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Young Children's Understanding of the Relationship Between Conventionality and Communication

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Young Children's Understanding of the Relationship Between

Conventionality and Communication

by

Kathleen R. Sullivan

A dissertation presented to the
Graduate School of Arts and Sciences
of Washington University in
partial fulfillment of the
requirements for the degree
of Doctor of Philosophy

December 2012

St. Louis, Missouri

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Acknowledgements

Dedication

This dissertation is dedicated to the loving memory of Ann Sullivan.

ABSTRACT OF DISSERTATION

Young Children's Understanding of the Relationship

Between Conventionality and Communication

by

Kathleen R. Sullivan

Doctor of Philosophy in Psychology

Washington University in St. Louis, 2012

Professor Lori Markson, Chair

This dissertation explores children's understanding of the conventionality of language, the notion that shared knowledge of the meanings of linguistic symbols enables communication using those symbols. Three studies investigate whether monolingual children recognize that different speakers share knowledge of lexical conventions, in this case the labels for objects, independent of children's own knowledge of those labels. Further, children's ability to use evidence of shared conventional knowledge when reasoning about communicative interactions is tested using a novel third-party communication task. Results indicate that three-year-old children track consistent labeling of novel objects across different speakers, and infer underlying shared knowledge of object labels across consistent speakers. Further, under supportive conditions, three-year-old children infer that inconsistent speakers know different labels for the same object, overriding their own default bias to assume that everyone will use the same label for an object when given evidence to think otherwise. Finally, four-year-old children can reason about communicative interactions in an unfamiliar language, recognizing that a bilingual speaker intends to direct her speech toward a particular monolingual speaker, depending on which

language she uses (e.g., toward another Spanish speaker when speaking in Spanish). This result suggests that four-year-olds understand that shared knowledge of a particular language enables communication between those speakers, and recognize the communicative efficacy of an unfamiliar language. Three-year-old children's difficulty with this communicative task suggests that children's conception of conventionality and its role in communication becomes enriched across early childhood.

Chapter 1: Children's reasoning about conventional communication

Using language to communicate with others is a fundamental human achievement. One of the major goals of cognitive science is to explain how the ability to communicate is acquired so easily at such a young age. This research has demonstrated that children recognize the mentalistic connection that language creates between speaker and listener. However, in order for linguistic symbols to function in communication, speakers and listeners must share knowledge of the meanings of those symbols (Saussure, 1916/1983). The conventionality of language supports communication because listeners can infer speakers' communicative goals, given the conventions they use. When speakers and listeners don't share knowledge of these relationships, as when two people speak different languages, they must rely on potentially less effective non-verbal means of communication.

While a broad range of studies, reviewed below, suggests that children recognize that speech connects speakers' and listeners' thoughts, current evidence about children's understanding of the conventionality of language is more preliminary. Recent studies have demonstrated that children expect others to use familiar labels for familiar objects, labels that children themselves know. However, this expectation could be explained in at least two ways. On one hand, children may simply expect to hear accurate labels for familiar objects, without considering the speaker's conventional knowledge. Alternatively, given that children can reason about other implications of speakers' knowledge, children may recognize that conventional knowledge plays a role in communication. That is, children may understand that different users of language share knowledge of conventions, and that this shared knowledge enables communication between speakers and listeners. This dissertation aims to characterize children's understanding of shared conventions and how this aspect of language supports comunication.

The first chapter reviews existing research on young children's understanding of conventional communication, drawing on studies of gestural and verbal production, comprehension, and learning. Chapter 2 presents a novel method to test whether children understand that different speakers share knowledge of object labels, independent of children's own knowledge of those labels. The study presented in Chapter 3 uses this methodology to test whether children recognize that different speakers can use different labels for the same objects, akin to speaking different languages. Chapter 4 explores young children's understanding of the relationship between conventionality and communication, presenting a test of children's understanding that two people can communicate when they know the same lexical conventions. The final chapter discusses the results of these studies, implications for theories of communicative development and word learning, and directions for future research.

The role of social reasoning in communicative development.

As adults, we appeal to unobservable mental states continuously and coherently to interpret, explain, and predict others' observable behavior (Malle, 2004; Malle, Moses, & Baldwin, 2001). Recent advances in research techniques have generated evidence that mentalistic reasoning emerges early in development. Prelinguistic infants construe humans as intentional agents who perceive and act on the world relative to those perceptions (Brooks & Meltzoff, 2002; Luo & Baillargeon, 2007), and relative to other mental states like preferences (Xu & Denison, 2009) and goals (Woodward, 1998; see Woodward, 2009). Non-mentalistic explanations have been proposed to account for these data, including perceptual triggers (Hood, Willen, & Driver, 1998), positive reinforcement (e.g., Corkum & Moore, 1998), and teleological reasoning (Gergely & Csibra, 2003). In response to some of these proposals, Johnson (2000)

argued against perceptual or conditioned triggers because infants show similar responses to the actions of novel non-human agents, which look and behave very differently than agents that infants experience in day-to-day life (Johnson, Slaughter, & Carey, 1998; Shimizu & Johnson, 2004). Further, recent evidence suggests that infants interpret another person's actions relative to that person's visual perspective, even when this perspective differs from infants' own (Luo & Baillargeon, 2007; Luo & Johnson, 2009). It would be challenging to reconcile these results with a perceptually-based, non-mentalistic interpretation of action. Rather, infants seem to view others' behavior as generated by, and constrained by, internal unobservable mental states.

What role might the ability to reason about others' mental states play in language acquisition? The main theories of word learning differ substantially in the role they accord to social information. One major theory proposes that word learning is intractable if children must consider every possible referent for a word, so they must start out with some initial constraints on their lexical inferences (e.g., Golinkoff, Mervis, & Hirsh-Pasek, 1994; Markman 1990, 1994; Regier, 2003). Support for this constraints account cites children's default tendency to interpret novel labels in principled ways. For example, children assume that nouns refer to whole objects at the basic taxonomic level (Golinkoff, Shuff-Bailey, Gordon, & Ruan, 1995; Markman & Hutchinson, 1984), rather than to parts or substances (Soja, Carey, & Spelke, 1991), and that these category labels are mutually exclusive (Au & Markman, 1987; Markman & Wachtel, 1988; Markman, Wasow, & Hansen, 2003; Merriman & Bowman, 1989). Importantly, these constraints apply to the relationships between words and meanings, and are not necessarily thought to be influenced by social reasoning.

Another major theory of word learning includes a role for social influence, but not in the form of mentalistic reasoning. The attentional learning account, proposed by Smith and

colleagues (Smith, Jones, Landau, & Gershkoff-Stowe, 2002; Smith & Samuelson, 2006; Smith & Yu, 2008), holds that word learning occurs when perceptual cues guide children's attention toward particular objects, and associations between these objects and words become established and strengthened over time. Certain social cues, like the speaker's direction of gaze, can enhance the salience of particular objects and guide children's attention toward them (Samuelson & Smith, 1998). However, Smith and colleagues claim that attention and association over time are sufficient to explain learning, and that abstractly represented concepts, like those specifying others' mental states, are not necessary (Smith, Jones, & Landau, 1996; Thelen & Smith, 2006). Thus, any social influence on word learning comes from the speaker's overt behavior, rather than children's inferences about the mental states that generate that behavior.

