The Impact of Peer Tutors' Use of Indirect Feedback and Instructions

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Abstract: During collaborative learning, computer-supported or otherwise, students balance task-oriented goals with the interpersonal goals of relationship-building; these goals may conflict, negatively impacting learning. In peer tutoring, for instance, tutors may avoid providing feedback to their partners to avoid the face-threat to their tutee. In this paper, we explore how the interpersonal closeness between tutor and tutee impacts tutors' use of indirectness with feedback and instructions, and the impact those moves have on tutees' problem-solving. We found that stranger tutors use more indirect instructions and provide more positive feedback to their tutee than friend tutors, and that stranger tutees attempted and solved more problems when their tutors used indirect instructions. We found no effect for dyads of friends, suggesting that interpersonal closeness reduces the face-threat of direct instructions. These results demonstrate that designers of CSCL tools should incorporate awareness of students' relationships into their systems, as that relationship impacts students' collaborative learning behaviors.

Introduction

In collaborative learning interactions, whether computer-mediated or face-to-face, students simultaneously pursue the task-oriented goals of learning and the interpersonal goals of getting along with or building a relationship with other students, much like in other social interactions (Burgoon et al., 1995). In some forms of collaborative learning, such as peer tutoring, students may offer each other advice, instructions, or feedback. Such pedagogical behaviors, while supporting the interactional goal of helping their partner learn, may conflict with the interpersonal goal of relationship-building with their partner due to the potential for such moves to threaten their partner's "positive face", or desire to be approved of by others (Brown and Levinson, 1987). Similarly, other productive learning behaviors, such as engaging in cognitive conflict, have been found to occur more often in groups of friends than strangers, perhaps because of a greater importance for strangers in avoiding face-threat while pursuing interpersonal goals (Azmitia & Montgomery, 1993). To mitigate the interpersonal consequences of pedagogical behaviors that are likely to threaten tutees' face needs, such as giving direct instructions and feedback, peer tutors without sufficient interpersonal closeness with their tutee might avoid providing the necessary feedback altogether. If they are more skilled at attending to interpersonal needs, they might phrase their words in a polite or indirect manner, to reduce the implicit face-threat (Person et al., 1995). Some computer supports for learning, such as some forms of intelligent tutoring systems, apply a polite style to the feedback and instructions provided to students, such as "Shall we calculate the result now?", to mitigate the face threat of direct feedback and instructional directives (Johnson and Rizzo, 2004). An overuse of such polite or indirect instructional moves, however, may have a negative impact on student learning, due to the ambiguity of indirectness (Person et al., 1995). Moreover, indirectness may not be the appropriate way for tutors to deliver feedback in all situations. In fact, previous studies on collaborative learning have shown that the frequency of politeness and the negative impact of face-threat diminishes over the course of a relationship (Ogan et al 2012), following prior work on the decreasing importance of positivity as the interpersonal distance between interlocutors decreases (Tickle-Degnen and Rosenthal, 1990). Further, while expert teachers may be communicatively competent enough to modulate their feedback and instructions to mitigate the face-threat of directness (Kerssen-Griep, 2008), it is not clear that untrained peer tutors are able to do so.

In order to design computational supports for collaborative learning that both effectively manage face needs and support cognitive conflict, we should thus first understand how untrained peer tutors mitigate face-threat to their tutees, either through indirect delivery of instructions and feedback, or by avoiding that feedback altogether. In this paper, we first investigate how reciprocal peer tutors' interpersonal closeness with their tutees, as well as their prior domain knowledge and tutoring self-efficacy, impacts their use and delivery style of potentially face-threatening tutoring moves. We then investigate the relationship between peer tutors' delivery style and their tutees' problem-solving. We found that stranger tutors provide more positive feedback and more indirect instructions than friend tutors do, and found that tutors with high self-efficacy used significantly more indirect instructions than low self-efficacy tutors, particularly for tutors with lower rapport with their tutee. For stranger dyads, independent of their self-efficacy, tutors' use of indirect instructions was positively predictive of their tutees' number of problems attempted and solved, but for friend dyads, there was no effect. These findings can help inform the design of CSCL tools that can detect students' interpersonal closeness and suggest different

ways for students to deliver instructions and feedback to mitigate face-threat, or to intervene to provide that direct support itself when necessary.

