Finding Common Ground: Referential communication in parent-child pairs

Anonymous CogSci submission

Abstract

Referential communication is ubiquitous in human interaction. Past work has shown that adults readily form referential pacts, or temporary agreements on referent names, with each other in conversation (e.g. (**???**)). Young children do so less reliably with peers, but some evidence suggests that explicit feedback from adults may be helpful ((**???**)). How might children learn from the adults they interact with in daily life? The present study seeks to understand the role that parents play in scaffolding children's referential pact formation in communicative settings. In Experiment 1a, we replicate (**???**)'s findings with adult participants using a modified matcher-director task. In Experiment 1b, we examine parent-child communication using the same task. Our results show that parents and children (ages 4, 6, 8) can converge on more efficient reference over the course of the task. Furthermore, parents of younger children, but not younger children themselves, produce longer referential expressions during the game. Our findings suggest that parents sensitively adapt their language to their children's developmental level in referential communication settings.

Keywords: referential pacts; parent-child communication

Introduction

OUTLINE: 1. The basis of successful communication is common ground. Adults are good at forming common ground and referential pacts with conversational partners; young kids are not that great at it. 2. We know from various lines of work that parents adapt their language use sensitively to their children's age, knowledge, etc. We think this also happens in referential communication. 3. Studies show that children have greater referential success with adult experimenters (e.g. Glucksberg & Krauss) and after training (e.g. Matthews et al.). We want to look at the role of adult input in a more naturalistic way. Hence, parent-child ref. comm study. 4. We expect parent language to change with age of child. Parents may adapt to young children by taking up children's referent names; OR parents may adapt by providing more scaffolding / information, etc.

As social beings, humans communicate with each other constantly. The basis of successful communication is mutual understanding, or common ground. One way to establish common ground is through the mutual construction of referential pacts, which are temporary agreements on referent names. Pact formation occurs naturally in conversation, and facilitates cooperation between partners (Fusaroli et al., 2012). While research shows that adults readily form referential pacts with one another (@ Brennan & Clark, 1996; Clark & Wilkes-Gibbs, 1986), studies with children have yielded mixed results (Branigan, Bell, & McLean, 2016; Glucksberg & Krauss, 1967). Children eventually become skilled conversationalists, but little is known about how they acquire and refine their communicative skills. The present study focuses on referential communication between children and caregivers, to further understand how children develop communicative abilities, and the role that parents play in scaffolding this development.

Referential pacts, or conceptual pacts, are temporary agreements on referent names between interlocutors. These pacts are constructed collaboratively during conversation, are partner-specific, and are dynamic and malleable (Brennan & Clark, 1996; Clark & Schaefer, 1989; Ibarra & Tanenhaus, 2016). The phenomenon of pact formation in adult conversation has been widely studied using matcher-director paradigms, where interlocutors refer to novel objects to one another (e.g. Clark & Wilkes-Gibbs, 1986). Researchers have found that conversational partners use shorter, more efficient references over time, and converge upon referent names for each novel objects. Importantly, these referent names differ across conversational pairs, but can also change within conversational partners based on shifting goals or informational needs (Clark & Wilkes-Gibbs, 1986; Ibarra & Tanenhaus, 2016). Thus, common ground is more than common sense—it is mutual knowledge that is built between partners within a conversation to achieve communicative success.

Similar matcher-director studies have been conducted in children, but have yielded mixed results. An early study by Glucksberg & Krauss (1967) found that young children were unable to form common ground with each other in a matcher-director task, even though they were able to complete the task when familiar pictures were used. Although young children may struggle to negotiate conceptual pacts with peers, they do expect speakers to be referentially consistent, just like older children and adults (Graham, Sedivy, & Khu, 2014). Other studies have shown that children are able to form referential pacts with others by the age of 6, and by age 10, are sensitive to multiple partners' knowledge states (**???**; Branigan et al., 2016). Taken together, these studies suggest that children's ability to reliably form conceptual pacts with one another emerge in early childhood, and continue to develop through middle childhood.