In contrast, the third major theory of word learning integrates mentalistic reasoning into the process of word learning. Proponents of the social-pragmatic account claim that word learning is supported by children's understanding of the intentions underlying communication (Bloom, 1997; Bloom & Markson, 1998; Csibra, 2003; Tomasello, 2000; Tomasello, Carpenter, Call, Behne, & Moll, 2005). Children comprehend new words as they attempt to interpret the communicative intentions of speakers, and produce newly learned words when communicating with listeners. Research testing the social-pragmatic account has provided results that cannot be explained by the constraints or attentional accounts. For example, as mentioned above, children show a default bias to assume that nouns refer to basic-level taxonomic categories (Golinkoff et al., 1995; Markman & Hutchinson, 1984). However, children will readily construe a noun as the label for a super- or subordinate category, if the speaker intentionally chooses category exemplars at that level (Xu & Tenenbaum, 2007a, 2007b). Further, while salient contextual cues can drive children's attention toward potential referents for novel words (Samuelson & Smith,

1998), they do so only when those cues are relevant to the speaker's communicative intentions (Diesendruck, Markson, Akhtar, & Reudor, 2004). Purely lexical mechanisms, like constraints, cannot account for these social influences. Likewise, attention and association are undoubtedly involved in children's word learning, but these processes alone cannot account for a variety of experimental results indicating the strong influence of social and conceptual knowledge on children's word learning (see Waxman & Gelman, 2009; Xu & Tenenbaum, 2007a, 2007b). In fact, the observed relationship between children's patterns of attention and their subsequent word learning may itself be evidence of an abstract understanding of communication, which guides both attention and learning.

The following literature review summarizes evidence that word learning is embedded in intentional communicative acts on the part of children and their conversational partners, such that children understand that a speaker's words are related to his or her thoughts and intentions, and that a listener's thoughts are changed by hearing speech. Further, growing evidence suggests that just as children expect an individual speaker's words to be related to her communicative intentions, children also expect different speakers to use the same words to accomplish the same communicative intentions.

Speakers' and listeners' thoughts interact through communication.

When inferring the referents of new words, infants actively monitor the object of the speaker's attention and thought. Cues to these mental states include the speaker's perceptual access and direction of gaze (Baldwin, 1991, 1993), the speaker's familiarity with potential referents (Akhtar, Carpenter, & Tomasello, 1996; Moll, Koring, Carpenter, & Tomasello, 2006), and conversational common ground between the child and the speaker (Akhtar & Montague,

1999; Tomasello & Akhtar, 1995). Samuelson and Smith (1998) argue that these cues simply guide or enhance children's own attention to particular referent objects, rather than generating inferences about the speaker's mental states. However, these cues only influence word learning when the speaker acts intentionally, rather than accidentally (Diesendruck et al., 2004; Tomasello & Barton, 1994), and only when they come from the speaker, rather than from another person (Gligla & Csibra, 2009). This selectivity suggests that children disambiguate the referents of words *via* the information that these cues provide about the speaker's thoughts.

On the other side of the communicative exchange, children recognize the difference between a listener's baseline, "precommunication" mental state, and the subsequent change in thought after communication. This ability to monitor others' knowledge states is first apparent in infants' preverbal gestures. One-year-old infants point more when an adult is not looking toward an exciting event than when she is looking (Liszkowski, Carpenter, & Tomasello, 2007b), or when an adult is unaware of a needed object (Liszkowski, Carpenter, & Tomasello, 2008; see also O'Neill, 1996; O'Neill & Topolovec, 2001). Infants thus appear to recognize their partners' lack of awareness about an event or object, and point to direct their attention. Young children's early speech suggests a similar monitoring of listeners' mental states. Wittek and Tomasello (2005) recorded two- and three-year-old children's responses to different questions, and found that children used more definite nouns in their responses to less specific questions than to questions that contained more specific content. This result suggests that children interpreted vague questions to imply relatively less knowledge on the part of the adult, and so provided relatively more informative responses (e.g., saying "the cat" rather than "that"). Similarly, three- and four-year-old children use more noun phrases when referring to something the listener cannot see, and more pronoun phrases when referring to something the listener can see, again

providing more information for a relatively less informed listener (Matthews, Lieven, Theakston, & Tomasello, 2006).

On one hand, this modulation suggests that children monitor their conversational partners' knowledge, via perceptual access and prior conversational context, and construct their own communicative acts in a way that builds on that listener's knowledge. On the other hand, children may expect conversation to be a back-and-forth exchange, regardless of the content of each turn. However, evidence from children's persistence suggests that their communicative acts are motivated by a desire to be understood, rather than simply expecting some nonspecific reaction from their partners. Infants persist in pointing if an adult looks at the wrong referent, a sign that they are not satisfied unless the adult shows evidence of understanding (Liszkowski, Carpenter, & Tomasello, 2007a). This persistence is also apparent in children's early verbal communication. Elaborating on a study by Shwe and Markman (1997), Grosse and colleagues (Grosse, Behne, Carpenter, & Tomasello, 2010) created a situation in which children requested objects from an experimenter. Four experimental conditions varied whether children did or did not receive the requested object, and whether or not the experimenter understood the child's message (by accurately or inaccurately repeating the requested object's label). Results indicated that 18-month-old children repeated or repaired their requests more when they were misunderstood than when they were understood, even when they had received the requested object. This persistence suggests that the goal of receiving the requested object did not exclusively motivate children's communicative acts. Rather, children also wanted to be understood, and repeated or repaired their statements when this apparently didn't happen.

Several recent studies also suggest that when children observe a communicative interaction between two others, they expect the listener to understand messages from the speaker.

Rakoczy and Tomasello (2009) recorded children's reactions to declarative statements, where a speaker described another person's actions, and to imperative statements, where the speaker told another person to do something. They found that children corrected the speaker when he did not accurately describe the person's actions, but corrected the listener when she did not comply with the speaker's request. Directing their corrections toward the listener suggests that children expected her to understand, and thus comply with, the imperative.

A recent study by Martin and colleagues (Martin, Onishi, & Vouloumanos, 2012) suggests that these expectations go beyond simply expecting any sort of contingent reaction from the listener. Rather, twelve-month-old infants appear to expect a listener to select the appropriate referent of speaker's request, specifically when that utterance is informative. For example, infants were surprised to see the listener select the wrong referent after the speaker uttered a word, but not after the speaker coughed. The authors interpret this surprise as indication that infants expect speech to convey information between speaker and listener.

This interpretation is supported by evidence that children's reasoning about communication is integrated with their reasoning about others' beliefs. Song and colleagues (Song, Onishi, Baillargeon, & Fisher, 2008) showed 18-month-old infants an actor who developed a false belief about the location of a toy, because the actor did not see when the toy was moved to a new location. Another actor then appeared and produced an utterance that was either informative ("The ball is in the cup!") or uninformative ("I like the cup!") about the new location of the toy. Infants' patterns of looking time suggested that they expected the actor's false belief to be corrected by the informative message, but not by the uninformative message (see also Lohmann, Carpenter, & Call, 2005). This result corroborates several other recent studies to suggest that infants in the second year of life possess a relatively coherent mentalistic

understanding of perception, action, and belief (Luo & Baillargeon, 2007; Onishi & Baillargeon, 2005; Sodian, Thoermer, & Metz, 2007; Surian, Caldi, & Sperber, 2007). Importantly, it provides evidence that infants, who are in the relatively early stages of language learning, recognize that language is informative to others.

Understanding the conventionality of language.

