673

Ennen, N. L., Stark, E., & Lassiter, A. (2015). The importance of trust for satisfaction, motivation, and academic performance in student learning groups. *Social Psychology of Education*, *18*, 615–633. https://doi.org/10.1007/s11218-015-9306-x

Fahy, P. J. (2003). Indicators of support in online interaction. *International Review of Research in Open and Distance Learning*, *4*, 83–100.

Ferrin, D. L., Bligh, M. C., & Kohles, J. C. (2008). It takes two to tango: An interdependence analysis of the spiraling of perceived trustworthiness and cooperation in interpersonal and intergroup relationships. *Organizational Behavior and Human Decision Processes*, *107*, 161–178. https://doi.org/10.1016/j.obhdp.2008.02.012

Furrer, C., & Skinner, E. (2003). Sense of relatedness as a factor in children's academic engagement and performance. *Journal of Educational Psychology*, *95*, 148–162. https://doi.org/10.1037/0022-0663.95.1.148

Gao, Q., Dai, Y., Fan, Z., & Kang, R. (2010). Understanding factors affecting perceived sociability of social software. *Computers in Human Behavior*, *26*, 1846–1861. https://doi.org/10.1016/j.chb.2010.07.022

Ginder, S. A., Kelly-Reid, J. E., & Mann, F. B. (2018). *Postsecondary Institutions and Cost of Attendance in 2016-17; Degrees and Other Awards Conferred, 2015-16; and 12-Month Enrollment, 2015-16: First Look (Provisional Data)*.

Gouldner, A. W. (1960). The norm of reciprocity: A preliminary statement. *American Sociological Review*, *25*, 161–178. Retrieved from http://www.jstor.org/stable/2092623

Haines, R. (2014). Group development in virtual teams: An experimental reexamination. *Computers in Human Behavior*, *39*, 213–222. https://doi.org/10.1016/j.chb.2014.07.019

Hill, J. R., Song, L., & West, R. E. (2009). Social learning theory and web-based learning environments: A review of research and discussion of implications. *American Journal of Distance Education*, *23*, 88–103.

Hsu, J. L., Hwang, W. Y., Huang, Y. M., & Liu, J. J. (2011). Online behavior in virtual space: An empirical study on helping. *Educational Technology and Society*, *14*, 146–157.

Hsu, M. H., Ju, T. L., Yen, C. H., & Chang, C. M. (2007). Knowledge sharing behavior in virtual communities: The relationship between trust, self-efficacy, and outcome expectations. *International Journal of Human Computer Studies*, *65*, 153–169. https://doi.org/10.1016/j.ijhcs.2006.09.003

Hulleman, C. S., Durik, A. M., Schweigert, S. B., & Harackiewicz, J. M. (2008). Task values, achievement goals, and interest: An integrative analysis. *Journal of Educational Psychology*, *100*, 398–416. https://doi.org/10.1037/0022-0663.100.2.398

Jarvenpaa, S. L., & Leidner, D. E. (1999). Communication and trust in global virtual teams. *Organization Science*, *10*, 791–815.

Johnson, D. W., & Johnson, R. T. (1979). Conflict in the classroom: Controversy And learning. *Review of Educational Research*, *49*(1), 51–70.

Johnson, D. W., & Johnson, R. T. (1989). *Cooperation and competition: Theory and research*. Edina, MN: Interaction Book Company.

Johnson, D. W., & Johnson, R. T. (1996). Cooperation and the use of technology. In *Handbook of Research for Educational Communications and Technology: A Project of the Association for Educational Communications and Technology* (pp. 1017–1044).

Johnson, D. W., & Johnson, R. T. (1999). Making cooperative learning work. *Theory into Practice*, *38*, 67–73.

Johnson, D. W., & Johnson, R. T. (2005). New developments in social interdependence theory. *Genetic, Social, and General Psychology Monographs*, *131*, 285–358. https://doi.org/10.3200/MONO.131.4.285-358

Johnson, D. W., Johnson, R., & Anderson, D. (1983). Social interdependence and classroom climate. *Journal of Psychology*, *114*, 135–142.

