

Synchronous and Asynchronous Discussions: Effects on Cooperation, Belonging, and Affect

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Abstract

Supporting productive peer-to-peer interaction is a central challenge in online courses. Although cooperative learning is a well-established method for eliciting productive interaction (Johnson & Johnson, 1989), online modes of cooperative learning have provided mixed results. To explore the factors underlying these mixed results, we used a quasi-experimental design to examine the effects of synchrony on students' sense of cooperation, belonging, affect, and cognitive processes in online small-group, discussion-based cooperative learning. Fifty-two undergraduate students were assigned to synchronous and asynchronous interaction conditions in an online course. The findings support prior research that asynchronous communication interferes with the relationship between cooperative goals and the outcomes of cooperation. The results extend the literature by indicating that synchrony positively affects students' perceptions of belonging, positive affect, and cognitive processes. Results inform theory and practice by showing that asynchronous cooperative learning may not work as designed due to students' lack of perceptions of interdependence.

Keywords: cooperative learning, collaborative learning, asynchronous discussion, synchronous discussion, small group

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Synchronous and Asynchronous Discussions: Effects on Cooperation, Belonging, and Affect

Supporting productive peer-to-peer interaction is a central challenge in online courses. This study examines cooperative learning as a method for supporting interaction. Although cooperative learning research provides robust evidence for the positive outcomes of face-to-face cooperative learning (Johnson & Johnson, 1989), online modes of cooperative learning have provided mixed results. Online learning is often synonymous with asynchronous interaction. The increasing use of synchronous formats, however, has resulted in multiple technologies to facilitate students' interactions and expanded the modes of interaction available to students; online cooperative learning is no longer solely asynchronous (Jeong & Hmelo-Silver, 2012, 2016). Thus,

existing research on online cooperative learning may not reflect how educators and students are using communication technologies.

This study examines the effects of synchronous versus asynchronous cooperative learning on students' sense of cooperation, belonging, and affect in online small-group cooperative discussions. The purpose of the study was to identify effects of asynchronous communication on cooperative learning. In the literature review, we place cooperative learning within the context of collaborative learning, explain the gaps in asynchronous cooperative learning literature, and describe the research questions. We then describe the design of the course we studied, the measures used, and our methods of analysis. In the final sections, we discuss results, limitations, and implications.

Theoretical Framework

In collaborative learning, students work together to negotiate and create shared group meaning (Stahl, Koschmann & Suthers, 2014). Cooperative learning, a more structured form of collaborative learning, is designed to promote the interdependence of students. According to social interdependence theory, the structure of interactions affects participants' affective and motivational states, such as belonging, affect, trust, and performance (Deutsch, 1949; Johnson & Johnson, 1989, 2005). In positive social interdependence (cooperation), participants have positive feelings about the activities and those with whom they have cooperated. When participants interact effectively with positive interdependence, they communicate effectively, coordinate their efforts, and share similar beliefs and values with other group members (Deutsch, 2012). In negative social interdependence (competition), participants adopt negative attitudes toward one another and have difficulty effectively coordinating their efforts. In small-group work, cooperative goals, in which one person's goal attainment is linked with another person's, are central to positive interdependence.

Asynchronous Cooperation

When researchers (Peterson & Roseth, 2016; Roseth, Saltarelli, & Glass, 2011; Saltarelli & Roseth, 2014) have compared synchronous and asynchronous communication in cooperative online learning, they found that asynchronous communication does not always support cooperative learning processes. For example, Roseth, Saltarelli, and Glass (2011) compared synchronous and asynchronous cooperative activities in video, audio, and text modes. Although the medium did not play a role in students' motivation or academic achievement, synchrony affects students' perceptions of cooperation. Saltarelli and Roseth (2014) examined the additive effects of synchrony and belonging on cooperative perceptions and found that belonging buffers some of the negative effects of asynchrony on cooperation. These two studies were limited in the sense that participants were recruited from on-campus courses and therefore, may not necessarily be accustomed to online learning. The current study addresses this limitation by testing a series of cooperative learning activities in an actual online course.

Each of these studies found that positive goal interdependence in the design of cooperative learning activities does not predict positive social interdependence in asynchronous contexts as it does in face-to-face (FTF) contexts. Therefore, there is a need to explore how synchrony affects cooperative learning. The first research question this study explores is whether cooperative perceptions are achieved similarly in synchronous and asynchronous modes.

Cooperative Learning Outcomes: Belonging and Affect

The second focus of this study is on cooperative outcomes of belonging and affect (positive and negative). Positive interdependence leads to a great sense of belonging (Johnson & Johnson, 1989) in cooperative learning. *Belongingness* refers to frequent, positive interaction with others that occurs within an ongoing relationship of mutual caring (Baumeister & Leary, 1995). Cooperation is driven, in part, by an individual's need to belong, and thereby leads to a higher sense of belonging than competition and individualism (Johnson & Johnson, 1989). Even when participants view others as being outside their group, those in cooperative situations view others more positively than those in competitive or individualistic situations (Worchel, Axsom, Ferris, Samaha, & Schweizer, 1978). When viewed through the lens of student engagement, belonging contributes to students' social-behavioral engagement, which refers to emotional engagement in specific learning tasks such as peer interaction (Pekrun & Linnenbrink-Garcia, 2012). Saltarelli and Roseth (2014) found that belonging could ameliorate some of the negative effects of asynchrony. Because they manipulated belonging in their study, it is unclear how belonging naturally develops in online cooperation. Additional clues to the role of belonging in online cooperation lie in social presence literature.