Taken together, these studies provide evidence that children actively recruit their mental state reasoning to engage in communicative interactions with others. Children recognize that speakers' thoughts and intentions cause the words they say, and that listeners' thoughts are impacted by the speech they hear. Language works this way because it is conventional: speakers and listeners share knowledge of the arbitrary relationships between words and their meanings. When discussing the arbitrariness of language, Saussure emphasized this shared knowledge, saying that, "[i]t is because the linguistic sign is arbitrary that it knows no other law than that of tradition, and because it is founded upon tradition that it can be arbitrary." (1916/1983, p. 74). Lewis (1969) expanded this characterization of the conventionality of language by describing linguistic communication as a coordinated action wherein different individuals use, and expect others to use, the same linguistic conventions. Under Lewis's formulation, conventions become established when two individuals must coordinate their behavior toward a joint goal. In the case of language, that joint goal is to understand one another's communicative intentions, and the most effective way to do this is to use established linguistic conventions.

Social-pragmatic theorists have proposed that children indeed expect speakers to use particular lexical forms to accomplish particular communicative intentions. Clark proposed that language learners recognize the Principle of Conventionality: "for certain meanings, there is a

form that speakers expect to be used in the language community" (Clark, 2007, p. 14; see also Clark, 1990, 1993; Clark & Berman, 1984). Diesendruck and Markson (2010) recently proposed an expanded definition of children's assumption of conventionality, which specifies for children *what* knowledge is shared and *who* shares this knowledge. Specifically, children assume that certain kinds of socially-learned knowledge, including the meanings of words and the functions of artifacts, are shared across different people, while other kinds of mental contents, like preferences, are idiosyncratic and individual.

Evidence for children's understanding of conventionality can be found both in their expectations about familiar words and in their interpretations of novel words. Sixteen-month-old infants are surprised to hear an adult utter the wrong label for the object she is looking at, but not if the adult is looking away from the object, or if the label is emitted by an electronic speaker (Koenig & Echols, 2003). If infants were guided solely by their own knowledge of familiar objects' labels, they should expect to hear those labels in all cases. Rather, infants specifically expected to hear a matching label when a human speaker was intentionally referring to that object. This selectivity supports Clark's claim that conventional expectations are based on the match between the speaker's referential intention (indexed by her direction of gaze; Baldwin, 1991) and the form she uses to accomplish that intention.

For a more explicit test of children's baseline conventional assumption, Markson and colleagues (Markson, Sullivan, & Diesendruck, in preparation) asked young children whether it was "okay" for a puppet to use matching, familiar mismatching, or novel labels for familiar objects. For example, the puppet held up a hammer and said "Oh look, I found a fork!" Two- and three-year-old children explicitly accepted the puppet's use of matching labels but rejected familiar mismatching object labels. Three-year-old children also rejected the use of novel labels

to refer to familiar objects, possibly because the speaker did not indicate the relationship between the known label and the novel label (Callanan & Sabbagh, 2001). These results suggest that, unless children are given a reason to think otherwise, they expect a speaker to use conventional labels. Further, this expectation is also normative, such that children are not just surprised at, but actually reject the use of mismatching labels.

Infants also assume that newly-learned labels will be used the same way by different people. Toddlers show equivalently accurate learning for a novel word whether they are tested by the original speaker or by a new speaker who was not present when children initially learned the word (Graham, Stock, & Henderson, 2006; Henderson & Graham, 2005). Similarly, thirteen-month-old infants are surprised if two speakers use the same label when reaching for different objects, suggesting that infants expect to hear the speakers use different words for different objects (Buresh & Woodward, 2007). Importantly, children do not necessarily expect two people to express a preference for (Graham et al., 2006; Henderson & Graham, 2005) or grasp (Buresh & Woodward, 2007) the same object. Children therefore appropriately expect that the use of conventional object labels generalizes across speakers, but that other kinds of behavior do not.

Children may also harness this conventional expectation to help them in ambiguous word learning situations, where a novel word may have multiple possible meanings. A number of studies have found that children avoid mapping novel labels to familiar objects (Au & Glusman, 1990; Liitschwager & Markman, 1994; Markman & Wachtel, 1988). These results have been taken as evidence for a lexical constraint that specifies that object labels are mutually exclusive: once an object has a label, it should not have another one (Golinkoff et al., 1994; Markman et al., 2003; Regier, 2003). In contrast, Diesendruck and Markson (2001) propose a pragmatic account for this bias, based on conventionality: children assume that if a speaker intends to refer to a

familiar object, she will use its conventional label, and therefore must not be referring to the familiar object when using a novel label. To test this proposal, Diesendruck and Markson (2001) taught children either a novel label (e.g., "This one is a dax.") or a novel fact (e.g., "This one came from a big store") referring to a novel object. The authors hypothesized that a purely lexical constraint would lead children to avoid a second label for the object, but not a second fact. Results indicated that children avoided both overlapping labels and overlapping facts, when the second fact was offered by a speaker knew the first fact (he was present when children were taught the first fact). This result suggests that children's ability to disambiguate information (words or facts) is based not on a lexical constraint, but on their expectations about speakers' knowledge, supporting a pragmatic account.

What underlying mechanism generates children's expectation that others will know and use conventional object labels? The results reviewed above are consistent with at least two possibilities. On one hand, children could assume that different speakers know conventional forms, and use those forms to accomplish their communicative intentions (Clark, 2007). On the other hand, children may simply expect to hear what they believe to be the accurate labels for familiar objects. While linguistic symbols are arbitrary and vary across languages, they also have truth values within a particular language. An explanation for these results based on conventionality rests on children's reasoning about the speaker's knowledge, whereas an explanation based on accuracy rests on children's own knowledge, without the need to appeal to the speaker's knowledge. Both conventionality and accuracy could explain children's baseline expectation that speakers will use familiar object labels. However, these accounts make different predictions in other cases. One point of divergence is whether children's expectations are amenable to change. An account based on speakers' conventional knowledge would predict that

children may revise their expectations given direct evidence that a speaker does not know conventions. In contrast, an expectation of accuracy would not necessarily be expected to vary with the speaker's knowledge.

To test these predictions, we familiarized three- and four-year-old children with a speaker who labeled four familiar objects using either accurate basic-level labels, inaccurate basic-level labels (e.g., called a chair "shoe"), or accurate but atypical superordinate-level labels (e.g., called a chair "furniture"). Children were then asked to guess how this speaker would label a new familiar object. Results indicated that children were significantly more skeptical of a previously inaccurate speaker's future accuracy, compared to a speaker who had used accurate basic-level or atypical, but accurate, superordinate-level labels (Markson et al., in preparation). This relative skepticism suggests that children can use a speaker's history of inaccurate labeling as evidence that an individual speaker lacks knowledge of conventional labels, and revise their baseline conventional expectation about that speaker. Importantly, children maintained their conventional expectation when asked about another speaker, restricting their skepticism to the appropriate individual.

This ability to evaluate a speaker's conventional knowledge may also guide children's word learning. A number of recent studies have demonstrated that preschoolers selectively learn novel object labels from accurate speakers, and avoid learning from inaccurate (Birch, Vauthier, & Bloom, 2008; Koenig, Clement, & Harris, 2003; Koenig & Harris, 2005), ignorant, or uncertain speakers (Sabbagh & Baldwin, 2001; Sabbagh, Wdowiak, & Ottaway, 2003). While these studies were designed to explore children's selective trust, one explanation for these results is that children become skeptical that inaccurate or ignorant speakers know conventional labels

in general. Thus, a new label offered by that person is unlikely to be conventional and should be avoided.