Johnson, D. W., Johnson, R. T., Ortiz, A. E., & Stanne, M. (1991). The impact of positive goal and resource interdependence on achievement, interaction, and attitudes. *The Journal of General Psychology*, *118*, 341–347.

Johnson, D. W., Johnson, R. T., Roseth, C. J., & Shin, T.-S. (2014). The relationship between motivation and achievement in interdependent situations. *Journal of Applied Social Psychology*, *44*, 622–633.

Johnson, D. W., & Norem-Hebeisen, A. (1977). Attitudes toward interdependence among persons and psychological health. *Psychological Reports*, *40*, 843–850.

Kalman, Y. M., & Rafaeli, S. (2011). Online pauses and silence: Chronemic expectancy violations in written computer-mediated communication. *Communication Research*, *38*, 54–69. https://doi.org/10.1177/0093650210378229

Kalman, Y. M., Scissors, L. E., & Gergle, D. (2010). Chronemic aspects of chat, and their relationship to trust in a virtual team. In *MCIS 2010 Proceedings*. Retrieved from http://aisel.aisnet.org/mcis2010

Kalman, Y. M., Scissors, L. E., Gill, A. J., & Gergle, D. (2013). Online chronemics convey social information. *Computers in Human Behavior*, *29*, 1260–1269. https://doi.org/10.1016/j.chb.2012.12.036

Kenward, M. G., & Roger, J. H. (1997). Small sample inference for fixed effects from restricted maximum likelihood. *Biometrics*, *53*, 983–997.

Kerr, N. L., & Kaufman-Gilliland, C. M. (1994). Communication, commitment, and cooperation in social dilemmas. *Journal of Personality and Social Psychology*, *66*, 513–529.

Khawaji, A., Chen, F., Marcus, N., & Zhou, J. (2013). Trust and cooperation in text-based computer-mediated communication. In *OzCHI '13 Proceedings of the 25th Australian Computer-Human Interaction Conference: Augmentation, Application, Innovation, Collaboration* (pp. 37–40). Adelaide, Australia.

Klautke, H. (2015). *Online cooperative learning: Effects of descriptive norms and cooperative partner messages on engagement, motivation, and achievement*. Michigan State University.

Kraut, R. E., Fussell, S. R., Brennan, S. E., & Siegal, J. (2002). Understanding effects of proximity on collaboration: Implications for technologies to support remote collaborative work. In P. Hinds & S. Kiesler (Eds.), *Distributed work* (pp. 137–162). MIT Press.

Kreijns, K., Kirschner, P. A., & Jochems, W. (2003). Identifying the pitfalls for social interaction in computer-supported collaborative learning environments : a review of the research, *19*, 335–353.

Kreijns, K., Kirschner, P. A., & Vermeulen, M. (2013). Social aspects of CSCL environments: A research framework. *Educational Psychologist*, *48*(4), 229–242. https://doi.org/10.1080/00461520.2012.750225

Kunnel, A., & Quandt, T. (2016). Relational trust and distrust: Ingredients of face-to-face and media-based communication. In Blöbaum (Ed.), *Trust and communication in a digitized world* (pp. 27–49). Switzerland: Springer International. https://doi.org/10.1007/978-3-319-28059-2

Lawler, E. J., Thye, S. R., & Yoon, J. (2008). Social exchange and micro social order. *American Sociological Review*, *73*, 519–542.

Lewandowski, J., Rosenberg, B. D., Parks, M. J., & Siegel, J. T. (2011). The effect of informal social support: Face-to-face versus computer-mediated communication. *Computers in Human Behavior*, *27*, 1806–1814. https://doi.org/10.1016/j.chb.2011.03.008

Lewicki, R. J., Tomlinson, E. C., & Gillespie, N. (2006). Models of interpersonal trust development: Theoretical approaches, empirical evidence, and future directions. *Journal of Management*, *32*, 991–1022. https://doi.org/10.1177/0149206306294405

Lewis, J. D., & Weigert, A. (1985). Trust as a Social Reality. *Social Forces*, *63*, 967–985.