Related Work

Reciprocal peer tutoring is a form of collaborative learning where same-age students work together by teaching each other, despite neither of them being an expert (Palincsar and Brown, 1984). Prior work has shown it to be an improvement over individuals learning alone, but the differences in both content knowledge and pedagogical knowledge between novice peer tutors and expert tutors may have significant consequences for both the process and outcomes of tutoring (Palincsar and Brown, 1984). Specifically, prior work has argued that providing instructional feedback, directives, or advice can be highly face-threatening and may be avoided by peer tutors (Person et al., 1995). However, tutors with greater instructional or interpersonal ability may be better able to mitigate face threat to their students, perhaps by presenting feedback in an indirect or polite way (Person et al., 1995), or by using nonverbal immediacy cues as described by Kerssen-Griep (2008). As we have described above, indirectness is one of the conversational strategies that plays a role in face management (others are praise and acknowledgement). To understand the impact of face management on peer tutoring behaviors, in particular the delivery of feedback and instructions, we draw on Brown and Levinson's (1987) theory of face management and politeness. In this theory, students, like any social actors, are motivated by their desire for what is referred to as positive face, or, to be approved of by others, and negative face, which is the desire to be autonomous and unimpeded by others (Brown & Levinson, 1987). As a result, tutors' instructional directives, if they take the form of demands, may threaten students' negative face, and tutors' instructional feedback, if given in a blunt manner, may threaten their tutees' positive face (Brown & Levinson, 1987; Johnson and Rizzo, 2004). However, the severity of that face-threat, and thus, its negative impact on the tutees, can be mitigated by the use of politeness or indirectness, which may be mediated by the interpersonal closeness between students. This follows Tickle-Degnen and Rosenthal's theory that the importance of positivity decreases as the interpersonal closeness between interlocutors grows (Tickle-Degnen and Rosenthal, 1990). However, it is unclear to what extent peer tutors minimize the face-threat of feedback and instructions by being indirect in their delivery, or how that indirectness impacts their tutees' problem-solving. Accordingly, some intelligent tutoring systems have attempted to mitigate the face-threat of providing feedback and instructions by phrasing tutor moves in a polite or indirect way, and they found benefits for some students on some types of questions (Johnson and Rizzo, 2004). However, their model operationalized Brown and Levinson's social distance as simply decreasing over subsequent sessions with a tutee, which does not account for the dynamic nature of relationship development, as even students who work together for multiple sessions may never develop the interpersonal closeness necessary for reducing the face threat of direct feedback.

To better operationalize the dynamic development of interpersonal closeness and its impact on face-management, we draw on the theory of interpersonal rapport, as described by Tickle-Degnen and Rosenthal (1990), as well as Spencer-Oatey's (2008) model of face-management. In these theories, we would expect positive face management strategies to decrease as the relationship between tutor and tutee develops over time (Spencer-Oatey, 2008; Tickle-Degnen and Rosenthal, 1990). Prior work has found, using friendship as a proxy for long-term rapport, that tutoring dyads of friends do in fact engage in more violations of social norms, such as playful teasing and social challenges, and that these are correlated with learning gains in friends. Those same behaviors lead to decreased learning among strangers (Ogan et al., 2012). This suggests that the relationship between tutor and tutee allows each to playfully challenge the other while tutoring, in what might be seen as face-threatening acts, when done between friends. In the same vein, the indirectness that may be appropriate or necessary between strangers, to mitigate face threat from direct feedback or instructions, might be unnecessary or even detrimental between friends. Here, to investigate how a dynamic measure of interpersonal closeness can capture changing face-management needs, we use two measures of interpersonal closeness, 1) externally-rated rapport between participants as a measure of their short-term interpersonal closeness, and 2) the friendship between participants as a proxy for their long-term interpersonal closeness.

Although expert tutors and teachers are able to effectively mitigate the face threat of a tutoring move through indirectness, politeness, or a self-effacing disclosure (Kerssen-Griep 2008), untrained peer tutors may not be as deft in their facework. Although we did not measure tutoring ability, we used the tutors' score on a pre-test as a proxy for their prior domain knowledge, following Rowan et al.'s (1997) findings that teacher prior domain knowledge was predictive of their students' performance. In addition to their content knowledge of the domain, prior work has shown the importance of teachers' instructional self-efficacy for their attention to the interpersonal goals of teaching as well as the instructional goals (Mojavezi, 2012; Saklofske et al. 1988). Teachers' self-efficacy beliefs, or the belief about their ability to impact student outcomes and the confidence

that they can do so, have been shown to impact teachers' use of different types of feedback (Saklofske et al., 1988) as well as students' motivation and achievement (Mojavezi, 2012).