While this hypothesis has not been directly tested, it is at least consistent with the results of three recent studies that investigated the mechanisms behind this selective learning. In two studies, Koenig and Woodward tested 24-month-old children's tendency to generalize a newly learned word from one speaker to another. Monolingual English-speaking children were exposed to a novel object label by a previously inaccurate speaker (Koenig & Woodward, 2010), or by one who had spoken exclusively in Dutch (Koenig & Woodward, 2011). Results indicated that when tested immediately and by the initial speaker (the inaccurate or Dutch speaker), children remembered the novel label. However, they responded randomly when tested after a brief delay (Koenig & Woodward, 2010) or by a different, English speaker (Koenig & Woodward, 2010, 2011). Note that this contrasts with children's typical ability to attend to a novel label used by one speaker and show accurate learning when tested by another speaker (Graham et al., 2006; Henderson & Graham, 2005). The fact that children did show accurate memory when tested immediately by the original speaker suggests that they did not completely ignore what they were taught.

This result is corroborated by a recent study by Sabbagh and Shafman (2009), who found that when preschoolers were taught a novel object label by a previously inaccurate speaker, they were more likely to subsequently choose that object when the same speaker then asked, "Which one *did I call* the [label]?" than if she asked, "Which one *is* the [label]?" The authors suggest that when offered a novel label by a previously inaccurate speaker, children form a tenuous, speaker-specific mapping for the label, rather than encoding it as a stable semantic memory. Together, these results suggest that children do not simply ignore inaccurate or unconventional speakers in

their selective learning. Rather, children may infer that new information offered by these speakers is not conventional, is not known by other speakers, and therefore should not be incorporated into children's own vocabulary.

Children can also bring their evaluation of a speaker's past accuracy to bear in ambiguous learning situations. The conventionality account holds that children apply novel words to novel objects because because speakers with conventional knowledge would use familiar words refer to familiar objects (Clark, 2007; Diesendruck & Markson, 2001). However, when that novel label is offered by a previously inaccurate speaker, children are significantly more likely to apply a novel label to a familiar object than when that label is offered by a previously accurate speaker (Diesendruck et al., 2010). If children use the speaker's previous inaccurate labeling to revise their conventional expectation, becoming skeptical that this speaker will use conventional labels for familiar objects, this may cause children difficulty in disambiguating the referent of the novel label used by that speaker. That is, children may reason that a speaker who does not know the conventional labels for familiar objects may in fact use a novel label to refer to a familiar object.

In these studies, speakers' accuracy was demonstrated using matching or mismatching labels for familiar objects; speakers were therefore both unconventional and simply wrong. This conflation of conventionality and accuracy is important because inaccuracy can lead children to make broad negative attributions about speakers. Preschool-aged children do not differentiate between a blindfolded inaccurate speaker and a speaker who does not have an excuse for her inaccuracy (Nurmsoo & Robinson, 2009). Further, five-year-old children judge a previously inaccurate labeler to be less knowledgeable than an accurate labeler about the names for things, but also attribute less factual knowledge and prosocial behavior to the inaccurate speaker (Brosseau-Liard & Birch, 2009). These negative attributions about inaccurate speakers could

disrupt children's word learning, in the absence of conventional reasoning. For example, children may develop negative feelings toward an inaccurate speaker, and avoid engaging with that speaker; this lack of engagement may disrupt learning.

Interestingly, two recent studies provide initial evidence that children can modulate their learning in the absence of objective accuracy, based on subtle social cues that suggest shared knowledge. When people disagree about which object is the referent of a novel label, children themselves endorse the object that was indicated by the majority of speakers, rather than the object chosen by a "lone dissenter" (Corriveau, Fusaro, & Harris, 2009). Children also weigh the approval or disapproval of others when a speaker uses a novel object label: children learn a label when a group of onlookers appeared to approve (by smiling and nodding), but not when the onlookers appeared to disagree or disapprove (by frowning and shaking their heads; Fusaro & Harris, 2008). However, these patterns could still have been caused by either conventionality or accuracy. Children could endorse word meanings that seem to be shared knowledge across a number of people, rather than those used by a single speaker in a 'one-off' way. Alternately, children could simply consider the majority usage to be accurate.

Current research questions.

The research reviewed above raises several important questions, which are explored in the studies that follow. The first issue to address is how to best characterize children's conventional understanding. Do young children recognize that speakers of a language share knowledge of conventions with each other? Or do children, by default, simply expect speakers to use accurate, familiar conventions? If children can consider other speakers' shared knowledge, above and beyond their own knowledge, they may also understand that there can be multiple

valid conventional systems, that is, different languages shared among different sets of people. A related question concerns the origins of this understanding: what evidence do children use to evaluate shared conventions, and how might they come to understand that language is conventional in the first place? Finally, evidence suggests that children's word learning occurs within joint intentional communicative interactions, and is also influenced by the conventional knowledge of their conversational partners. These results raise the possibility that children recognize that conventionality enables communication. Do children recognize that communication with language is only possible when speakers and listeners share knowledge of language conventions? Essentially, this comes down to the question of whether children understand that speakers and listeners have to know the same language in order to communicate.

The studies in this dissertation tested the following questions:

Do children understand that people share knowledge of lexical conventions?

Study 1 tests children's reasoning about different speakers' knowledge of novel object labels. If children can use an individual speaker's pattern of labeling to assess that speaker's conventional knowledge (Markson et al., in preparation), it is possible that they could use the pattern of labeling *across* individuals to infer whether those speakers know the same conventions. Importantly, this study removes the possibility that children's responses can be based on objective judgments of or affiliation with a particular speaker.

Do children understand that people can know different lexical conventions, akin to speaking different languages?

Children are highly sensitive to whether another person speaks their own language (Kinzler, Dupoux, & Spelke, 2007). However, it is yet unclear whether children recognize that different conventional language systems exist, or whether children believe that other language speakers are simply atypical or inaccurate. Study 2 uses the same basic methodology as Study 1 to test whether children can infer *different* knowledge of lexical conventions across speakers. This type of reasoning may prove more challenging for children than inferring shared knowledge, given children's strong assumption that different speakers will use the same label for an object (e.g., Graham et al., 2006). However, different speakers' labeling of objects can give children direct evidence that they know different lexical conventions.

Do children recognize that shared knowledge of conventions enables successful communication?

While Studies 1 and 2 focus on children's inferences about different speakers' knowledge of conventions, Study 3 explores children's reasoning about communication between speakers and listeners. To do this, children in Study 3 participate in a live interaction with three adults, one who speaks exclusively English, one who speaks exclusively Spanish, and one who switches between English and Spanish. Note that participants are three- and four-year-old monolingual English speakers. Children then watch while the bilingual speaker requests a needed object, using either English or Spanish. If children understand that use of a shared language enables communication between a speaker and a listener, then they should recognize that requests made in English are directed toward the English-monolingual speaker, and requests made in Spanish are directed toward the Spanish-monolingual speaker.

Taken together, these three studies essentially explore the coherence of children's reasoning about communicative conventions. Children's ability to track consistent and

inconsistent labeling across different speakers could help them recognize the shared and conventional nature of language. Children may further understand the relevance of consistent language use for communication, tracking whether different people speak the same way or not, and adjusting their expectations about communicative interactions between those speakers accordingly.