Linnenbrink, E. A. (2005). The dilemma of performance-approach goals: The use of multiple goal contexts to promote students' motivation and learning. *Journal of Educational Psychology*, *97*, 197–213. https://doi.org/10.1037/0022-0663.97.2.197

Long, J. D., & Pellegrini, A. D. (2003). Studying Change in Dominance and Bullying with Linear Mixed Models. *School Psychology Review*, *32*, 401–417.

Lusher, D., Kremer, P., & Robins, G. (2014). Cooperative and competitive structures of trust relations in teams. *Small Group Research*, *45*, 3–36. https://doi.org/10.1177/1046496413510362

Maruping, L. M., & Agarwal, R. (2004). Managing team interpersonal processes through technology: A task-technology fit perspective. *The Journal of Applied Psychology*, *89*, 975–990. https://doi.org/10.1037/0021-9010.89.6.975

Matschke, C., Moskaliuk, J., Bokhorst, F., Schummer, T., & Cress, U. (2014). Motivational factors of information exchange in social information spaces. *Computers in Human Behavior*, *36*, 549–558. https://doi.org/10.1016/j.chb.2014.04.044

Mayer, R. C., & Davis, J. H. (1999). The effect of the performance appraisal system on trust for management: A field experiment. *Journal of Applied Psychology*, *84*, 123–136.

Mayer, R. C., Davis, J. H., & Schoorman, F. D. (1995). An integrative model of organizational trust. *Academy of Management Review*, *20*, 709–734.

Meeuwisse, M., Severiens, S. E., & Born, M. P. (2010). Learning environments, interaction, sense of belonging and study success in ethnically diverse student groups. *Research in Higher Education*, *51*, 528–545. Retrieved from http://www.jstor.org/stable/40785093

Midgley, C., Maehr, M. L., Hicks, L., Roeser, R., Urdan, T., Anderman, E., & Kaplan, A. (1996). *The patterns of adaptive learning survey (PALS)*. Ann Arbor, MI: University of Michigan.

Molm, L. D. (2010). The structure of reciprocity. *Social Psychology Quarterly*, *73*, 119–131. https://doi.org/10.1177/0190272510369079

Molm, L. D. (2008). The structure of reciprocity and integrative bonds: The role of emotions. *Social Structure and Emotion*, 167–192. https://doi.org/10.1016/B978-0-12-374095-3.00010-0

Nowak, K. L., Watt, J., & Walther, J. B. (2009). Computer mediated teamwork and the efficiency framework: Exploring the influence of synchrony and cues on media satisfaction and outcome success. *Computers in Human Behavior*, *25*, 1108–1119. https://doi.org/10.1016/j.chb.2009.05.006

Pai, P., & Tsai, H. T. (2016). Reciprocity norms and information-sharing behavior in online consumption communities: An empirical investigation of antecedents and moderators. *Information and Management*, *53*, 38–52. https://doi.org/10.1016/j.im.2015.08.002

Pan, C.-Y., & Wu, H.-Y. (2013). The cooperative learning effects on English reading comprehension and learning motivation of EFL freshmen. *English Language Teaching*, *6*, 13–27. https://doi.org/10.5539/elt.v6n5p13

Pekrun, R. (2006). The control-value theory of achievement emotions: Assumptions, corollaries, and implications for educational research and practice. *Educational Psychology Review*, *18*, 315–341. https://doi.org/10.1007/s10648-006-9029-9

Peterson, A. T., Beymer, P. N., & Putnam, R. T. (2018). Synchronous and asynchronous discussions: Effects on cooperation, belonging, and affect. *Online Learning Journal*, *22*(4), 7–25. https://doi.org/10.24059/olj.v22i4.1517