Methods

We seek to investigate how the interpersonal closeness between peer tutors and their tutees impacts the tutors' use of indirectness with instructions and feedback and how those moves in turn impact their tutees' learning.

Research Questions

RQ1: Do tutors with lower interpersonal closeness with their tutees provide feedback about their tutees' correctness at different rates than dyads with greater interpersonal closeness? Due to the potential face-threat in giving negative feedback to their partners, we hypothesize that both tutors in dyads of strangers and tutors in low-rapport dyads will provide less negative feedback (Person et al., 1995). Friends and high-rapport dyads would have less need for face-threat mitigation, and will thus use more negative feedback (Spencer-Oatey, 2008).

RQ2a: Do tutors with a lower interpersonal closeness with their tutee use more indirect language while tutoring than tutors with a greater interpersonal closeness? Based on prior literature on the use of indirect language to mitigate the face-threat of various tutoring moves, we hypothesize that tutors with a lower interpersonal closeness with their tutee will use more indirect language while tutoring than tutors in dyads with greater closeness (Brown and Levinson, 1987; Johnson and Rizzo, 2004).

RQ2b: Do tutors with a lower tutoring self-efficacy use more indirect language while tutoring than tutors with greater self-efficacy? From prior literature on the use of hedges and subjectivizers to convey uncertainty (Rowland, 2007), we hypothesized that tutors with lower tutoring self-efficacy would use more indirect language due to their uncertainty. However, an alternative hypothesis is that tutors with greater tutoring self-efficacy would attend more to their tutees' needs for face-management and would use more indirect language with their tutoring moves to mitigate the face-threat of feedback and direct instructions (Brown and Levinson, 1987; Kerssen-Griep, 2008; Saklofske, 1988)

RQ3: Does a tutor's use of indirect feedback lead to improved problem-solving for their tutee? From prior literature on the motivational benefits of face-threat mitigation, we hypothesize that there will be an interaction between a dyad's interpersonal closeness and their use of indirect tutoring language, such that in stranger dyads and low-rapport dyads (both friend and stranger), when tutors use more indirect tutoring moves, their tutees will attempt and solve more problems (Kerssen-Griep 2008). An alternative hypothesis is that direct feedback and instruction leads to more problem solving.

Dialogue Corpus and Annotation

The dialogue corpus described here was collected as part of a larger study on the effects of rapport-building on reciprocal peer tutoring. The participants were assigned to 12 dyads that alternated tutoring each other in linear Algebra equation solving for 5 weekly hour-long sessions, for a total of ~60 hours. Each session was structured such that the students engaged in brief social chitchat in the beginning, then had one tutoring period of 20 minutes with one of the students randomly assigned to the role of tutor, then engaged in another social period, then had the second tutoring period where the other student was assigned the role of tutor. This process was repeated for five sessions. As each student was randomly assigned to be the tutor for half of the tutoring periods, they were not expected to have any greater prior knowledge than their partner for the problems they were tutoring them on. All students were supported with a set of instructions on how to teach the particular problems for which they were assigned the role of tutor. The students took a pre-test before the first session and a post-test after the fifth session to assess their learning gains. However, because of a ceiling effect on the pre-test, we used the problems the tutees solved during the sessions as a proxy for a learning outcome measure for each session. The participants (mean age = 13.5, min=12, max=15) came to a lab on an American university campus in a mid-sized city for the study. Half were male and half were female, assigned to same-gender dyads, so that, in other work with this corpus, gendered differences in the social, rapport-building behaviors of the participants could be identified. To investigate how the use of various tutoring behaviors differs between dyads with varying degrees of interpersonal closeness, we used friendship as a proxy for long-term closeness and asked half of the participants to bring a same-age, same-gender friend to the session with them, and for the other half of the dyads, we paired them with a stranger. Audio and video data were recorded, transcribed, and segmented for clause-level dialogue annotation.