The current studies tested three- (Studies 1, 2, and 3) and four-year-old children (Study 3). In many previous studies, three-year-old children show strong expectations about conventional language use, rejecting unconventional labels and becoming skeptical of speakers who use them (while two-year-olds do not; Markson et al., in preparation), and selectively learning from conventional speakers over unconventional speakers (Koenig et al., 2004). However, a broader understanding of conventionality appears to develop across the preschool years, such that four-year-old children are better than three-year-old children at tracking the relative accuracy of speakers (Pasquini et al., 2007) and even four-year-old monolingual children can have difficulty explicitly recognizing the conventions of other languages (Akhtar et al., 2012). These results suggest that three- and four-year-olds may be able to recognize shared conventions and reason about communication among other speakers, but also that these abilities may change across this age range.

Chapter 2: Inferring shared conventional knowledge across speakers.

Study 1 directly tested whether children recognize that different speakers share knowledge of lexical conventions. Children were familiarized with two pairs of actors who labeled several novel objects with novel labels (Figure 1A), and were then asked to predict which actors would use the same labels for further novel objects. Children themselves did not know the names for any of these objects, so they could not evaluate the actors' accuracy. Likewise, neither label could be considered the majority usage (Corriveau et al., 2009), given that two actors used each label. However, the pattern of consistency across actors could lead children to infer that the consistent labelers share knowledge of lexical conventions more generally. Thus, we predicted that children would choose the previously consistent actors when asked who would use the same labels during the test trials.
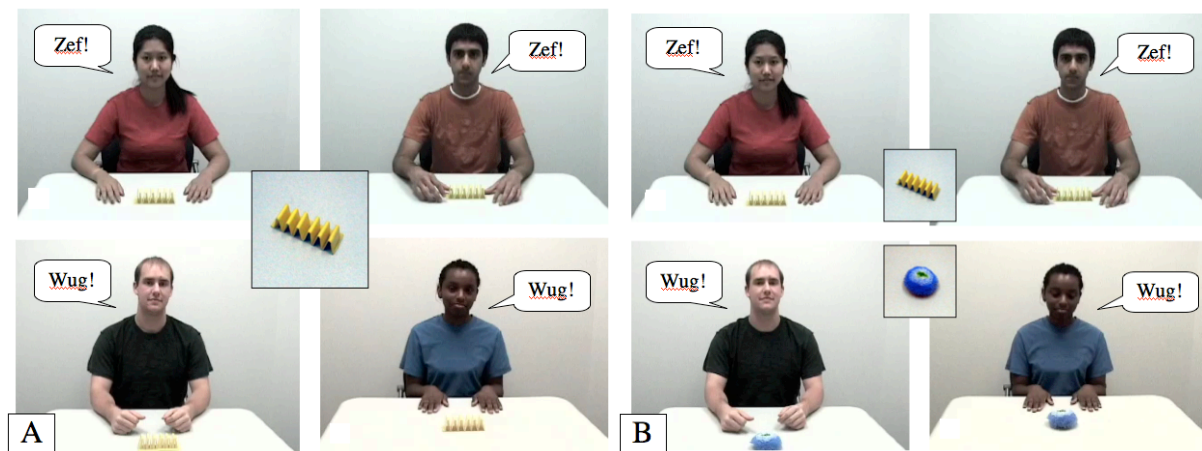
Figure 1. Schematic representation of a familiarization trial from the experimental (A) and control (B) conditions of Study 1 and Study 2. In this example, the top actors (Red and Orange) constituted one matching pair of speakers, while the bottom actors (Green and Blue) constituted the other pair of matching speakers (words were spoken by the actors, not presented visually).

However, children could also show this predicted pattern of responding based on the actors' behavioral consistency, without reasoning about their shared knowledge (i.e., "they did

the same thing before, they'll do the same thing again"). To evaluate this possibility, a second group of children participated in a control condition in which two pairs of actors labeled different novel objects (Figure 1B). Thus, children in the experimental condition saw all four actors labeling the same object, with two actors using one label and two actors using a second label, on each familiarization trial. Children in the control condition saw two actors labeling one object, and the other two actors labeling a different object, on each familiarization trial. Both conditions instantiate the same behavioral consistency, such that actors within pairs use the same labels and actors across pairs use different labels. Importantly, however, the control condition provides no information for children to evaluate shared knowledge between specific actors. Children in the control condition may reason that the pairs use different labels because they are referring to different objects. In contrast, children in the experimental condition may appeal to the actors' underlying knowledge to explain why the two pairs use different labels for the *same* object. If children respond as predicted in the experimental condition but not in the control condition, it would suggest that these responses are based on children's inferences about shared knowledge, informed by the actors' prior labeling.

Method

Participants. Thirty-two three-year-old children participated (M_{age} = 41.7 months, range = 36 to 48 months, 16 girls and 16 boys). Four additional participants were excluded from analyses, three because they failed to complete the procedure and one because of experimenter error. Children were recruited from local preschools and from a database of local families who had expressed interest in participating in developmental research. Parental consent was obtained prior to testing, and children received a small gift for their participation.

Design and materials. Each child participated in four familiarization trials followed by four test trials, presented using PowerPoint on a MacBook laptop computer. Test sessions were videotaped using a small camera embedded in the screen of the laptop. On each trial, four video clips were visible simultaneously (see Figure 1). Each clip showed an adult actor sitting at a table with a novel object. The actors self-identified as an Asian American female, a Indian American male, a Black American female, and a European American male. Throughout the experiment, the experimenter referred to the actors using their shirt colors as their proper names (i.e., Red, Green, Orange, and Blue). Each actor was displayed in the same quadrant of the screen throughout the procedure.
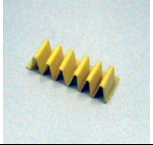
On each familiarization trial, the experimenter played the actors' video clips one at a time. All four clips were always visible on the screen; when one actor's clip was played, the other actors were shown as a still image. During each clip, the actor picked up the novel object, then alternated gaze between the object and the camera while uttering a single novel word (e.g., "Dax!"). Table 1 shows the novel objects and words used during familiarization and test trials in Studies 1 and 2. The four actors comprised two pairs based solely on the labels they used; during each familiarization trial, actors within a pair both used the same label, while the other pair of actors both used a different label. Pairs always consisted of one male and one female actor, and which two actors were paired together was counterbalanced across children. Across the four familiarization trials, the four actors were presented in the same order (e.g., Red, then Green, then Orange, then Blue) as pilot testing indicated that this consistency facilitated children's memory. This order of presentation was maintained across the four test trials; on each test trial, all four actors were shown with an object, but only one actor was shown labeling it. Thus, the

order in which the speakers labeled the objects was consistent throughout the familiarization and test trials for each child, but was counterbalanced across children.

Children were randomly assigned to participate in either the experimental or control condition. In the experimental condition, on each familiarization trial, all four actors labeled the same object, such that children saw four objects across the four familiarization trials, one per trial. In the control condition, on each familiarization trial, each pair of actors labeled different objects, such that children saw a total of eight objects across the four familiarization trials, two per trial. Test trials were identical across the two conditions, with all four actors holding the same object. The order of presentation of objects within the familiarization and test trials was randomized across participants. Table 1 shows the novel objects and words used during familiarization and test trials in Studies 1 and 2.