Social presence, the perception of "realness" of someone in online communication (Gunawardena, 1995), is related to belonging in that it can contribute to the ongoing relationship among students. In a recent review of collaborative learning, Cherney, Fetherston, and Johnsen (2017) found that technologies that afford more cues (e.g., video, audio, synchrony) are associated with greater social presence. Further evidence is needed to understand how belonging relates to online cooperation. Our second research question asks whether synchrony affects belonging in cooperative learning, which we investigate by analyzing students' self-report measures.

Emotion is defined as a short-term, specific feeling (Schunk, Meece, & Pintrich, 2014) and may be positive (e.g., enthusiastic, happy) or negative (e.g., anxious, frustrated). Cooperation generally elicits positive emotions and inhibits negative emotions (Zschocke, Wosnitza, & Bürger, 2015). Do these emotions occur in online interaction? Meyer and Jones (2012) found that online student presented emotions and interpreted the emotions of others in an effective way. Although students can express and interpret emotions in asynchronous and text-based environments, it is unclear whether asynchronous cooperation elicits the positive emotions that it does in face-to-face environments. Our third research question focuses on the association between synchrony and emotions in cooperative learning. We answer this research question by analyzing a self-report measure and chat logs in an online course.

Cognitive Processes in Asynchronous Cooperation

Our final focus of this study is to explore how cognitive processes might differ in synchronous and asynchronous cooperation. Cooperative learning encourages cooperative processing and enhances the incorporation of other's ideas and reasoning into one's thinking (Johnson & Johnson, 1989). Although cooperative learning literature provides strong evidence for its ability to stimulate cognitive processing, it is unclear whether these effects occur consistently in asynchronous cooperative learning.

In his examination of asynchronous discussions, Waters (2012) found that students could emerge as thought leaders, helping stimulate conversation and interaction with others. Those who were rated as thought leaders by their peers posted more frequently and visited the discussions more frequently than those who were not rated as thought leaders. His findings suggest that activity

in the discussion, regardless of whether it is synchronous or asynchronous, can elicit rich discussion and deep cognitive processing.

Although cognitive processing may have the potential to reach similar levels in synchronous and asynchronous conditions, the processes used in each condition may be different. For example, Wicks et al. (2015) compared high-collaboration and low-collaboration groups. The high-collaboration group worked synchronously and the low-collaboration group worked asynchronously. They found more forethought and planning in synchronous groups and more reflection in the asynchronous groups. These mixed results inform our fourth research question: do students engage in similar cognitive processes in both synchronous and asynchronous cooperation? To explore this question, we analyzed the chat logs in an online course.

Clarifying the way asynchrony affects online cooperation is important to help instructors design learning activities that achieve the desired outcomes. This study clarifies those effects by exploring four research questions in a mixed methods study. The first research question (synchrony's effect on cooperation) builds on previous research showing that asynchronous cooperation changes students' perceptions of social interdependence, diminishes cooperative perceptions and increases competitive and individualistic perceptions (Peterson & Roseth, 2016; Roseth et al., 2011; Saltarelli & Roseth, 2014) and extends the generalizability of the previous research. The second research question (synchrony's effect on belonging) builds on previous research showing that belonging can buffer some of the effects of asynchrony on cooperation (Saltarelli & Roseth, 2014) and that rich technology can support social presence (Cherney, Fetherston, & Johnsen, 2017). The third research question (synchrony's effect on emotion) follows from previous research showing that students can effectively express and interpret emotions online (Meyer & Jones, 2012), but it is unclear whether online cooperation elicits positive emotions and inhibits negative emotions (Zschocke, Wosnitza, & Bürger, 2015). The fourth research question (synchrony's effect on cognitive processes) follows from previous research that indicates that students engage in different cognitive processes when cooperating asynchronously versus synchronously (Wicks et al., 2015).

Methods

This study explores asynchronous cooperation to investigate the factors underlying the results of prior studies that indicate asynchrony affects the well-established processes of cooperative learning. We gathered quantitative and qualitative data to examine the following research questions.

1. Are there differences in cooperative processes between synchronous and asynchronous modes of cooperative learning?
2. Are there differences in belonging between synchronous and asynchronous modes of cooperative learning?
3. Are there differences in emotion (positive and negative) between synchronous and asynchronous modes of cooperative learning?
4. Are there differences in how students engage in cognitive processes when in synchronous/asynchronous modes of discussion?

Participants

We collected data from 52 undergraduate students (62% female, 91% Caucasian) in an online teacher education course at a public university in the Midwest. See Table 1 for demographic characteristics.

Table 1.

