Pragmatic adaptation in multi-party communication

Verbal communication is a key part of human interaction: we use it to ask for objects, teach facts to others, and express our feelings. We tailor our communication depending on who we are talking to according to our prior interactions with them, what words they know, and what they know about the topic being discussed. **This adaptation is dynamic; over the course of a conversation, shared terminology and shorthands naturally arise.**

This convergence to a shared shorthand, often called partner-specific adaptation, has been **studied using reference games where an instructor uses language to convey to a matcher which of a set of images to select** [1-3]. The images are often hard-to-describe shapes like tangrams, so initially instructors use long, hesitant descriptions and matchers often need to ask for clarification. Over repeated rounds using the same set of images, **participants form a conceptual pact where they settle on what short name or phrase to use** for each of the pictures. **This adaptation is partner-specific**, if the instructor switches to talking with other matchers (who are not part of the pact), they switch back to using longer, more elaborated descriptions [2,4]. **These phenomena have become a key model system for the study of communication more broadly.**

One theory for this adaptation is that **instructors are modelling the knowledge state of the matcher**; because the matcher accepts and seems to understand an utterance, the speaker knows they can build on this common ground and shorten the utterance [1]. **This recursive, mentalistic model of communication has been formalized in the Rational Speech Act model** (RSA), which predicts utterances and interpretations, assuming both listener and speaker model the other's knowledge state [5]. On the other hand, **a contrasting theoretical framework, the Interactive Alignment Account, holds that the adaptation instead comes from priming between the language of interlocutors**, as they jointly converge on words and a view of the situation [6,7].

Much of our communication takes place outside of dyadic contexts, however: we are taught in classrooms, socialize with groups, and work as teams. Yet little research has addressed one-to-many communication. **I propose to fill this gap by studying how adaptation occurs when one instructor communicates with multiple matchers at once.** This work will address the dynamics of adaptation between larger sets of people as well as how instructors communicate when one matcher understands a reference faster than another. **Additionally, I will test whether adaptation occurs when matchers cannot talk back and the only feedback is whether the correct image was selected.** Comparisons between trials where matchers can communicate and where they cannot will clarify the role of matchers' utterances in converging on reference language.

Intellectual Merit: This project **tests the Interactive Alignment Account**, which predicts that adaptation will occur most when matcher's language is present and overlaps in words and structure with instructor's language. In addition, **I will collect data needed to broaden theories to multi-party communication** where responses from multiple matchers need to be weighted. Extending theories requires a large base of evidence across multiple conditions; **I will leverage the online methods of Hawkins et al. (2020) to make data collection at scale possible** [8].

Experiment Design: Hawkins et al. (2020) built an online platform that paired crowdworkers into dyads to play a tangram reference game; participants typed freely in a chat box to communicate and received automatic feedback on whether the correct shape was selected [8]. They collected more than 15 thousand utterances from 139 dyads, and replicated the adaptation effects previously observed in in-person oral communication experiments. **I will collaborate with Robert Hawkins to adapt the platform for larger groups and then use the same tangram identification and selection task. I will vary my experiments along two dimensions: whether there are 2 or 3**

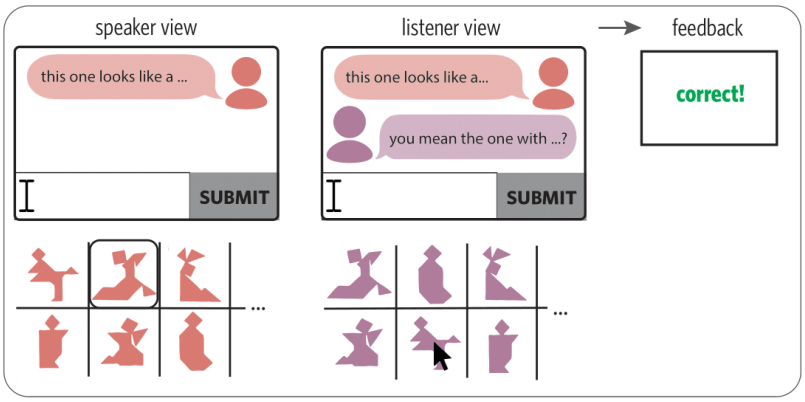

Figure 1: Schematic of tangram reference game from Hawkins et al. (2020) [8]

matchers per instructor and whether matchers can type messages in the chat box. In either case, all chat messages will go to all participants, and in all cases, matchers will receive feedback on whether their selection was correct, while the instructor will receive feedback on all the selections. Using this online platform, we will be able to easily recruit participants (ex. via crowdwork sites like MTurk and Prolific) and collect a large corpora of utterances.

Predictions: Instructors will show less adaptation when there are more and more variably performing matchers. This would mean that adaptation is driven by some interaction between the instructor and each individual matcher. **Adaptation will occur even when matchers cannot communicate, but initial performance will be lower** due to difficulty conveying initial reference. This pattern would support the RSA theory and also point to two-way communication being more important for establishing a communicative foundation than for refining terms. As an extension, I could test this further by showing new matchers the instructor utterances from a previous game to test whether understanding early trials is essential to understanding later shorthand references.

Exploratory computational models: One of my goals is to adapt RSA-style computational models to multi-agent situations. I will adapt a simple computational model of teaching [9] by using NLP semantic models to map from words to meaning. I will experiment with different features such as length, distinctiveness, and similarly to previous successful utterances, and I will consider different weightings of matcher performance. **By testing a variety of models to human data, I will learn what components are important.**

Broader Impact: This project will create a large dataset of utterances, which will be useful to other researchers in testing models. Further, to enhance reproducibility and replicability, I will make all my data, code, and analysis available, as I have done on previous projects. This project will create great opportunities for mentorship; **I will mentor a student from the NSF-funded Center for the Study of Language and Information summer REU program**, which recruits students from under-represented groups. Finally, **this work could inform teaching practices, by quantifying the roles of student verbal communication and assessments for tailoring lessons**.

References: 1. Clark & Wilkes-Gibbs. Cognition (1986). **2.** Wilkes-Gibbes & Clark. J of Memory and Language (1992). **3.** Brennan & Clark. J of Experimental Psychology (1996). **4.** Yoon & Brown-Schmidt. J of Experimental Psychology (2014). **5.** Goodman & Frank. Trends in Cognitive Sciences (2016). **6.** Pickering & Garrod. Behavioral and Brain Sciences (2004). **7.** Garrod & Pickering. Trends in Cognitive Sciences (2009). **8.** Hawkins, Frank, & Goodman. Cognitive Science (2020). **9.** Frank & Liu. Preprint on PsyArXiv.