The rapport, or short-term interpersonal closeness between the participants, was evaluated using a "thin-slice" approach (Ambady and Rosenthal, 1992), where the corpus was divided into 30-second video slices

provided to naive, third-party raters in a randomized order, so they would each slice's rapport, and not the delta across multiple slices. Three raters rated the rapport present in each slice on a Likert scale from 1-7, and a single rating was chosen for each slice using a bias-corrected weighted majority vote approach, as in Sinha and Cassell (2015). From the 120 thirty-second slices in each session, we calculated a summary rapport score for each session, or the "utopy", which we use in this paper as our rapport measure. Prior work has shown that statistical summaries such as a measure of central tendency or proportion of high and low ratings of rapport collapse the temporal dimension and are not as robust as more stochastic-based models which capture the evolution of rapport over time (Sinha, 2016. We thus fit a Markov chain of order 1 to the sequence of 120 rapport ratings for each session, and used the resulting transition probability matrix to generate a measure of the entropy (or, uncertainty) and utopy (Dillenbourg, 2015), or likelihood of the dyad being in a high-rapport state.

As part of a larger study on the relationship between rapport-building and peer tutoring, this corpus was annotated for a set of social, rapport-building verbal and nonverbal behaviors, as well as pedagogical, tutoring-related behaviors from both the tutor and tutee. Social conversational strategies, as in Sinha and Cassell (2015), include such phenomena as students' self-disclosure, reference to shared experiences, praise, and social norm violations, each of which serves a rapport-building function, as described in Zhao et al. (2014), with Krippendorff's alpha for all codes > .75. We annotated the dialogue corpus for a set of tutoring and learning behaviors, such as question-asking, "knowledge-telling", or step-level instructions and procedures, and feedback from tutors on their partner's correctness (Madaio et al., 2016), with Krippendorff's alpha for all codes > .7. In Table 1, we describe two tutoring strategies relevant in this paper for their potential to threaten the tutees' face: tutors' feedback, and their instructions, or "knowledge-telling". Then, to understand the ways that dyads with tutors of differing levels of interpersonal closeness with their tutees (both friendship status and rapport utopy) mitigated the face-threat of their tutoring instructions and feedback, we coded our corpus for four types of indirectness, which are often used to soften or mitigate the face threat of being "bald on record" with direct instructions, advice, or feedback (Brown and Levinson, 1987). We annotated for: apologizing, hedging language, the use of vague category extenders, and "subjectivizing" (Zhang, 2013; Neary-Sundquist, 2013; Fraser, 2010), as described in more detail in Table 2. The Krippendorff's alpha for five trained raters rating all four codes was > .7. Then, we labeled a clause as *indirect feedback* if the same clause had an annotation for indirectness and an annotation for feedback, either positive or negative. Typical examples of indirect feedback include: "I think you got it." "I guess that's what it is." "Oh, no, actually, it's not." "No, it's just nineteen." We labeled each clause as *indirect instructions* if it had an annotation for indirectness and an annotation for "knowledge-telling" (instructions and directives used by the tutor). Typical examples of indirect instructions are: "Actually, just add five here." "I think you're gonna divide it by a fraction or something." "I would probably subtract the sixteen." Finally, we provided the participants with a questionnaire following the study with a set of items for constructs relevant to rapport-building. We used items about tutors' self-efficacy for tutoring, a 7-item scale indexing whether the participants thought they were good tutors and were concerned about tutoring quality, motivation and impact on their tutee.

Table 1: Annotations of Tutoring Moves and Indirect Language

Code	Definition	Example
Apology	Apologies used to soften direct speech acts.	"Sorry, it's negative 2."
Hedges	Qualifying words to reduce the intensity or certainty of utterances.	"You just add 5 to both sides."
Extenders	Words used to indicate uncertainty by referring to vague categories.	"You have to multiply or something."
Subjectivizer	Words that reduce intensity or certainty.	"I guess you divide by 3 here."
Positive Feedback	Explicit evaluations of correct answers or steps.	"Yep, that's it!"
Negative Feedback	Explicit evaluations of incorrect answers or steps.	"No, that's wrong."
Knowledge-telling	Explicitly stating procedures or steps for the tutee.	"Multiply it by the fraction."