Participant Demographic Characteristics

Students (N=52)	% Students
<i>Sex</i>	
Male	38%
Female	62%
<i>Race/Ethnicity</i>	
White	90%
Black	4%
Multi-Racial	2%
Asian/Pacific Islander	2%
Unknown	2%
<i>Age</i>	
18-19	8%
20-21	65%
22-24	27%
<i>Year in School</i>	
First	4%
Second	6%
Third	17%
Fourth	67%
5+	6%

The Course

The online course examines learning in and out of school settings from a variety of theoretical perspectives. The course is required for all students entering the teacher preparation program and is also taken by students in other programs as an introduction to psychological and other perspectives on learning. The instructor structured the course as eight two-week modules, with materials for independent work as well as an expectation of weekly participation in small-group discussions. Students were assigned to three- to four-person *home teams* for these weekly discussions. Each student worked with the same home team for the first half of the semester, with new teams formed at mid-semester for the remainder of the course. These weekly small-group discussions are the focus of this study.

The small-group discussions took place in *TitanPad* (<https://titanpad.com>), a collaborative writing tool in which users can simultaneously edit a shared document and engage in text-based chat in an adjacent window (see Figure 1). Each person’s writing and chat entries show up in a different color, making individual contributions apparent. Group tasks were presented in the TitanPad document; group members discussed with their group members in the chat window and wrote in the shared document in response to a given prompt, such as “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?” The instructor designed the group work around each module’s topics, specifically behaviorism, individual cognitive processing (memory, attention, schemas, stereotypes), social learning and cooperative learning, motivation, and learning as development.

The screenshot displays the TitanPad interface. At the top, there is a title bar with the document name "M6P1-RED-A-Motivation (rename)" and several utility icons: Security, Pad Options, Import/Export, Saved revisions, and Time Slider. Below the title bar is a rich text editor toolbar with icons for bold, italic, underline, strikethrough, bulleted list, numbered list, link, unlink, image, and undo/redo.

The main document area contains the following text:

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 TitanPad below about important ideas that come up in your discussion.

You 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. Our focus in grading will be on your discussion in the chat box; your notes in the TitanPad below are just 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).

Carol Dweck argues that people often hold one of two mindsets about intelligence: a *fixed* mindset or a *growth* mindset.

- 1. What is the *fixed* mindset and how does it affect a student's motivation?**
Having a fixed mindset is when a person believes that there is a certain fixed or set limit to their intelligence or other traits and that no matter what they do they can not exceed this limit because they are born with it. This has a negative effect on a student's motivation because the students would lack any sort of effort if they felt as though their intelligence could reach a certain limit.
- 2. What is the *growth* mindset and how does it affect a student's motivation?**
Growth mindset is basically the opposite of a fixed mindset. It is the mindset of always being able to learn more and more as long as you put in the effort. There is no limit to how much one can learn or how smart one can be. This leads to a higher sense of motivation because people know they can get better.
- 3. According to Dweck, how does the praise a teacher gives affect students' mindsets?**
It can stunt their mindsets and cause them to feel like they have a fixed level of learning. The problem usually comes from praising their intelligence as opposed to their effort. Effort is better, because then a student is willing to try harder because they feel they can do the task if they try hard enough, but if it is intelligence they won't try harder because they feel they just are not smart enough for that task and will stick with simpler tasks.
- 4. Does the fixed vs. growth mindset explanation explain any of your own experiences with motivation to learn and perform in particular domains, e.g., particular school subjects, sports, music?**
One example that we found when growing up was my difficulty in understanding why some kids were better at certain sports than we were. For example (Robert) would always get sad or angry when I would lose in a soccer game because the other team was better. I would always think to myself they were just born with better skills and I'll never be able to match that no matter how hard I try. But obviously that not true. I would lack in certain genetic dispositions but I could always practice and develop to learn the game.

On the right side of the interface is a chat window. It features a header with a profile picture placeholder and the text "Invite other users and they will show up here." Below this is a "Share this pad" button. The chat history shows several messages from participants, each with a timestamp:

- [Redacted] right, so you shouldn't motivate based on intelligence 17:41
- [Redacted] She does not advocate for it very much 17:41
- [Redacted] to say the least 17:41
- [Redacted]: Effort is ok though 17:41
- [Redacted]: Cause that will motivate them to keep trying harder 17:41
- [Redacted]: right because then you're praising them for their attempt 17:41
- [Redacted]: exactly 17:41
- [Redacted]: they want to keep trying 17:41
- [Redacted] 4? 17:45
- [Redacted]: So for number 4 I can't really think of a time when I had a fixed mindset on anything 17:45
- [Redacted]: for question 4, I remember when I was younger I used to get really discouraged playing soccer and never want to practice when we played teams where the kids were better than I was because I always thought to myself that kids were just born with really good soccer skills and I would never get that good 17:45
- [Redacted]: Yea thats a good point actually 17:45
- [Redacted]: Honestly I still think to myself when I watch professionals that I think no matter how hard I practiced or trained I would never be able to learn and develop that much 17:46
- [Redacted]: but in reality thats not true 17:46
- [Redacted]: if you put in enough work you could get there 17:46
- [Redacted]: Yea it also depends on the environment you grow up in 17:46
- [Redacted]: Cause pros most likely started at a really young age and had their parents sending them to camps and other training stuff all their lives 17:47

At the bottom of the chat window is a "Chat:" label and a text input field.

Figure 1. TitanPad example activity.