Objects Labeled During Familiarization and Test Trials for Studies 1, 2, and 2a.

Familiarization Objects

Object A		Object B		Pair 1 Label	Pair 2 Label
	Green funnel		Red and white pet food server	Dax	Blicket
	Orange pasta server		White coffee grabber	Fendle	Koba
	Green pastry brush		Yellow drain cover	Toma	Mido
	Yellow knife holder		Blue sponge	Zef	Wug

Test Objects

		Test Label (Study 1)	Contrasting Test Label (Study 2)
	White paint can opener	Sooby	Daffle
	Red cup with handles	Rommick	Letta
	Red popsicle holder	Gazzer	Spect
	White drain cover	Danu	Gopper

Procedure. The experimenter began the testing session by "introducing" the child to still images of the four actors. Images of the familiarization objects then appeared on the center of screen, and the experimenter explained that these people would tell the child what they call those things. The child then saw four familiarization trials, during which the four actors each labeled a novel object. After each trial, the experimenter asked the child to identify the consistent actors, saying, for example, "Red called this a dax. Who else called this a dax too?" If the child responded incorrectly or did not respond after two prompts, the experimenter reminded the child which actors had used the same labels, and proceeded to the next trial.

Following the four familiarization trials, still images of the actors appeared on screen, with still images of the familiarization objects arrayed in the center of the screen. The experimenter then asked the child two check questions. Pointing to the images of the objects, the experimenter said, for example, "Red told us what she called these things. Who else said the same thing as Red?" If the child responded incorrectly or did not respond after two prompts, the experimenter reminded the child which actors had said the same thing. The experimenter then asked this check question for the other pair of speakers.

Children then participated in the four test trials. On each test trial, one actor labeled a novel object while the other three actors sat silently with that object. The experimenter then asked the child, "Can you guess? Will anyone else call that a [label] too?" A different actor labeled an object on each of the four test trials, such that children identified who would use the same label as each actor over the course of the test trials. After completing the test trials, children were praised and thanked for their participation.

Coding. Children's responses to the two check questions were coded as to whether they accurately identified the matching actors after familiarization. For the test trials, children's

statements or gestures indicating one or more of the actors were recorded. These responses were coded as to whether they indicated the previously matching actor, a previously mismatching actor (from the other pair), or made some other response (e.g., chose the matching actor and one or both of the mismatching actors, or indicated that no one else would use that label).

Results

Children in both conditions were equivalently accurate in response to the check questions (accurate responses out of two, $M = 1.75$, $SD = .447$ for experimental, $M = 1.50$, $SD = .816$ for control), $t(30) = 1.074$, $p = .291$. Further, more accurate responses to the check questions were not correlated with the number of matching ($r = -.218$, p = .417, for the experimental condition, $r = -.138$, $p = .610$ for the control condition) or mismatching ($r = -.218$, $p = .417$, for the experimental condition, $r = .075$, $p = .784$, for the control condition) responses during the test trials. In the control condition, scores on the check questions were not correlated with the number of other responses during the test trials ($r = .059$, $p = .829$; as described below, no children in the experimental condition gave responses that were coded as "other").

Figure 2 presents the average number of matching, mismatching, and other choices from children in the experimental and control conditions. Separate independent groups t-tests indicated that, when asked which actors would use the same labels on test trials, children in the experimental condition chose the matching actor significantly more than children in the control condition, $t(30) = 3.51$, $p = .001$, children chose a mismatching actor equivalently in both conditions, $t(30) = .33$, $p = .74$, and children in the control condition gave significantly more other responses than children in the experimental condition, $t(15) = 3.60$, $p = .003$.
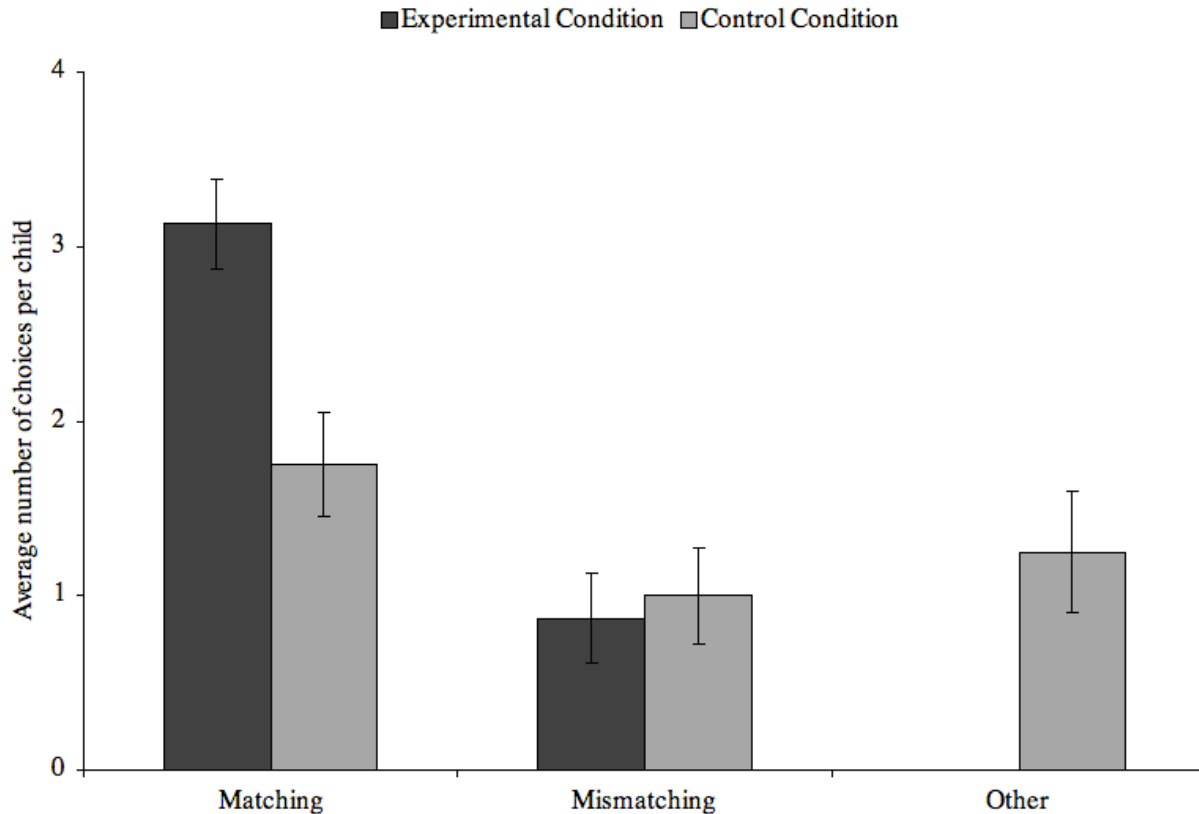
Figure 2. Children's choices of previously matching or mismatching actors, or a different response (e.g., no one, everyone), when asked "[Actor] called this a [label]. Can you guess? Will anyone else call that a [label] too?" in Study 1. Error bars indicate standard error of the mean.