TODO: mention Glucksberg, Krauss, and Weisberg, 1966, which showed that kids fail with one another (Exp. 1) but succeed when as listeners when the (adult) experimenter is the speaker (Exp. 2), even when the experimenter gradually reduces utterances. In addition, they succeed when the experimenter initially elicits each kid's *own* preferred description and then feeds it back to them (Exp. 3)

TODO: In introduction of classic explanations for failures in kid-kid dialogue, briefly mention Asher & Oden, 1976? (which, contrary to Glucksberg, showed kids *couldn't* make good messages for *themselves* in the future, arguing it's probably not just egocentricity), the Beal & Flavell 1982, or Robinson & Robinson, 1977/1982 (which argued kids are bad at realizing messages can be ambiguous, and therefore cannot judge what will be an appropriately informative messages), Roberts & Patterson (1983) which correlated quality of referring expressions with perspective-taking skills...

TODO: mention Deutsch & Pechmann, 1982? (which showed young kids *can* communicate with each other with a little initial prompting by adult experimenter, suggesting that adults may 'seed' conventions)

TODO: mention Garrod & Clark, 1993 or Anderson, Clark & Mullin (1994). (which suggest the problem lies not in message formulation but in their failure to manage interactional stuff like giving feedback to their partner when they don't understand and explicitly asking for clarification.)

Thus far, research on children's communicative development have largely focused on peer interactions. While these studies allow us to see how children's referential abilities differ at various ages, they may not capture the full picture. Children do not only interact with each other. Indeed, much of young children's daily interactions involve adults such as caregivers and teachers. To better understand how children become skilled conversationalists, we must explore the role that adults play in children's communicative development.

Parent-Child Interaction

Young children interact with their caregivers on a daily basis. Research in the field of language development has found that linguistic input from parents and caregivers are predictive of children's language learning outcomes (Weisleder & Fernald, 2013). While many studies have examined how parental speech influences children's acquisition of vocabulary and grammar, less research has been done on how parents scaffold children's communicative development more broadly. Language learning does not occur in isolation, and a broader understanding of language development requires that we study that communicative contexts in which language is used. Parents and caregivers are sensitive to their children's needs, and are able to adapt their language accordingly. When interacting with young children, parents modify their sentence structure and content based on their children's vocabulary knowledge (Leung, Tunkel, & Yurovsky, in press; Masur, 1997). In an observational study by Masur (1997), parents and children played with toy animals. The author found that parents used different sentence structures when referring to animals, depending on whether their children were familiar with the animal's canonical label. In a more recent study, Leung et al. (in press) examined parents' speech in a communicative game, where parents guided children to select animals on an iPad screen. Results showed that parents used longer sentences with more adjectives when referring to animals that they believe their children do not know. Taken together, these studies show that parents are able to sensitively adapt their language based on their children's developmental level. How might conversing with more linguistically-advanced interlocuters influence children's communicative development? There is some evidence that adults can scaffold children's referential communication (Glucksberg & Krauss, 1967; Matthews, Lieven, & Tomasello, 2010). As mentioned above, preschoolers were unable to complete the matcher-director task with peers in Glucksberg & Krauss' (1967) study. However, in a follow up study, experimenters asked preschoolers to name the abstract objects prior to playing the game. When an adult experimenter used the preschoolers' preferred referent names, children were able to complete the task. This finding suggests that children's failure to complete the referential communication task may lie in their inability to negotiate conceptual pacts with one another, rather than an inability to map a referent name onto a referent.

Explicit feedback may also influence children's referential communication abilities. Matthews et al. (2010) conducted a training study, in which young children received explicit feedback from adult experimenters in a referential communication setting. Participants who underwent training were more likely to spontaneously produce unambiguous referential expressions at test, indicating that feedback can support the development of communicative abilities. However, both studies discussed here examine adult-child interaction in a highly constrained setting: the adults are experimenters with a clear script of how to speak to the child participants. To better understand how adults may scaffold children's communicative development, we must study adult-child interactions in a more naturalistic setting.