Enrolled students were divided randomly into four class sections, with home teams formed within each section. The weekly small-group discussions took place *synchronously* in two course sections, *asynchronously* in the other two sections. In the synchronous sections, home teams were directed to agree on a one-hour meeting time between Tuesday and Saturday to hold their small-group discussions. Students in the asynchronous sections were directed to participate in their small-group discussion between Tuesday and Saturday each week, with encouragement to participate several times during that time block. Each discussion activity was designed with cooperative goals and instructions to encourage cooperative interaction among group members. Tasks and discussion questions were the same for synchronous and asynchronous sections.

To encourage cooperative behaviors, we provided students with a set of guidelines for participating in group work, which was consistent with prior research indicating computer-mediated communication rules that enhance trustworthiness and reduce uncertainty (Walther & Bunz, 2009). The guidelines instructed students to communicate frequently, set deadlines and adhere to them, connect and build on one another's talk, and encourage meaningful participation by all group members. The guidelines included illustrative examples that were specific to the synchronous or asynchronous modality. For instance, the synchronous example for the *communicate frequently* guideline was, "Use the TitanPad 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." The example for asynchronous students was, "Use the TitanPad 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 TitanPad and there are no new messages, post that you've checked in."

Self-Report Measures

We administered surveys at two time points: the middle of the semester (after the final discussion with the first home teams) and the end of the semester (after the final discussion with the second home teams). The surveys included items on various motivational and social interdependence constructs. All items included in the analyses were measured on a 5-point Likert scale from 1 (*strongly disagree*) to 5 (*strongly agree*). Means and standard deviations for variables used in the analyses are presented in Table 2.

Table 2.

Descriptive Statistics

	Async T1	Sync T1	Async T2	Sync T2	Async Total	Sync Total
	<i>M</i> (SD)					
Individualism	3.59 (0.99)	3.24 (1.01)	3.65 (1.10)	2.99 (1.17)	3.59 (0.95)	3.15 (0.96)
Cooperative	3.23 (0.94)	3.55 (0.66)	3.30 (0.93)	3.50 (1.05)	3.31 (0.89)	3.52 (0.73)
Competitive	2.58 (0.64)	2.62 (0.86)	2.69 (0.67)	2.57 (1.01)	2.65 (0.54)	2.61 (0.79)
Belonging	3.76 (0.70)	4.14 (0.65)	3.75 (0.67)	4.19 (0.74)	3.77 (0.67)	4.18 (0.63)
Positive Affect	2.48 (1.01)	2.78 (1.02)	2.71 (1.15)	2.68 (1.10)	2.58 (0.93)	2.72 (0.95)
Negative Affect	2.37 (1.15)	1.73 (0.85)	2.17 (1.05)	1.86 (1.05)	2.25 (0.92)	1.79 (0.91)

Belonging and affect. Student perceptions of belonging and affect were used as measures of motivation. Composite variables were constructed to assess each construct at Time 1 and Time 2. Student perceptions of belonging ($\alpha = .82; .85$) consisted of six items (“I felt accepted by my group members”) and was adapted from Furrer and Skinner’s (2003) measure. Positive affect ($\alpha = .91; .95$) was constructed from three items (“While working with my group, I generally felt happy”), and negative affect ($\alpha = .81; .85$) was constructed from three items (“While working with my TitanPad Group, I generally felt anxious”) from Linnenbrink’s (2005) measure.

Social interdependence. Perceptions of cooperation, competition, and individualism were assessed using the Social Interdependence Scale (Johnson & Norem-Hebeisen, 1977). Composite variables were constructed to assess each construct at Time 1 and Time 2. Perceptions of cooperation ($\alpha = .86; .91$) were assessed using a five-item scale (“I learn important things from the other students in my group). Perceptions of competition ($\alpha = .82; .81$) were assessed using a five-item scale (“I believe competing with the other student(s) is a good way to work in my group”). Perceptions of individualism ($\alpha = .86; .91$) were assessed using a three-item scale (“I wish we would work by ourselves in this course”).

LIWC Measures

Initially, we examined the chat logs from each cooperative group by counting the number of posts in each group activity. To further examine the chat logs, we used Linguistic Inquiry and Word Count software (Pennebaker, Booth, Boyd, & Francis, 2015) to examine word count, positive emotion, negative emotion, discrepancy, and certainty. The LIWC software identifies psychological constructs in writing by identifying words within categories, which were developed from psychological measurements. Independent judges rated the word lists to determine the final lists, and then the lists were revised and refined in 1997 and 2007. For each construct, the software determines the percentage of category words within the entire text. Some categories, such as affect, have been evaluated for their correspondence to self-report measures. For example, Tov, Ng, Lin, and Qiu (2013) found that LIWC-identified frequency coefficients for positive and negative emotion correlated with self-reported positive and negative emotions.