To assess whether individual children showed the predicted pattern of responding, children were categorized based on whether they made three or four matching choices across the four test trials. Eleven out of 16 children in the experimental condition (68.8%) consistently chose the matching actor, compared to four out of 16 children in the control condition (25%). Chi-square analysis revealed that significantly more children in the experimental condition than in the control condition showed the predicted response on the majority of trials, χ^2 (1, N = 32) = 6.15, p = .01. To explore the possibility that older children showed more consistent responding, bivariate correlations were calculated between the child's age in months and the number of matching and mismatching responses. This analysis revealed that age was not correlated with

matching or mismatching responses for the experimental condition (p's > .56). There was a marginal postive correlation between age and the number of matching responses given by children in the control condition, $r = .465$, $p = .07$, but age was not significantly correlated with the number of mismatching responses, $p = .57$.

Discussion

Study 1 assessed children's ability to infer shared knowledge of lexical conventions between two speakers based on the consistency with which those speakers label novel objects. In the experimental condition, children watched two pairs of speakers label novel objects; for each object, speakers within a pair used the same novel label, while the other pair of speakers used a different novel label. Each label was used by two speakers, so children were unable to establish which might be the majority usage (Corriveau et al., 2009), and children could not use their own knowledge to predict what the speakers might or should say because the objects were unfamiliar to children. Despite these challenges, children tracked which speakers used the same labels: when asked which speakers would use the same labels for new novel objects, children in the experimental condition reliably chose the previously consistent speakers. This suggests that children inferred that consistent speakers knew the same labels for objects in general, and used this inference of shared knowledge to predict future consistent labeling.

It is unclear what a metric for chance responding might be in the current procedure. Children could choose more than one actor on each test trial, or could state that no actors would use a particular label. Indeed, "other" responses were more common in the control condition than in the experimental condition, which suggests that children do not simply use any kind of consistent labeling to make their predictions. Children in both conditions saw the same pattern of behavioral consistency across speakers; that is, for each familiarization trial, one pair of speakers

used the same label, and the other pair used a different label. Further, the procedure was identical in both conditions; all children were asked equivalent check questions, so any similarity among the speakers was highlighted equivalently across conditions. However, in the control condition, speakers used the same labels while looking at the same objects, while the other pair of speakers used different labels while looking at different objects. Children in the control condition did not use this consistency to make systematic predictions in the test trials.

Children's failure to choose the previously matching actor in the control condition suggests that behavioral consistency alone could not have driven children's choices in the experimental condition. Rather, the pattern of consistent labeling across speakers led children in the experimental condition to reason about the underlying mental states that generated this consistency, and to infer that consistent speakers knew the same labels more generally. This result suggests that children do not need to know an object's conventional label in order to assess whether other speakers share knowledge of that label. Of course, children likely use their own knowledge of conventional labels to predict how others will label *familiar* objects. However, the present findings suggest that they are capable of reasoning about shared knowledge of lexical conventions independently, in the absence of their own knowledge of those specific conventions.

Chapter 3: Inferring non-shared conventional knowledge across speakers.

The results of Study 1 extend the evidence reviewed above, which indicates that children expect others to share their own knowledge of conventions. Children show a robust ability to recognize when someone speaks differently than they do, sensitivity which guides children's learning, inferences, and social preferences (Kinzler et al., 2007). However, less is known about children's conception of those atypical speakers themselves. For example, do children differentiate between inaccurate users of their own language and speakers of another language? The results of Study 1 suggest that children's understanding of conventionality goes beyond their own knowledge of conventional forms. These findings raise the possibility that children can reason coherently about other conventional systems. Study 2 asks whether children understand that different conventional language systems use different forms to express the same meaning.

Existing evidence that children can recognize more than one conventional system comes primarily from bilingual and multilingual children. Research suggests that bilingual children are better than monolingual children at inhibiting their knowledge of familiar conventions, when asked explicitly whether it is possible to use an unconventional form (Bialystok, 1988). Experience with multiple conventional systems also influences children's bias to assume that novel labels refer to novel objects, rather than to familiar objects. Monolingual toddlers (Byers-Heinlein & Werker, 2009) and preschoolers (Diesendruck, 2005) show a strong tendency to look toward or choose a novel object rather than a familiar object when they hear a novel label. In contrast, bilingual toddlers (Byers-Heinlein & Werker, 2009) and preschoolers (Au & Glusman, 1990; Diesendruck, 2005) are less likely to show this tendency. These results are at least consistent with the notion that bilingual children recognize that two lexical forms could legitimately refer to the same object.

Testing monolingual children's understanding of multiple conventions is complicated by their own knowledge of conventions and by their substantial experience that everyone speaks the same way. For example, monolingual children tend to assume that novel words apply to novel labels regardless of whether the speaker may be using a different language (Diesendruck, 2005). However, a recent study provides initial evidence that monolingual toddlers might be able to differentiate between conventional systems. Specifically, children with relatively large vocabularies can learn a novel object label from a speaker of a different language; however, children fail to generalize this newly learned word to another speaker (Koenig & Woodward, 2011). Children may recognize that these speakers know different languages, and thus do not necessarily expect them to use the same label for that object.

A more direct test of children's ability to consider different lexical conventions would remove children's need to inhibit their own knowledge of familiar conventions. To do this, Study 2 presented children with the same familiarization trials used in Study 1. The pattern of labeling *across* pairs of speakers creates a scenario akin to watching people speak two different languages. In contrast to Study 1, on subsequent test trials, children were asked whether any of these speakers would use *different* labels for further novel objects. For example, children watched one speaker label a novel object a "sooby", and were then asked whether anyone would call that a "gazzer" instead. The main hypothesis was that children would view inconsistent labeling across pairs of speakers as evidence that these speakers know different lexical conventions. As in Study 1, a control condition was included to assess whether simple behavioral inconsistency would generate the same pattern of responses.

Method

Participants. Thirty-two typically developing three-year-old children (M_{age} = 42.4 months, range = 37-48 months, 16 boys and 16 girls). Four additional children were excluded from analyses, three because they failed to complete the procedure and one because of experimenter error. Children were recruited, and parental consent obtained, as in Study 1.

Design and materials. The basic structure was identical to Study 1, consisting of four familiarization trials, two check questions, and four test trials. Stimuli were identical to those used in Study 1. Testing sessions were videotaped via a small camera embedded in the laptop screen.

Procedure. The procedure was identical to that used in Study 1, with the exception of the test question. On each test trial, one actor labeled an object. Children were then asked, "Can you guess? Will anyone else call that a [different label] instead?" For example, the experimenter would say, "Red called that a sooby. Can you guess? Will anyone else call that a gazzer instead?" Children's verbal and gestural responses were recorded and coded as in Study 1. If children responded "Yes" or nodded to the test question, the experimenter prompted the child to choose one or more actors by asking, "Who will call that something different?"

Children in the experimental condition should infer that the two pairs of speakers use different labels because these speakers know different labels in general. Children in the control condition should recognize that the two pairs of speakers use different labels because they are looking at different objects, and thus children are likely to assume that these speakers know the same labels in general. Thus, children in the experimental condition should choose the previously mismatching actor more frequently than children in the control condition.

Results

Children were equivalently accurate in both conditions in response to the two check questions ($M = 1.56$, $SD = .81$ for the experimental condition, $M = 1.40$, $SD = .737$ for the control condition), $t(30) = .581$, $p = .565$. As in Study 1, an individual child's score on the check questions did not significantly predict their responses to the test questions, nor did these check scores mediate any relationship between condition and responses.