Peterson, A. T., & Roseth, C. J. (2016). Effects of four CSCL strategies for enhancing online discussion forums: Social interdependence, summarizing, scripts, and synchronicity. *International Journal of Educational Research*, *76*, 147–161. https://doi.org/10.1016/j.ijer.2015.04.009

Porter, S., & ten Brinke, L. (2010). The truth about lies: What works in detecting high-stakes deception? *Legal and Criminological Psychology*, *15*, 57–75. https://doi.org/10.1348/135532509X433151

Ramirez, A., Zhang, S., McGrew, C., & Lin, S.-F. (2007). Relational communication in computer-mediated interaction revisited: A comparison of participant-observer perspectives. *Communication Monographs*, *74*, 492–516. https://doi.org/10.1080/03637750701716586

Ridings, C. M., Gefen, D., & Arinze, B. (2002). Some antecedents and effects of trust in virtual communities. *Journal of Strategic Information Systems*, *11*, 271–295. Retrieved from www.elsevier.com/locate/jsis

Roseth, C. J., Johnson, D. W., & Johnson, R. T. (2008). Promoting early adolescents' achievement and peer relationships: the effects of cooperative, competitive, and individualistic goal structures. *Psychological Bulletin*, *134*, 223–46. https://doi.org/10.1037/0033-2909.134.2.223

Roseth, C. J., Lee, Y., & Saltarelli, W. A. (2019). Reconsidering jigsaw social psychology: Longitudinal effects on social interdependence, sociocognitive conflict regulation, motivation, and achievement. *Journal of Educational Psychology*, *111*, 149–169.

Roseth, C. J., Saltarelli, A. J., & Glass, C. R. (2011). Effects of face-to-face and computer-mediated constructive controversy on social interdependence, motivation, and achievement. *Journal of Educational Psychology*, *103*, 804–820. https://doi.org/10.1037/a0024213

Ruef, M., Aldrich, H. E., & Carter, N. M. (2003). The structure of founding teams: Homophily, strong ties, and isolation among U.S. entrepreneurs. *American Sociological Review*, *68*, 195. https://doi.org/10.2307/1519766

Saltarelli, A. J. (2012). *Effects of belongingness and synchronicity on face-to-face and computer-mediated online cooperative pedagogy.* Michigan State University.

Saltarelli, A. J., & Roseth, C. J. (2014). Effects of synchronicity and belongingness on face-to-face and computer-mediated constructive controversy. *Journal of Educational Psychology*, *106*, 946–960.

Sarker, S. S., Ahuja, M., Sarker, S. S., & Kirkeby, S. (2011). The role of communication and trust in global virtual teams: A social network perspective. *Journal of Management Information Systems*, *28*, 273–309. https://doi.org/10.2753/MIS0742-1222280109

Sarker, S., & Sahay, S. (2004). Implications of space and time for distributed work: An interpretive study of US-Norwegian systems development teams. *European Journal of Information Systems*, *13*, 3–20. https://doi.org/10.1057/palgrave.ejis.3000485

Schellens, T., & Valcke, M. (2005). Collaborative learning in asynchronous discussion groups: What about the impact on cognitive processing? *Computers in Human Behavior*, *21*, 957–975. https://doi.org/10.1016/j.chb.2004.02.025

Schunk, D. H. (1991). Self-efficacy and academic motivation. *Educational Psychologist*, *26*, 207–231. Retrieved from https://www-tandfonline-com.proxy2.cl.msu.edu/doi/pdf/10.1080/00461520.1991.9653133?needAccess=true

Schunk, D. H., Meece, J. L., & Pintrich, P. R. (2014). *Motivation in Education: Theory, Research, and Applications* (4th ed.). Upper Saddle River, NJ: Pearson.

Scissors, L. E., Gill, A. J., Geraghty, K., & Gergle, D. (2009). In CMC we trust: The role of similarity. In *CHI 2009 - Computer Mediated Communication 1* (pp. 527–536). Boston.