The present study aims to explore how parents and children interact to form referential pacts in conversation. Based on prior developmental research showing that sensitivity to conceptual pacts emerge in early childhood, and referential abilities gradually develop through middle childhood (**???**; **???**; Branigan et al., 2016; Graham et al., 2014), we opted to study 4-8 year-old children. The main goal of this is to understand whether and how parents scaffold children's communicative development, by comparing parent-child referential communication across ages.

Based on previous work on adult-child referential communication, there are two possible accounts of parent adaptation

in referential pact formation. 1) Parents of younger children would take up more of their children's referent names in order to boost referential success, in line with Glucksberg and Krauss' (1967) finding that children had high receptive referential success when experimenters used names generated by the child. 2) Parents of younger children provide more higher-level feedback and scaffolding throughout the game, such as through rephrasing children's referential expressions or asking for clarifying information, in line with Matthews et al.'s (2010) training study.

Experiment 1a: Referential Communication in Adults

Methods

Participants Participants were recruited from the University of Chicago's online subject pool, to achieve a planned sample of 20 pairs. At the time of analysis, data from 17 dyads were included.

Stimuli Twelve solid black images of tangrams, and colored versions of the same tangrams, were selected from a database of Public Domain images. The tangram images were normed on Amazon Mechanical Turk (mTurk) for pairwise similarity. Two images were excluded from the set based on similarity judgments, forming the final set of 10 images used for the study.

Procedure Each dyad played a cooperative game with iPads. Pairs sat at a table with a divider in the middle, which prevented participants from looking at each other's iPad screens during the game. The game was a simplified version of the matcher-director task used in Clark & Wilkes-Gibbs (1986). Participants were told that they would take turns being the director and matcher. They were told that the director should describe the image inside the blue square, and the matcher should select an image based on the director's description. After instruction, the practice and experimental trials began. On each experimental trial, two solid black tangrams appeared on the iPad screens. The same images appeared on each screen, but their positions were randomized. On the director's screen, one image appeared inside a blue square, while the images on the matcher's screen simply appeared on a white background (Figure 1). Upon selection of an image on the matcher's screen, the selected image became colorful, and a sound is played (independent of accuracy). After each trial, the roles were switched. Practice trials followed the same structure as experimental trials, but images of fruits and vegetables were used during this round. All sessions were videotaped, and the videos were transcribed using DAtavyu–an Open-Source coding software (Datavyu Team, 2014)

Design There were 4 blocks of 10 trials. Each tangram appeared as the target once during each block, such that each tangram was the target four times during the game. Trials within blocks were randomized. The 10 tangrams were shuffled and randomly assigned to either participants at the beginning of the game. The assignment dictates who would be the director for a particular target in Round 1. Thus, each participant played the role of director two times for each of the 10 tangrams. In each round, the targets appeared with different foils. The trials were constructed such that the most similar tangrams (based on mTurk worker judgments) did not appear together.

Experiment 1b: Parent-Child Interaction

Methods

Participants Children (ages 4, 6, and 8) and their parents were recruited from a database of families in the local community, to achieve a planned sample of 60 parent-child pairs. A total of 75 children and their parents participated, but data from 12 pairs were dropped due to experimental error or failure to complete the study. The remaining sample of 63 parent-child dyads were included in analysis.

Stimuli The same images from Experiment 1a were used in the parent-child version of the experiment.

Procedure Each parent-child pair played the game described in Experiment 1a. Pairs sat at a table with a divider in the middle, and were told that they would take turns being the director and matcher. Parent-child pairs completed the same number of practice and test trials as the participants in Experiment 1a. All sessions were videotaped, and videos were transcribed using an Open-Source coding software, Datavyu (2014).

Design Experiment 1b used the same design as Experiment 1a, such that parents and children each played the role of director two times for each of the 10 tangrams. To ensure that the task would not be too difficult for young children, the trials were constructed such that the most similar tangrams (based on mTurk worker judgments) did not appear together.

Results

We should combine these basic measures into a single 2-col figure.

