Exploring expectations based on speaker-specific variation in informativity

When the speaker says, "Pass me the glass" in the presence of multiple glasses, how might a listener interpret the utterance? The listener might rely on preceding discourse or the visual salience of a particular glass, maintaining the assumption that the speaker is trying to be maximally informative. Alternatively, the listener might conclude that the speaker failed to incorporate the contextual information or made a speech error. Examining such interpretations is of theoretical importance because they generalize to, and systematically modulate, pragmatic processing of subsequent utterances in discourse. For example, those who assumed that the speaker was inattentive or pragmatically incompetent would relax their expectation that the speaker will provide necessary and sufficient information for picking out a referent [1]. Given the variability of referential expressions used in spontaneous speech [2] [3], a model of referential resolution must be able to account for how listeners would generalize observed data to guide their interpretations of future input.

In the current paper, we introduce a web-based experimental paradigm and report results from an initial set of studies that manipulate speakers' use of prenominal scalar adjectives in English (e.g., "Click on the big cake"). We test both adults and preschoolers to examine differences in how they keep track of speaker-specific characteristics of adjective use and generalize them to interpret previously unseen adjectives. We hypothesize that 1) adults' generalization would reflect their prior beliefs about how scalar adjectives are used in general and 2) preschoolers may lag behind adults in keeping track of speaker-specific information to calibrate their referential expressions. If children's behaviour deviates from that of adults', it could provide a potential explanation for why children show non-adult-like pragmatic inferences [4] despite the fact that they otherwise are equipped with the capacity to achieve pragmatically enriched reference resolution [5].

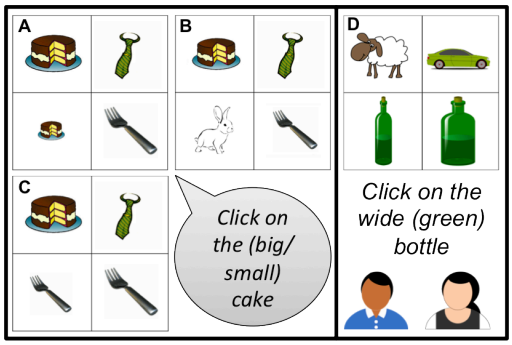

Figure 1. General Methods for the exposure phase (ABC), and the generalization phase (D)

General Methods: Our paradigm has an *exposure phase* and a *generalization phase*. In the exposure phase, participants are introduced to two speakers (male and female) and instructed to click on an object in a visual display (Figure 1). One of the speakers always produces instructions including a prenominal adjective (*the modifying speaker* e.g., "Click on the big cake") while the other speaker never produces modified instructions (*the non-modifying speaker* e.g., "Click on the cake"). Depending on the visual display, the non-modifying speaker's instruction will not pick out a unique referent (e.g., Figure 1-A) and the modifying speaker will be providing superfluous information (e.g., Figure 1-B, 1-C). In the generalization phase, participants are presented with an utterance with or without a prenominal adjective and asked to identify the likely speaker. By using adjectives that were not used in the exposure phase, we assess how listeners generalize to utterances with new adjectives.

Experiment 1 (n=32) established that listeners would attribute new utterances with pre-nominal modifications to the modifying speaker. Participants were equally likely to select the modifying speaker for the modified generalization trials with both old (previously encountered) and new adjectives (83% of total responses to relevant trials). They also systematically chose the non-modifying speaker for the bare-noun trials (82.6%).

Experiment 2 (n=65) tested the granularity that listeners are generalizing over, e.g., whether they generalized to utterance length (form-based generalization), or inferred that one of the speakers was more or less informative (informativity-based generalization). In addition, we examined whether calling attention to speaker differences in naturalness and

clarity would affect the type of generalization (n=32). This begins to address an important issue in pragmatics—namely the degree to which top-down expectations affect how a listener generalizes from information in an utterance. We predicted that while participants might pick up on these speaker differences implicitly, the addition of an explicit cue might increase informativity-based generalizations by highlighting these low-level ambiguities in the signal. We find that participants were most likely to make informativity-based generalizations regardless of instruction-type. However, the explicit instructions increased the proportion of informativity-based generalizations. We analyze the data using multivariate mixture models to identify the number and distribution of different generalization patterns.

Experiment 3A (n=64) tested the hypothesis that a rational listener should be less likely to generalize from over-informative compared to under-informative input, based on previous work that found that speakers more frequently over-modify [2], and only under specific circumstances are willing to under-modify [3]. We tested this prediction by making the modified instructions in the exposure phase over-informative (see: Figure 1B) and gave listeners either the original instructions or the explicit instructions from Exp. 2. In a second study, **Experiment 3B (n=34)**, the exposure phase was modified to emphasize the non-optimality of over-modification using trials in which over-modification might temporarily mislead the listener (see: Figure 1C). We found evidence for form-based generalizations in Exp. 3A. In Exp. 3B, participants neither reliably selected the non-modifying speaker for the concisely-modified trials (45%), nor the modifying speaker for the over-modified trials (57%). This sets the stage for further work aimed at identifying conditions under which listeners might make informativity-based generalizations from utterances with unnecessary and potentially confusing adjectives.

Experiment 4 (n=9, M=4 years old): Our initial application of the paradigm to pre-school children, focused on under-informative utterances. Feedback was given to highlight the non-optimality of the under-informative speaker. In the exposure phase children were given feedback on the images they selected. On 50% of the trials, after the child had selected selecting one of alternatives (e.g., the bigger cake in Panel A) she was told that the non-modifying speaker had wanted the other member of the contrast set, i.e., the smaller cake-- as would be expected by chance. Our preliminary data suggests that children are equally as likely to select the modifying speaker for both the unmodified test trials (44%) and the modified test trials (63%), suggesting that they had not tracked the speaker-specific use of informative modification.

Discussion: Results from the three sets of experiments with adults suggest that listeners generalize information at the speaker level to update their referential expectations for new utterances. By focusing on generalization from exposure, we can begin to fill a gap in the literature by examining how listeners use the variable input that is commonly observed in spontaneous speech production. Questions about how listeners generalize from variable input provides a important empirical test-bed for extending and testing rational listener frameworks that will scale up to the challenges that listeners face in dealing with the multiple types of uncertainty that they face in interpreting utterances in context. The findings in our preliminary study with preschoolers suggest that children, unlike adults, do not seem to associate the observed variability in the input with the speaker identity. Future research with preschoolers aims to look at individual differences in the ability to generalize to speaker-specific information, and the role of memory limitations in tracking speaker-specific information. Findings from this line of research will provide some insight on why children appear to struggle with contextual cues in pragmatics tasks, despite seemingly having the capacity to reason pragmatically.

References: [1] Grodner & Sedivy (2011) *Processing and Acquisition of Reference*; [2] Engelhardt, Bailey, & Ferreira (2006) *JML*; [3] Brown-Schmidt & Tanenhaus (2008) *Cog. Sci*.; [4] Papafragou & Musolino (2003) *Cognition*; [5] Stiller, Goodman, & Frank (2014) *Lang Learn Dev.*