In addition to examining affect in the chat logs, we explore cognitive processes by analyzing two LIWC variables: discrepancy and certainty. The greater use of discrepancy words indicates that the writer is diverting attention away from him or herself (Pennebaker, 2011), and the use of discrepancy verbs suggests a difference between reality and how the writer wants things to be. Discrepancy words are correlated to influencing behavior (Pennebaker, 2011) and high performance (Rodrigo, 2017), and indicates analytical thinking. High use of certainty words can lead to more perceptions of trustworthiness, and they broadcast an individual's willingness to take risks (Moons, Spoor, Kalomiris, & Rizk, 2013; Watson & Spence, 2007). Trustworthiness is especially important for cooperation, as they develop reciprocally, with trustworthiness creating more cooperation and more cooperation creating more trustworthiness (Ferrin, Bligh, & Kohles, 2008). We expect both discrepancy and certainty words to be present in the cooperative groups because trustworthiness affects cooperation and cognitive processing in cooperative groups relies on explaining, summarizing, and integrating ideas from other.

In our study, each chat post in the chat logs varied from one word to 495 words, which could skew the construct ratio for shorter posts. Therefore, we aggregated all of the posts from an individual in a specific conversation and conducted our analysis at the conversation level. The content of the course encouraged the use of specific words that may have influenced the LIWC

analysis. For example, the discussion about stereotypes may have triggered the use of more negative emotion words (e.g., hurt, worried, annoyed) than the discussion about behaviorism. Although the topics may have affected the LIWC analysis, we assumed that the topics would have the same influence in both the synchronous and asynchronous groups.

Analysis

The first, second, and third research questions (synchrony and cooperative perceptions, synchrony and belonging, and synchrony and emotion) were answered by conducting a repeated measures MANOVA using self-report measures of cooperation, competition, individualism, belonging, positive affect, and negative affect. In addition, we conducted a multiple linear regression to supplement our primary analysis. To answer our fourth research question (synchrony and cognitive processes) and further explore the third research question (synchrony and emotion) we conducted a one-way between-groups MANOVA with the LIWC-coded chat log data for positive emotion, negative emotion, discrepancy, and uncertainty.

Results

Preliminary Self-Report Analysis

Means and standard deviations of all variables used in the self-report analysis are presented in Table 2. Overall, students in asynchronous groups reported higher levels of individualism, competition, and negative affect compared to students in the synchronous groups. Students in the synchronous groups reported higher levels of cooperative perceptions, belonging, and positive emotions compared to students in the asynchronous groups.

Self-Report Analysis

To address the first three research questions (asynchrony's effect on cooperation, belonging, and emotion), a repeated measures MANOVA was conducted to examine whether there were differences in belonging, individualism, and negative affect between groups (synchronous/asynchronous) and within groups (two time points). Five students were dismissed from the final analyses due to incomplete data, leaving 47 students (51% synchronous). Results are presented in Table 3.

Table 3

Summary of Repeated Measures MANOVA

Factor	MANOVA, $F(6, 40)$	ANOVA, $F(1, 45)$					
		Ind	Coop	Comp	Bel	Pos Aff	Neg Aff
Synchrony	1.39	3.97**	1.84	0.02	4.72**	0.26	3.66*
Time	0.20	0.41	0.20	0.29	0.57	0.09	0.26
Synchrony x time	0.74	0.55	0.89	0.53	0.20	1.28	2.37

* $p < .10$, ** $p < .05$

The repeated measures MANOVA showed no significant multivariate effect for between subjects (for each construct) across learning mode (regardless of time), $F(6,40) = 1.39$, $p = 0.24$. Furthermore, there was no significant multivariate effect for within-subjects across time

(regardless of learning mode), $F(6,40) = 0.20, p = 0.98$. There was also no significant multivariate effect across interaction between learning mode and time, $F(6,40) = 0.74, p = 0.62$.

However, when we examined the univariate results of the study, student perceptions of belonging were higher for students in the synchronous group than the asynchronous group, $F(1,45) = 4.72, p = 0.04$, partial eta squared = 0.10; perceptions of individualism were higher for students in the asynchronous group than the synchronous group, $F(1,45) = 3.97, p = 0.05$, partial eta squared = 0.08; and negative affect was higher for students in the asynchronous group than in the synchronous group, $F(1,45) = 3.66, p = 0.06$, partial eta squared = 0.08. There were no significant differences between synchronous and asynchronous groups when examining positive affect, perceptions of cooperation, or perceptions of competition. Although there were significant differences between online learning mode, there were neither significant effects across time for the constructs measured nor significant interaction between learning mode and time.

Secondary Self-Report Analysis

Because significant differences were found between synchronous and asynchronous groups for multiple measures, we conducted a linear multiple regression to supplement our primary analysis. Synchrony and social interdependence variables (cooperation, competition, and individualism) were used as predictors to examine the relationship between belonging and negative affect. Composite variables were constructed to represent average levels of belonging, negative affect, cooperation, competition, and individualism across all time points. Correlations for variables included in this analysis are included in Table 4. Results of the multiple regression are included in Table 5.