Results

First, because friends are generally more talkative than strangers in their peer tutoring interactions (as described in more detail in Madaio et al., 2016), we normalized the amount of indirect utterances by the total number of utterances used by that participant in each session. By far the most frequently used marker of indirectness in our dataset was the use of hedges (e.g. "just", "actually", etc.) with normalized mean = .05 and standard deviation = .04, followed by subjectivizers (e.g. "I think", "I guess", etc) (m=.02, sd=.03), and apologies (m=.01, sd=.01), and with vague category extenders by far the most infrequent (e.g. "and stuff", "or something", etc.) (m=.002,

sd=.01). This distribution aligns with findings from Rowland's (2007) work studying the use of hedges, subjectivizers (what he calls "shields"), and extenders in student-teacher mathematics lessons. To analyze tutors' use of indirect delivery with their instructions and feedback, we first created an aggregate count of all indirect language, from each of the 4 indirectness codes described above for each participant. Then, after finding the co-occurrence of indirect language with tutors' feedback and instructions, we normalized those frequency counts by the total number of "on-task" utterances, or the total number of annotated task-related questions, explanations, feedback, and metacognitive utterances, following Madaio et al. (2016).

Table 2: Means and Standard Deviations of Normalized Frequency of Indirectness and Indirect Tutoring:

Dyad Type	Indirectness	Indirect Feedback	Indirect Instructions
All Tutors	.09 (.06)	.002 (.005)	.01 (.02)
Friend Tutors	.06 (.05)	.002 (.005)	.01 (.02)
Stranger Tutors	.11 (.06)	.002 (.01)	.02 (.03)

Tutors' Use of Positive and Negative Feedback (RQ1)

First, we investigated our hypothesis that tutors with lower interpersonal closeness with their tutees would use fewer instances of negative feedback (Person et al., 1995). To test this hypothesis, we ran a repeated measures ANOVA on the normalized frequency of tutors' negative feedback, crossing the between-subjects factors of Relationship (Friend/Stranger), Rapport (High/Low), Self-Efficacy (High/Low), and the median split of the tutors' Pre-Test performance (High/Low) with the within-subject factor of Session and Tutoring Period, and using each dyad's tutoring period and session number as error terms. There was no statistically significant effect of any of the factors on tutors' use of negative feedback. We then investigated whether stranger tutors were using more *positive feedback* to boost their tutees' face, rather than avoiding negative feedback. We thus ran the same model on tutors' use of positive feedback, finding a highly significant effect of relationship on the amount that tutors used positive feedback (F(1,64) = 12.8, p<.001). To find the direction of that difference, we ran a t-test, and found that stranger tutors were significantly more likely (t(71) = 3.77, p<.001) to use positive feedback (m=.17, sd=.12) than friend tutors (m=.08, sd=.08). We hypothesized that stranger tutors may be using more positive feedback because their tutees were solving more problems correctly. Therefore, we conducted a t-test, which showed that stranger tutees did not solve significantly more problems than friend tutees.

Tutors' Use of Indirect Feedback and Instructions (RQ2)

We then investigated the hypothesis that stranger tutors, and tutors in low-rapport dyads, would use a more indirect style than friend tutors and tutors with high-rapport with their tutees. We ran a repeated measures ANOVA on the tutors' *indirect feedback*, using the same within-subject and between-subject factors and the same error terms as in RQ1. To investigate our alternative hypothesis about tutors' self-efficacy interacting with their relationship with their tutee (RQ2b), we included interaction terms for Relationship, Rapport, and Self-Efficacy. There was no statistically significant effect of any factor on tutors' use of indirect feedback. We then ran the same repeated measures ANOVA model on tutors' use of *indirect instructions*, finding a highly significant main effect of relationship on the tutors' use of indirect instructions (F(1,70) = 7.4, p < .01). To find the direction of that difference, we ran a Mann-Whitney-Wilcoxon test, for comparing means of non-normal distributions, which showed that stranger tutors were significantly more likely (U = 3749, p .< .05) to use indirect instructions (m=.02, sd=.03) than friend tutors (m=.007, sd=.02). There was a significant interaction effect of Rapport and Self-Efficacy on all tutors' use of indirect instructions (F(1,70) = 4.5, p < .05), as seen in Figure 1. High-self-efficacy tutors with low rapport with their tutees were significantly more likely (U=4052, p<.001) to use more indirect instructions (m=.03, sd=.02) than high self-efficacy tutors with *high* rapport with their tutees (m=.01, sd=.01). This supports our hypothesis that tutors with lower interpersonal closeness (i.e. rapport) with their tutees would use more indirect instructions than those with greater interpersonal closeness. However, it is primarily the high self-efficacy tutors with low rapport with their tutees that appear to use this strategy, as they were (marginally) significantly more likely (U=928, p=.07) to use more indirect instructions (m=.03, sd=.02) than low self-efficacy tutors with low rapport with their tutees (m=.01, sd=.01).
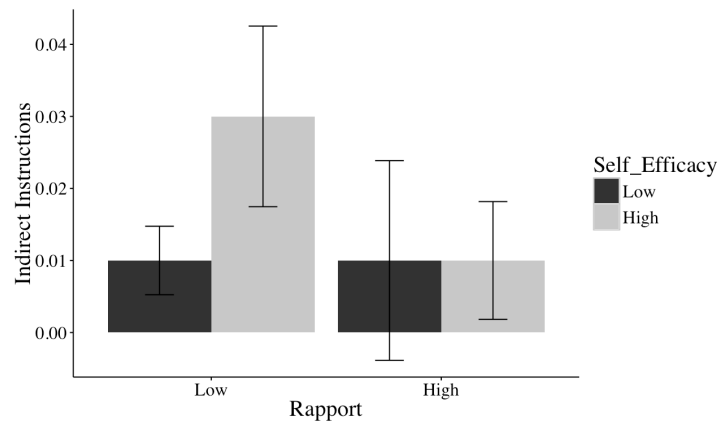
Figure 1. Interaction Effect of Rapport and Self-Efficacy on Tutors' use of Indirect Instructions