Serva, M. A., Fuller, M. A., & Mayer, R. C. (2005). The reciprocal nature of trust: A longitudinal study of interacting teams. *Journal of Organizational Behavior*, *26*, 625–648. https://doi.org/10.1002/job.331

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. https://doi.org/10.1037/0021-9010.91.6.1385

Staples, D. S., & Webster, J. (2008). Exploring the effects of trust, task interdependence and virtualness on knowledge sharing in teams. *Information Systems Journal*, *18*, 617–640. https://doi.org/10.1111/j.1365-2575.2007.00244.x

Van Lange, P. A. M., Joireman, J., Parks, C. D., & Van Dijk, E. (2013). The psychology of social dilemmas: A review. *Organizational Behavior and Human Decision Processes*, *120*, 125–141. https://doi.org/10.1016/j.obhdp.2012.11.003

Van Ryzin, M. J., & Roseth, C. J. (2018a). Enlisting peer cooperation in the service of alcohol use prevention in middle school. *Child Development*, *89*, 459–467.

Van Ryzin, M. J., & Roseth, C. J. (2018b). Cooperative Learning in middle school: A means to improve peer relations and reduce victimization, bullying, and related problems. *Journal of Educational Psychology*, *110*, 1192–1201.

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*, 253–265. https://doi.org/10.1007/s10979-007-9103-y

Walther, J. B. (1992). Interpersonal effects in computer-mediated interaction: A relational perspective. *Communication Research*, *19*, 52–90. https://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* (E-book, pp. 235–257). Cambridge, MA: The MIT Press.

Walther, J. B. (2009). Theories, boundaries, and all of the above. *Journal of Computer-Mediated Communication*, *14*, 748–752. https://doi.org/10.1111/j.1083-6101.2009.01466.x

Walther, J. B., & Bunz, U. (2005). The rules of virtual groups: Trust, liking, and performance in computer-mediated communication. *Journal of Communication*, *55*, 828–846.

Walther, J. B., Bunz, U., & Bazarova, N. N. (2005). The rules of virtual groups. *Proceedings of the 38th Annual Hawaii International Conference on System Sciences*, 1–10. https://doi.org/10.1109/HICSS.2005.617

Walther, J. B., Loh, T., & Granka, L. (2005). Let me count the ways: The interchange of verbal and nonverbal cues in computer-mediated and face-to-face affinity. *Journal of Language and Social Psychology*, *24*, 36–65. https://doi.org/10.1177/0261927X04273036

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 and Electronic Commerce*, *5*, 355–378. https://doi.org/10.1080/10919399509540258

Weidman, R., & Bishop, M. J. (2009). Using the jigsaw model to facilitate cooperative learning in an online course. *The Quarterly Review of Distance Education*, *10*, 51–64.

West, B. T., Welch, K. B., Galecki, A. T., & Gillespie, B. W. (2007). *Linear Mixed Models: A Practical Guide Using Statistical Software*. Boca Raton, FL: Chapman & Hall/CRC. https://doi.org/10.1198/jasa.2008.s216

Wu, X., Anderson, R. C., Nguyen-Jahiel, K., & Miller, B. (2013). Enhancing motivation and engagement through collaborative discussion. *Journal of Educational Psychology*, *105*, 622–632. https://doi.org/10.1037/a0032792

Xu, J., Du, J., & Fan, X. (2014). Emotion management in online groupwork reported by Chinese students. *Educational Technology Research and Development*, *62*, 795–819. https://doi.org/10.1007/s11423-014-9359-0

Zschocke, K., Wosnitza, M., & Bürger, K. (2015). Emotions in group work: insights from an appraisal-oriented perspective. *European Journal of Psychology of Education*, *31*, 359–384. https://doi.org/10.1007/s10212-015-0278-1

Zumbrunn, S., McKim, C., Buhs, E., & Hawley, L. R. (2014). Support, belonging, motivation, and engagement in the college classroom: A mixed method study. *Instructional Science*, *42*, 661–684. https://doi.org/10.1007/s11251-014-9310-0