Table 4

Correlations

	1	2	3	4	5	6
1. Synchrony						
2. Belonging	.30*					
3. Negative Affect	-.25	-.66**				
4. Competition	-.03	-.24***	.26			
5. Cooperation	.14	.72**	-.58**	.03		
6. Individualism	-.23	-.47**	.66**	.30*	-.64**	

* $p < .05$, ** $p < .01$, *** $p < .001$

Table 5
Summary of Multiple Regressions

	Belonging		Negative Affect	
	B (SE)	β	B (SE)	β
Intercept	1.78 (0.56)		1.61 (.90)	
Synchrony	0.31 (0.12)	0.23*	-0.20 (0.20)	-0.11
Competition	-0.32 (0.10)	-0.32**	0.20 (0.16)	0.15
Cooperation	0.70 (0.10)	0.83***	-0.37 (0.16)	-0.33*
Individualism	0.15 (0.09)	0.22	0.37 (0.14)	0.39*
F (4, 46)	20.49***		11.94***	
R ²	0.64		0.51	
Adj R ²	0.61		0.47	

* $p < .05$, ** $p < .01$, *** $p < .001$

For belonging, 61% of the variation was explained by synchrony, cooperation, competition, and individualism, $F(4, 46) = 20.49$, $p < .001$. All independent variables were significant except for individualism. Cooperation ($\beta = .83$, $p < .001$) positively predicted belonging whereas competition ($\beta = -.32$, $p = .002$) negatively predicted belonging. Synchrony also showed a positive relationship with belonging ($\beta = .23$, $p = .02$). For negative affect, 47% of the variation was explained by the individualism variable, $F(4, 46) = 11.94$, $p < .001$. The only significant predictors of negative affect were cooperation ($\beta = -.33$, $p = .03$) and individualism ($\beta = .39$, $p = .01$).

Preliminary LIWC Analysis

Students exchanged 4,379 posts over 11 discussions, with students in the synchronous group exchanging most of the posts (84.9%). At the conversation level, students in the synchronous and asynchronous conditions posted in different patterns. Synchronous students wrote 218.43 ($SD = 159.61$) words per conversation, with an average of 14.99 ($SD = 15.67$) words per post. Asynchronous students wrote 108.04 ($SD = 79.71$) words per conversation with an average of 31.17 ($SD = 28.91$) words per post. In other words, the synchronous students rapidly exchanged shorter posts. A t-test was used to confirm that there were significant differences for words per conversation ($t(461) = -9.08$, $p < .001$) and words per post ($t(4516) = 22.06$, $p < .001$) between synchronous and asynchronous students. Using Cohen's (1988) guidelines, the magnitude of the differences in the means for words per conversation (mean difference = -110.38, 95% *CI*: -134.29 to -86.49) was large (eta squared = .15) and the magnitude of the differences in the means for words per post (mean difference = 16.18, 95% *CI*: 14.75 to 17.723) was moderate (eta squared = .10).

Means and standard deviations of all variables included in the LIWC analysis of chat logs are included in Table 6. Overall, students in the synchronous groups had higher mean values on all variables included in the analysis compared to students in the asynchronous groups.

Table 6

LIWC Descriptive Statistics

	Async	Sync
	<i>M</i> (SD)	<i>M</i> (SD)
Tone	69.21(30.41)	76.92 (26.41)
Affect	5.69 (4.72)	6.36 (4.06)
Positive Emotion	4.70 (4.80)	4.98 (3.20)
Negative Emotion	0.94 (1.58)	1.33 (2.66)
Discrepancy	1.71 (1.93)	2.12 (1.85)
Tentativeness	3.11 (2.83)	3.43 (2.18)
Certainty	1.59 (1.80)	2.37 (3.44)

LIWC Analysis

To explore the fourth research question (synchrony's effect on cognitive processes) and further examine the third research question (synchrony's effect on emotion), a one-way between-groups MANOVA was used to investigate differences between synchronous and asynchronous groups on positive emotion, negative emotion, discrepancy, and certainty in discussion posts using the LIWC software. Results are presented in Table 7.

Table 7

LIWC One-way Between-Groups MANOVA

Factor	MANOVA, <i>F</i> (7, 455)	ANOVA, <i>F</i> (1, 461)						
		Tone	Affect	Positive Emotion	Negative Emotion	Discrepancy	Tentativeness	Certainty
Synchrony	5.71 ^{***}	8.51 ^{**}	2.74 [†]	0.57	3.47 [†]	5.50 [*]	1.93	8.86 ^{**}

^{***}*p* < .001, ^{**}*p* < .01, ^{*}*p* < .05, [†]*p* < .10

There was a statistically significant difference between synchronous and asynchronous groups on the combined dependent variables, $F(4, 458) = 5.41, p < 0.001$; Pillai's Trace = 0.05; partial eta squared = 0.05. When the results for the dependent variables were considered separately, significant results were found between groups for negative emotions $F(1, 461) = 3.47, p = 0.063$, partial eta squared = 0.007, discrepancy $F(1, 461) = 5.50, p = 0.019$, partial eta squared = 0.012, and certainty $F(1, 461) = 8.86, p = 0.003$, partial eta squared = 0.019. No significant results were found between groups for positive emotions. When examining the mean scores, students' in the synchronous groups had higher mean scores on negative emotions, discrepancy, and certainty when compared to students' in the asynchronous groups.