Impact of Tutors' Indirect Tutoring on Tutees' Problem-Solving (RQ3)

Finally, we investigated our hypothesis that tutors' greater use of indirect feedback and instructions is associated with greater problem-solving for the tutee, particularly for dyads of lower interpersonal closeness. We ran a linear mixed effect model using the tutees' percent of problems solved in each tutoring session as the dependent variable, and using the normalized frequency of tutors' indirect feedback and instructions, tutors' *direct* feedback and instructions, and tutees' own self-explanations as fixed effects, along with interaction terms for each of the above with Relationship and Rapport, with random effects of Dyad and Session. We included the tutees' self-explanations, following the findings of Madaio et al. (2016) that tutees' self-explanations (i.e. annotations of knowledge-telling) were a more significant predictor of their learning than their tutors' instructions. We included the *direct* feedback instructions (in addition to the indirect) to see whether that directness impacted tutee learning, due to the potential for negative face-threat. While we found in response to RQ1 that strangers and friends solved the same number of problems overall, in this model, stranger tutors' use of indirect instructions was positively predictive ($\beta = .64$, $p = .05$) of their tutees' problem-solving. We further investigated whether the use of indirectness with instructions and feedback might serve a motivational role, leading to an increased amount of *problems attempted* for the tutee. We thus ran the same mixed effects model, but with the tutees' number of problems attempted as the dependent variable. In this model, stranger tutors' use of *indirect instructions* was significantly positively predictive ($\beta = .84$, $p < .001$) of their tutees' amount of problems attempted. No other factors were significant.

Discussion

In this paper, we investigated the extent to which the interpersonal closeness (both short- and long-term) between peer tutors and their tutees impacts their learning, by way of the face-management that tutors engage in when providing instructions and feedback. A CSCL system that is not aware of the interpersonal closeness between collaborating students may mischaracterize the impact of face-threat mitigation behaviors and respond inappropriately. Here, the differences we found in tutors' use of indirectness with various tutoring behaviors suggest that interpersonal, relational aspects of the tutoring interaction impact the pedagogical task goals and vice-versa. Although stranger tutors used more positive feedback than friends, their tutees did not solve significantly more problems than friend-only dyads. This suggests that they may be using that positive feedback to boost their partners' face rather than accurately diagnosing the correctness of their partners' problem-solving. Further, the lack of significant effects of the positive feedback on tutee learning indicate that, while it may serve a relational, face-boosting role, it may not serve a pedagogically useful role, and may even, as Person et al. (1995) pointed out, lead to ambiguity about the correct procedures or answers, possibly eroding the tutee's trust in their tutor over time. Further, the stranger tutors' use of more indirect instructions than friend tutors suggests that stranger tutors may be hedging or qualifying their instructions to avoid the face-threat of directness. The benefits of this face-threat mitigation for dyads with low interpersonal closeness can be seen in the positive effect of indirect instructions on the amount of problems stranger tutees attempted and solved correctly. However, the benefits of indirect feedback for tutees disappear as the relationship strengthens between tutor and tutee. While interpersonal closeness affects tutors' use of face-threat mitigation strategies, not all tutors engage in equal amounts of face-management. Tutors' self-efficacy for tutoring also impacted their use of indirect instructions, as seen in the interaction between rapport and self-efficacy. As expected, tutors with low rapport