Performance accuracy Were children able to succeed at the reference game, in collaboration with their parents? We begin by examining accuracy across age groups. While accuracy was initially well above chance at all age groups, we found a significant main effect of age (b = , t = ; $p = 0.001$). Pairs with 4-year-olds performed significantly more poorly than pairs with older children. Critically, however, accuracy improved significantly over the four repetition blocks for all groups (b = 0.47, t = 3.2; $p = 0.001$). Such improvement for 4-year-olds contrasts with early results of communication between age-matched children (**???**,@KraussGlucksberg69_DevoReferenceGames), which found no improvement in accuracy with kingergardeners (age 5).

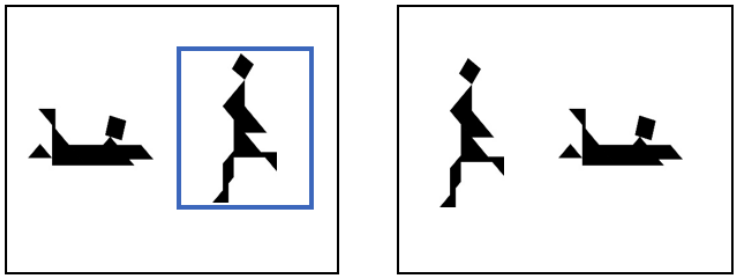


Figure 1: Example of iPad screens for the director (left) and matcher (right) during the game.

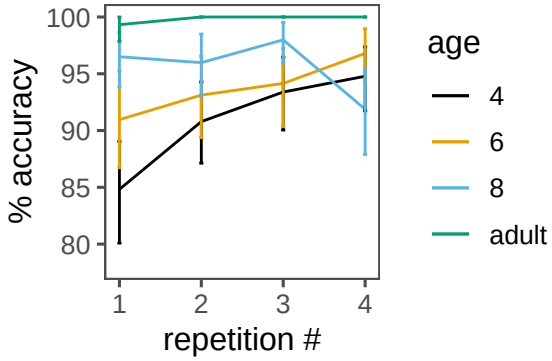


Figure 2: Accuracy

TODO: describe mixed-effect structure. Also, note that big dip in 8-year-olds looks like driven by subid 17 who got every trial in last block incorrect.

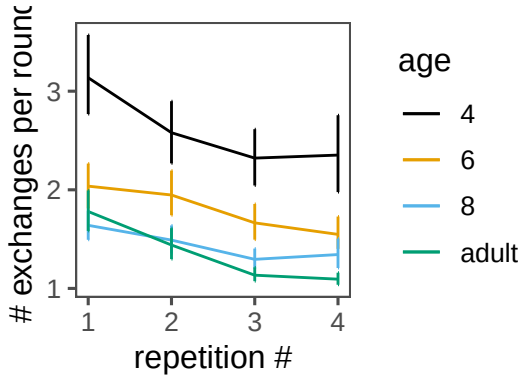


Figure 3: Number of dialogue exchanges.

Interactive dialogue exchanges If the ability of children to successfully establish reference in both director and matcher roles depends on scaffolding provided by their parents, we would expect additional dialogue turns for younger children. We counted the total number of exchanges on each trial, defined as the Consistent with previous work in adults (**???**), we found a significant main effect of repetition (b = -0.18, t = -3.84; $p < 0.001$). Fewer dialogue turns were required on later trials. However, we also found a significant main effect of the child's age (b = -0.32, t = -3.76; $p < 0.001$). Pairs with 4-year-old children took roughly one additional turn at each point in the experiment than pairs with older children, who more closely resembled adults. This increased level of interactivity between parents and younger children provides an interesting contrast with previous studies showing decreased interactivity in pairs of younger children (**???**, @anderson_interactive_1994). These lengthier exchanges may reflect efforts by parents to provide and elicit additional clarification or confirmation, or may simply reflect attentional difficulties.

TODO: Can we follow-up by analyzing how many of these were questions vs. confirmation vs. purely keeping kids on task? Also: describe mixed-effect structure.