Discussion

This study explored the effects of synchrony on belonging and affect as outcomes of cooperation. As expected, students communicating asynchronously had higher individualistic perceptions. This finding supports prior research that asynchronous communication interferes with the relationship between cooperative goals and cooperation (Peterson & Roseth, 2016; Roseth, Saltarelli, & Glass, 2011; Saltarelli & Roseth, 2014). Those who collaborated asynchronously also

had lower perceptions of belonging and higher negative affect. Although these findings might suggest that asynchrony negatively affects the outcomes of cooperative learning, our second analysis revealed a more precise understanding and extends prior research.

In our second analysis of the self-report measures, we investigated the two cooperative outcomes identified as having mean differences (belonging and negative affect) to identify whether asynchrony affected those outcomes beyond its effect on cooperation. We found that asynchrony affects the relationship between cooperative goals and cooperative perceptions, but the relationship between cooperative perceptions and outcomes is mixed. Both synchrony and interdependence perceptions predicted belonging. In the self-report measures, we found that interdependence perceptions (cooperation and individualism) were significant predictors of negative affect, while synchrony was not.

Chat Logs

Within the chat logs, the LIWC analysis identified words for each category. The results described above indicate that both the synchronous and asynchronous groups were similar in their use of positive emotion words, like *agree*, *better*, *well*, and *great*. Synchronous groups used more negative emotion words (e.g., *sorry*, *disagree*, *mistake*, *bad*), discrepancy words (e.g., *should*, *would*, *could*, *hoping*), and certainty words (e.g., *always*, *never*, *all*, *completely*). In this section, we provide examples of how students used the words in each of these categories, and those words are indicated by the italicized text.

Pennebaker (2011) describes the LIWC emotion words as a “rough measure of people’s emotional state” (location 204). Arguello et al. (2006) found that the use of emotion words in online discussions increase the likelihood of getting a reply to a post. Emotion words have been used to measure a person’s immersion in an experience or event (Tausczik & Pennebaker, 2010). In this study, students use positive emotion to express agreement with and encouragement to their group mates. In using negative emotion words, they apologized for poor team behavior and compared their ideas with those of others. In addition, the group discussion about stereotypes elicited negative emotion words.

Students often used positive emotion words to express agreement with their group mates. For example, one student posted, “Hello! :) *Okay*, sounds *good!* :) So, I think we can *agree* the reason why we didn’t notice the changing objects in the card trick and monkey business videos are due to use paying close attention to something else.” Another student posted, “And I really *liked* how you connected the concept of selective attention to how we behave in society. Yeah i *agree* with that!!”

Students used positive emotion words to make supportive and encouraging statements to group members. One student posted, “Casey *great* example of a TV show that stereotypes.”, and another posted:

I also found it very *interesting* that none of us brought up the same stereotypes. We all discussed something different, but they all stemmed from what society told us to think, mass media, or others in our lives. I also am *glad* that we came to our own judgment about the stereotypes in our lives. I *truly enjoyed* reading everyone's post and everyone did a *great* job!

Many of the negative emotion examples included apologies. For example, variations of “Hi Everyone... *Sorry* for the delay on joining the group.” was common in the synchronous groups.

Negative emotion words appeared in post that expressed problems with technology, such as “I'm really *sorry* I'm so *confused* by this titan pad thing 😞” and “Tiffany, I made a *mistake* and erased some of your name and it's showing up in my color. I'm going to erase that and you can put it back if you want.”

Few students used negative emotion words when comparing their ideas with those of their group mates. For example, one student said, “I *disagree* with Jacob because I believed fixed mindset is when people don't think they can change the way they think and learn.” Although students rarely used negative emotion words to disagree with each other in practice, they recognized that disagreement was part of cooperative learning, as one student describes, “I feel that working together means that a group of people are focusing on completing a task together. They may be *arguing* and *disagreeing* when working together.”

The most common use of negative emotion words was in the discussion of specific topics. In the discussion about fixed and growth mindset, students frequently used the words *fail* and *failure*. One student explained, “When I was younger I had a fixed mindset and didn't push myself. I also would be completely destroyed by *failure*. Now that I'm older I have a growth mindset because I look at *failure* positively.”

In particular, the stereotypes discussion involved high percentages of negative emotion words. One student posted:

Yeah i agree, it's not exactly ethical but it definitely taught an important lesson. There was no physical *harm* being brought to them. I think the teacher probably could have thought of a better option though to *avoid* the grey area.

Another student posted, “The teachers words had a huge impact on the students they're so young and those words really *hurt* their feelings. The brown eyed were *hurt* and felt *bad* about themselves because of their eye color.” Although the topic of stereotypes should have elicited negative emotion words from both groups, the synchronous students were more likely to use these words. The synchronous students may have been more willing to talk directly about a difficult topic because they could feel assured that they will receive a quick response from their group mates, which would allow them to rectify any misunderstandings. In other words, the synchronous students may have found it less risky to discuss a difficult topic directly.

The use of discrepancy words may be able to encourage cooperation by facilitating explanation and reflection. In the present study, students in the synchronous groups used more discrepancy words than those in the asynchronous group. In analyzing the chat transcripts, we found that students used the discrepancy words to negotiate the logistics of the group work, test out their ideas, and influence the ideas of the group.