with their tutee were more likely than those with high rapport to give instructions indirectly. However, this effect was present only for highly self-efficacious tutors. Unexpectedly, there was no difference between low and high rapport dyads for tutors with low self-efficacy. This suggests that more self-efficacious tutors may be better able to modulate the directness of their instructions to attend more to the need for face-management when their interpersonal closeness with their tutee is lower, irrespective of their actual domain knowledge.

For the computer-supported collaborative learning community, researchers who design tools to support peer tutoring should be aware of the ways in which the interactional goals of tutoring may be impacted by the interpersonal goals of face-threat mitigation in the context of relationship-building. That is, the collaborative learning behaviors exhibited by students may differ depending on whether they are friends or strangers, or have a greater or lower rapport between them, and those same behaviors may have different impacts on student learning, depending on that closeness. Designers of collaborative intelligent tutoring systems, as in Olsen et al.'s (2014) work, might build in awareness of the interpersonal closeness between students, and, in addition to cognitive instructional supports, might recommend students phrase their instructions to each other more indirectly when interpersonal closeness is lower. These findings can also inform the design of educational dialogue systems, or conversational agents which could support peer tutoring by detecting and responding appropriately to the interpersonal dynamics between the human students and the conversational agent, *and* by building a deeper rapport with the students over time, as seen in (Zhao et al. 2014; Sinha et al., 2015) so as to be able to be more direct and blunt with instructions and feedback. To detect the interpersonal closeness described here, Yu et al. (2013) developed a method for the automatic prediction of friendship, which (the lack thereof) was the strongest predictor of the use of indirect language with instructions. Zhao et al., (2016) have developed a method for the automatic detection of rapport based on temporal association rules between multimodal data such as students' conversational moves and nonverbal behaviors and the subsequent change in their rapport. More broadly, this work contributes to a more robust understanding of the ways in which interpersonal closeness impacts the collaborative learning process by way of peer tutors' face-management. While prior work has hypothesized that social distance impacts the use of politeness and indirectness, our work provides two operationalizations of that social distance, friendship and rapport, and shows how each type of interpersonal closeness differently impacts peer tutors' face-threat mitigation while tutoring, showing the impact of those face-management tactics for different tutees' problem-solving.

Future Work and Limitations

This work is part of a larger research program to understand the ways in which interpersonal rapport impacts teaching and learning, and will be used to inform the design of a conversational agent that simulates a peer tutor as the front end of an intelligent tutoring system. Our goal for this agent is to build rapport with its tutee, reducing the face-threat of particular instructional moves when necessary by using instructional moves in socially appropriate ways. One of the limitations of this work for investigating differences in the effects of rapport that can inform such an agent is the small sample size, particularly for dyads of strangers. We are currently conducting a similar study with 16 dyads of strangers to better understand how the rapport-building process develops within dyads starting from the same interpersonal baseline, and how that rapport impacts their teaching and learning process and outcomes. Another limitation of this work is the culturally dependent nature of what may be perceived as face-threatening or indirect by the interlocutors, and future work should take into account the culture of the participants in understanding face-threat. In addition, we are currently involved in investigating other potentially face-threatening pedagogical behaviors, to understand whether and how high-rapport dyads engage in for instance, cognitive conflict, help-seeking, help-offering, and others. While in this paper, using the normalized aggregate frequency of a particular set of annotated behaviors revealed interesting differences between groups of dyads, some of the most beneficial tutoring behaviors may occur infrequently or may have their benefits mediated by contingent patterns of use and responses from their partner (Ohlsson et al., 2007). Therefore, an analysis that does not take this contingent, temporal pattern of use into account may miss important effects. To better understand the contingent patterns of use for particular tutoring and learning behaviors, we plan to use temporal association and sequence mining to discover the sequences of pedagogical and social behaviors that contribute to greater rapport and learning, to predict rapport from multimodal features. We intend for this work to contribute to the design of socially-aware computer-supported collaborative learning systems, which can more appropriately respond to learners' social states in pedagogically beneficial ways.

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