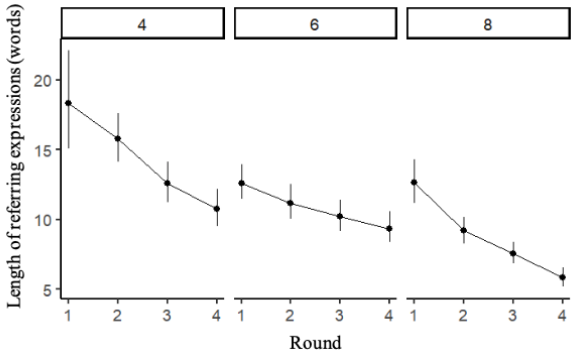


Figure 4: Change in length of referring expressions, split by age groups.

Reduction in length of referring expression

TODO: Control for # of exchanges? (obviously if younger pairs are taking extra turns they are producing more words overall)

TODO: Look at interactions? we see older pairs use more words overall (main effect) but do they *reduce* more?

A key signature of successful communication among adults is an increase in efficiency over repeated reference (**???**,@Clark1986Referring). As pairs form conceptual pacts,

they are able to communicate the same meaning using fewer words. We asked whether children spontaneously adapt their referring expressions in the same way. We operationalize efficiency as the number of words in the director's referring expressions for each trial. Because participants in a pair alternated roles, each participant served as the director twice for each tangram. We can therefore compare their first referring expression against the one they produced two repetition blocks later.

Using a mixed-effects model, we predicted utterance length including fixed effects of child age, repetition block (first vs. last), and speaker identity (parent vs. child) and random intercepts at the dyad- and tangram-levels. First, we found a significant main effect of repetition block (b = X, t = X, p = X), with all participants producing relatively more efficient utterances over time. Second, we found a significant main effect of age (b = X, t = X, p = X). Dyads with older children used shorter referring expressions overall.

Third, we were interested in whether these age effects were driven by parents or children. That is, do younger children produce longer utterances than older children, or do *parents* of younger children expect that longer utterances will be required? When looking only at children's referring expressions, the three groups did not appear to differ. On the other hand, the three groups of parents differed in their length of referring expressions. Specifically, parents of 4-year-olds used longer referring expressions throughout the game.

Reaction Time We analyzed reaction time for each trial. Reaction time was stored automatically by the game's computer code, and can be understood as time taken to complete the trial (rather than reaction time to a stimulus per se). Reaction times longer than 20000ms (2 minutes) were discarded. Since the game did not have an option for pausing, trials had abnormally long reaction times when dyads needed to take a break from the game (e.g. children needing to use the bathroom). Similar to length of referring expressions, reaction time decreased from Round 1 to Round 4 for pairs in all age groups (Figure 5). When split by age group, reaction times showed similar patterns to length of referring expression, such that dyads with older children were faster overall (Figure 6).

Take these results out? (seems redundant with length of referring expression and number of exchanges?)

Where do pacts come from?

Pairs of age-matched children are notoriously poor at repeated referential communication (**???**), failing to coordinate on mutually comprehensible referring expressions.

Our results demonstrate that when children perform the same task with their parents, this coordination problem can be solved: they converge on increasingly accurate and efficient pacts, as adults do. What, then, allows children to coordinate with their parents but not with their peers?

One possibility is that children lack the ability to *adapt* to their partner: they have a strong preference for a particular idiosyncratic description and are not sensitive to the possibility that their partner may not understand it. Under this hypothesis, children fail with other children because they each continue to use mutually incomprehensible expressions, and only succeed with their parent as a result of the parent's flexibility.

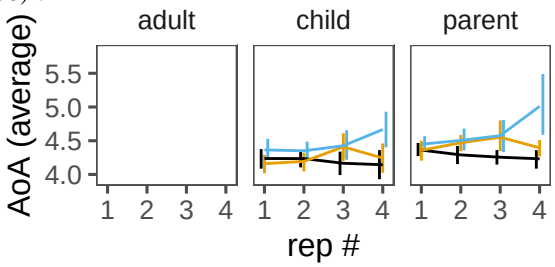
An alternative possibility is that young children are able to adapt but are uncertain about what an appropriate label would be in the first place. They fail with other children because neither can generate an understandable enough initial label to start the pact-formation process, but will quickly pick up on a good label supplied by their parent.

