

# Understanding Rapport over Multiple Sessions with a Social, Teachable Robot

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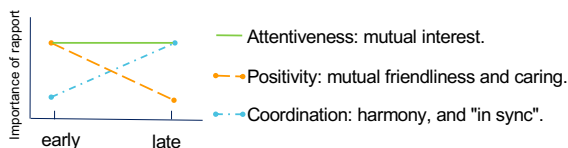
## Motivation

Intelligent social robots have positive effects on learning and motivation. One mechanism is through **rapport**, or feeling of connection.

Most human-robot rapport research has not investigated how rapport is built over time.

## Rapport Theory

Tickle-Degnen & Rosenthal (1990)



Different components of rapport might change over time. It's not clear whether the same phenomena can be observed in human-robot settings.

## Research Question

How do students differ from each other and differ from early to late interaction stages in the way that they build rapport with a teachable robot?

**Problem 1**  
Emma's friends have been arguing over who can make s'mores faster. Emma has an equation for how fast Tasha can make s'mores. Help her figure out an equation for how fast Zach can make s'mores.

Step	S'more Maker	Minutes (y)	S'mores (x)	Setup (b)	Slope (m)
0	Tasha	8	2	4	2
1	Zach	9	2	1	???



Figure 1. Example of a math problem, and the scenario of interaction.

## Multiple-Sessions Study

Emma is a NAO robot who was taught to solve math problems.

Socially, Emma mimicked Tickle-Degnen & Rosenthal's model of rapport: positivity decreased, coordination increased, and mutual attentiveness remained stable over time.

7 middle-school students (4 females, 3 males), each interacted with Emma for five 30-min sessions over several weeks.

We manually coded participants' 13 linguistic strategies, then translated the strategies to three dimensions of rapport (attentiveness, positivity and coordination) using Independent Component Analysis (ICA) in the problem level.

Table 1 Example dialogue, coded with conversational strategies.

Emma:	Interesting. Why do you think we[inclusive] do that?
Learner:	Because it's going to be equivalent[responsive]...so that means two times two equals[ask question]?
Emma:	Sweet. I think I get it. we[inclusive] multiply two times two, so then is four the answer?
Learner:	Yes, <i>Emma</i> [name]. That's correct.

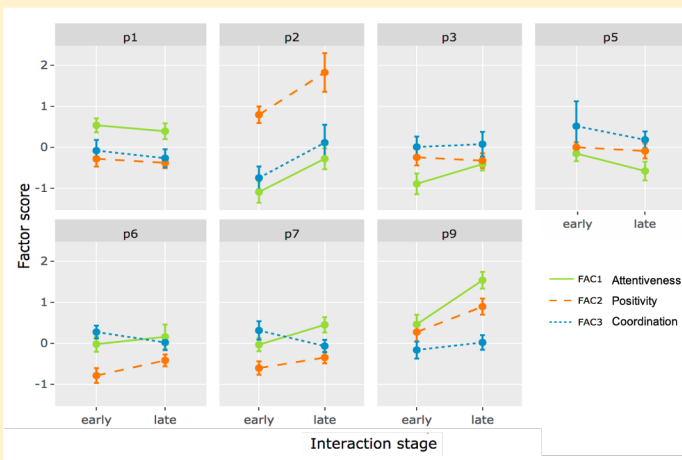


Figure 2 Each individual's rapport trends from early to late interaction stage.

## Major Results

**Attentiveness** went up across most of participants. **Positivity** appeared to vary from participant to participant, p2, p9 who started from a high scores had dramatic increases. **Coordination** decreased in 4 out of 7 learners with large variations.

Flat cluster (p1, p3, p6 and p7) tended to adopt a favorable strategy and stick with it.

Increasing cluster (p2 and p9) and the decreasing case (p5) changed their strategies, having different expectations and perceptions towards Emma.

## Discussion

Rapport changes from early to late interaction stages in human-robot tutoring dialogue did NOT follow the same trends as human rapport theory.

Next steps:

Add dyadic features of rapport and use automated text analysis approach to extract linguistic strategy.

Generalize the model to larger corpus.

## Selected References

Tickle-Degnen, L., & Rosenthal, R. (1990). The nature of rapport and its nonverbal correlates. *Psychological inquiry*, 1(4), 285-293.