Students used discrepancy words to suggest how they could proceed with the group work. For example, a student posted:

Also for the 3 scenarios I think *if* we *wanted* to pick A we *could* discuss the idea that the teacher *should* respond by praising the students hard work but not how smart they might be to encourage that work to continue. We *could* then integrate how in the presentation from Amy how she learned that it was beneficial to do that or also use an example from one of the studies in the article about praise.

In one case, a student used discrepancy words to suggest an approach to make the group more effective by posting, “Hey guys! I was *hoping* for this week we *could* start getting discussion going earlier on in the week! I will try to be checking the pad everyday. I think that *would* make discussion go better!”

Discrepancy words allowed students to test out answers, such as “I think that for that texting and driving question, the individual driving *would* be using a zoom-lens method of selective attention. Actually, he or she *could* also be using the spotlight model.” Another student posted, “Do we *want* to do a picnic? I have a decent photo for that too.”

More commonly, students used discrepancy words to influence the ideas of the group. For example, a student posted:

For 4 maybe we *could* say something about how our interests determine whether we have a fixed mindset or a growth mindset about a certain subject. For instance, *if* I hated math maybe I *would* be more content with just knowing what I know and not *expecting* my knowledge to expand. Idk [I don't know] what do you guys think?

Another student posted:

I think people *would* think of things that they have categorized as belonging in a bedroom, even *if* they aren't in this picture. I was thinking a busy street. For that I *would* say people *would* remember the guy with the yellow backpack.

The LIWC category of certainty includes words that express “authoritativeness” and confidence. Those who are perceived as authoritative are seen as trustworthy, which facilitates cooperation. The primary purposes of students’ use of certainty words were to express their confidence in their ideas and to encourage group members.

Students used certainty words to express authoritativeness when explaining their ideas. For example, one student posted, “We *all* discussed something different, but they *all* stemmed from what society told us to think, mass media, or others in our lives.” Another posted, “Product placement is huge when it comes to grabbing attention. That happens to me *all* the time in grocery stores! *Especially* with sale signs.” Another explained, “I feel a lot of people believe they have the ability to multitask, *especially* our generation, but driving already has so many elements that *must* be focused on.” However, students were apt to use certainty words to express a lack of authoritativeness as well. For example, a student posted, “I'm not *completely sure* on how to expand on my answer.” Another admitted, “The card video *completely* stumped me.” Similarly, a student posted, “I *never* realized or would have thought about passages that way either that or my thought process when looking at the pictures or reading them was in the *total* wrong direction.”

Using certainty words, students posted recognition and encouragement of their group mates. “Hi *everyone*! I think *everyone* did a great job with their thoughts about attention and how it is used in real life and not just in magic.” Another student posted, “I *truly* enjoyed reading *everyone's* post and *everyone* did a great job!” Using certainty words in this type of post might have contributed to trustworthiness in the group.

When we examine the self-report and chat log results together, a complicated picture emerges. Although there was no difference in positive affect in the self-report measure or the chat log, the results regarding negative affect are mixed. In the self-report measure, asynchronous groups had higher negative affect in the self-report measure, but secondary analysis revealed that cooperation and individualism perceptions predicted negative affect. The analysis of the chat logs

indicates that the synchronous students were more likely to use negative emotion words. These differing results suggest that students in the asynchronous groups may refrain from expressing their negative emotions within the discussion. Asynchronous students may perceive the expression of negative emotions as a risk and refrain from it, although this study did not examine this explanation.

In our exploratory LIWC analysis of cognitive processes (discrepancy and certainty), we found that students in the synchronous condition had higher use of discrepancy and certainty words, which indicate analytical thinking (Pennebaker, 2011). This result indicates that students in the synchronous condition expressed more authoritativeness and willingness to take risks. The use of these words may contribute to collaboration by facilitating the discussion of logistics, sharing of ideas, and encourage the group.

Limitations and Implications

We note two primary limitations to this study. First, we did not control for the level of participation. Although we provided interaction guidelines to encourage equal interactions and the instructional design of the conditions was identical, the asynchronous groups exchanged fewer posts than the synchronous groups, and the lower interaction may have affected the perceptions of interdependence. Second, we designed the tasks with cooperative goal interdependence, although we did not assess whether students clearly understood the cooperative goals. Despite these limitations, the study provides clear evidence of the positive effects of synchronous interaction on cooperation, belonging, and affect.

These findings are important for theory because they indicate that asynchrony affects the empirically established relationship between cooperative goals and cooperative perceptions. The affect and belonging differences we identified suggest that online learning is not a uniform environment, but a varied environment with different behavioral options and communication process that affect cooperation. For practitioners, these results suggest that asynchronous cooperative learning may not work as designed, because the presence of cooperative goals does not predict cooperative outcomes in asynchronous cooperation. This study indicates that further research should investigate whether instructors should require synchronous cooperation in small group work to achieve greater cooperation and belonging or whether there are other ways to structure asynchronous cooperation to achieve these outcomes. Future research should continue to explore ways to induce cooperative perceptions in learning facilitated by asynchronous communication. Our results warrant future research to explore whether students working asynchronously perceive expressing negative emotion as a risk and therefore avoid it. Although we have identified differences in the use of discrepancy and certainty words in synchronous and asynchronous contexts, future research should further explore how students are using cognitive process in synchronous and asynchronous cooperation.

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