These accounts make different predictions about who is adapting to who: do pacts originate with children, or with adults? We test this prediction by quantitatively analyzing the natural-language transcripts.

What predicts success?

In order to estimate the complexity of language used by participants, we used self-reported age of acquisition estimates collected by Kuperman, Stadthagen-Gonzalez, & Brysbaert (2012). These researchers asked almost 2000 Mechanical Turkers to judge the age at which they first acquired each of a large set of words on a 7 point Likert scale. Although one might be suspicious that adults have little access to this kind of information, these judgments are highly correlated with parents' estimates of the age at which their children learn corresponding words, and are better than a variety of other measures (e.g. frequency, concreteness, word length) in predicting lexical decision times (Kuperman et al., 2012).

For each participant, on each trial, we estimated the linguistic complexity of their contribution by averaging the estimated age of acquisition for each word in their utterance^[We first removed any words in a list of 174 stopwords like "at" and "me" from the `tm` package (Feinerer, Hornik, & Meyer, 2008)'.



Discussion

Our main effect of reduction in length of referring expression replicates the effect found in Clark and Wilkes-Gibbs (1986), suggesting that parents and children were forming conceptual pacts with one another as the game progressed (Figure 2). This effect was found across all three age groups, and patterns were largely similar across groups. Our results show that children as young as 4 are able to cooperate with a more linguistically capable partner to form conceptual pacts in con-

versation. Taken together with prior research suggesting that 4-year-olds are not yet able to form conceptual pacts with their peers (Glucksberg & Krauss, 1967), our findings indicate that adults could scaffold younger children's conversational abilities to facilitate effective referential communication.

Older children and their parents used shorter referring expressions overall (Figure 3). This finding may reflect older children's more advanced linguistic skills compared to their younger counterparts, such that they produce more succinct (and perhaps more efficient) referring expressions. Older children may also require less descriptive information about the target tangram in order to identify it. These explanations are not mutually exclusive, but further analysis suggests that the latter may reflect our data more accurately.

When analyzing length of referring expression separately for parents and children, we found that the age difference was largely driven by parents (Figure 4). While children's length of referring expression did decrease across rounds, patterns did not seem to differ across age groups. On the other hand, parents of 4-year-olds used longer referring expressions than parents of older children. One potential reason for why parents used longer referring expressions with younger children could be that these children required more scaffolding. Younger children may have difficulty focusing on relevant dimensions of the target tangram, such that parents need to provide more information in order for their children to select the correct tangram. Qualitative analysis is currently underway, and will be helpful for understanding the reason parents use varying lengths of referring expressions with their children. Our analyses thus far suggest that parents may be adapting their speech for effective communication, using longer, more informative sentences with younger children, and shorter ones with older children.

Reaction times decreased across rounds for all parent-child pairs (Figure 6). Our reaction time analyses showed patterns similar to that of length of referring expressions. While dyads across age groups showed the same pattern of decreasing reaction time, older children and their parents were faster overall. These results show that parents and children are calibrated to each other during the game. If reaction times did not match length of referring expressions, that could indicate that parents and children were providing too little or too much information to each other, such that the two measures would be mismatched. Thus, the intuitive finding that reaction times matched referring expression lengths serves to strengthen the argument that parents calibrate to their children in communicative settings.

Thus far, our analyses show that children can cooperate with their parents to form conceptual pacts about novel referents. Given that children as young as 4 years old were successful in forming referential pacts with others, our results suggest that parents, who are more linguistically-advanced, can scaffold children's communicative abilities. Qualitative analysis is currently ongoing, and will be helpful for answering the following questions: How do parents and children each drive the referential pact formation process? How do these roles change across development? A deeper understanding of the characteristics of parent-child referential communication across development will shed light onto the how children develop their conversational skills, and how parents may scaffold the process.

Future Directions

Adult conceptual pact formation has been widely studied, and the effects have been fairly robust. The present study rests upon the assumption that adults readily form conceptual pacts with one another in referential communication settings, but a direct comparison between parent-child pairs and adult-adult pairs playing the same game may be helpful. We are currently recruiting adult participants to play the same communication game. Since our study uses a simplified version of Clark and Wilkes-Gibbs' (1986) original paradigm, recruiting adult participants would be helpful for understanding children's developmental trajectory between ages 4 and 8. Our data would allow us to ask how parent-child pairs differ from adult-adult pairs, both quantitatively and qualitatively.

A useful follow-up would be to alter the trials, such that similar tangrams are paired together. Currently, tangrams that are most dissimilar to each other are paired, as a way to ensure that the game would not be too difficult for young children. Anecdotally, however, the researchers have noticed that older children occasionally comment on the game being too easy. Other than increasing the difficulty of the game, pairing similar tangrams also has the important benefit of allowing us to understand how different pressures influence referential communication and conceptual pact formation. The follow-up study could be directly compared to the current study, and would allow us to further explore how parents calibrate to their children in referential communication settings.

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Place acknowledgments (including funding information) in a section at the end of the paper.

References

Branigan, H. P., Bell, J., & McLean, J. F. (2016). Do you know what i know? The impact of participant role in children's referential communication. *Frontiers in Psychology*, *7*, 1–15. http://doi.org/10.3389/fpsyg.2016.00213

Brennan, S. E., & Clark, H. H. (1996). Conceptual pacts and lexical choice in conversation. *Journal of Experimental Psychology: Learning Memory and Cognition*, *22*(6), 1482–1493. http://doi.org/10.1037/0278-7393.22.6.1482

Clark, H. H., & Schaefer, E. F. (1989). Contributing to discourse. *Cognitive Science*, *13*(2), 259–294. http://doi.org/10.1016/0364-0213(89)90008-6

Clark, H. H., & Wilkes-Gibbs, D. (1986). Referring as a collaborative process. *Cognition*, *22*, 1–39.

Datavyu Team. (2014). Datavyu: A video coding tool. *Databrary Project, New York University. URL Http://Datavyu. Org*.

Feinerer, I., Hornik, K., & Meyer, D. (2008). Text mining infrastructure in r. *Journal of Statistical Software*, *25*(5), 1–54. Retrieved from http://www.jstatsoft.org/v25/i05/

Fusaroli, R., Bahrami, B., Olsen, K., Roepstorff, A., Rees, G., Frith, C., & Tylén, K. (2012). Coming to terms: Quantifying the benefits of linguistic coordination. *Psychological Science*, *23*(8), 931–939. http://doi.org/10.1177/0956797612436816

Glucksberg, S., & Krauss, R. (1967). What do people say after they have learned how to talk? Studies of the development of referential communication. *Merrill-Palmer Quarterly of Behavior and Development*, *13*(4), 309–316.

Graham, S. A., Sedivy, J., & Khu, M. (2014). That's not what you said earlier: Preschoolers expect partners to be referentially consistent. *Journal of Child Language*, *41*(1), 32–48. http://doi.org/10.1017/S0305000912000530

Ibarra, A., & Tanenhaus, M. K. (2016). The flexibility of conceptual pacts: Referring expressions dynamically shift to accommodate new conceptualizations. *Frontiers in Psychology*, *7*. http://doi.org/10.3389/fpsyg.2016.00561

Kuperman, V., Stadthagen-Gonzalez, H., & Brysbaert, M. (2012). Age-of-acquisition ratings for 30,000 english words. *Behavior Research Methods*, *44*(4), 978–990.

Weisleder, A., & Fernald, A. (2013). Talking to children matters: Early language experience strengthens processing and builds vocabulary. *Psychological Science*, *24*(11), 2143–2152. http://doi.org/10.1177/0956797613488145