Figure 3 presents the average number of matching, mismatching, and other responses from children in the experimental and control conditions of Study 2. When asked to guess which actors would use different labels for novel objects on test trials, children's average number of match, mismatch, and other responses did not differ across conditions, $t(30) = 1.57$, $p = .13$ for match responses; $t(30) = 1.47$, $p = .13$ for mismatch responses; $t(30) = .13$, $p = .90$ for other responses.
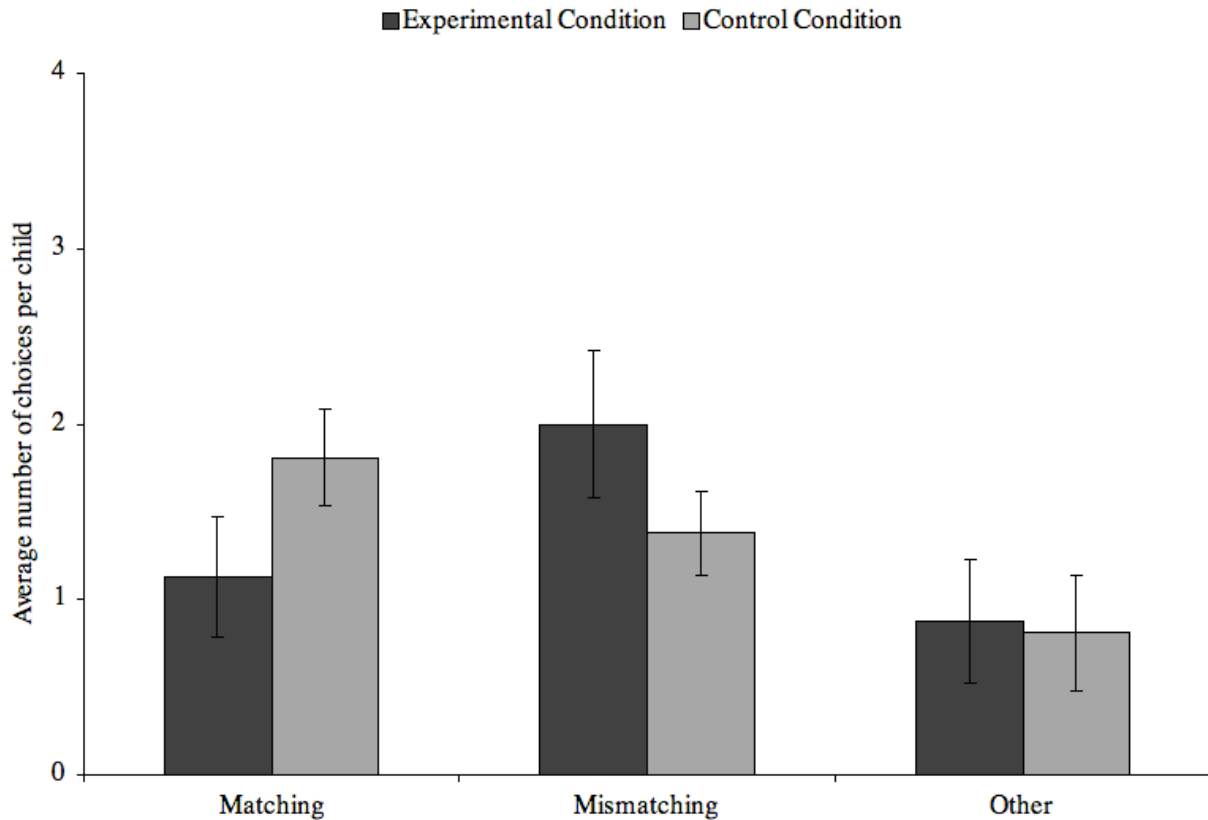
Figure 3. Children's choices of previously matching or mismatching actors, or a different response (e.g., no one, everyone), when asked "[Actor] called this a [label]. Can you guess? Will anyone call that a [different label] instead?" in Study 2. Error bars indicate standard error of the mean.

To assess whether individual children showed the predicted pattern of responding, children were categorized based on whether they gave three or four mismatching responses across the four test trials. Eight out of 16 (50%) children in the experimental condition consistently chose the mismatching actor, significantly more than in the control condition (two out of 16 or 12.5%), χ^2 (1, N = 32) = 5.25, *p* = .02. To explore the possibility that older children showed more consistent responding, bivariate correlations were calculated between the child's age in months and the number of matching and mismatching responses. This analysis revealed a marginal negative correlation between age and the number of matching responses in both the

experimental, $r = -.47$, $p = .069$, and control conditions, $r = -.459$, $p = .074$. Age was not correlated with mismatching or other responses for either the experimental (p's > .18) or control conditions (p's > .19).

Discussion

Study 2 assessed children's ability to infer that speakers know different lexical conventions, based on their use of different labels for the same novel objects. As in Study 1, children did not know the label for these objects, nor could they judge either label to be the majority usage (Corriveau et al., 2009). After hearing one speaker label a novel object on each test trial, children in Study 2 were asked to predict whether any of the other speakers would use a different novel label for that object. Children's predictions were compared to those of children in the control group, who had also seen the speakers use different labels during familiarization, not because they knew different lexical conventions but because they labeled different objects. Analysis of the average number of choices across children did not reveal significant differences between the experimental and control conditions. However, categorical analyses indicate that these averages conflate two distinct subgroups of children. Half of the children in the experimental condition showed the hypothesized pattern of responding, predicting that previously inconsistent speakers would use different labels for at least three of the four test trials. The other half of children in the experimental condition, and the majority of children in the control condition, showed a more random pattern of responding. The predicted pattern of responding was not related to age, leaving open the question of why some children in the experimental condition showed the predicted responses whereas other children did not. However, as in Study 1, children's random responding in the control condition rules out the possibility that

the simple tracking of behavioral inconsistency between speakers could have generated children's responses in the experimental condition.

In the current experimental condition, several factors could have disrupted children's reasoning about the inconsistent speakers. Recall that during the test trials, the experimenter introduced a potential alternative label for the novel object, saying, for example, "Red called this a sooby. Will anyone call it a gazzer instead?" This introduces a new element to the procedure relative to the familiarization phase and check questions, where the experimenter repeated the labels used by the speakers on the videos. Children may have been surprised by the experimenter's use of a completely novel word during the test trials. It is also possible that children expected previously inconsistent speakers to use different labels on the test trials, but were unsure about whether they would use the particular alternative label offered by the experimenter. Further, the experimenter's use of alternative labels for the test objects required children to overcome their default bias to avoid overlapping labels for objects (Markman & Wachtel, 1988). These factors may have been particularly relevant within this relatively artificial experimental context, where children explicitly asked to predict the speakers' labeling, rather than participating in a naturalistic communicative exchange.

During the initial design of this study, we reasoned that providing children with an alternative label during the test trials (e.g., "Red called this a sooby. Will anyone call it a *gazzer* instead?") would reduce the task demands for children by making the test questions more concrete. However, these contrasting labels may have heightened children's reliance on their default assumption that different speakers will use the same label for a novel object, despite the familiarization that provided evidence to the contrary. Given this possibility, Study 2a tested whether children would acknowledge that previously inconsistent speakers would use different

labels for novel objects, when a contrasting label was not presented. During the test trials, the experimenter asked children, "Red called this a sooby. Can you guess? Will anyone call it something different instead?" Children may recognize that the previously inconsistent speakers know different lexical conventions in general, but the experimenter's use of an alternative label in the previous experiment may have disrupted their predictions. If this is the case, then children in the current experiment should predict that previously inconsistent speakers will call the objects by a different, but unspecified, label.

Method

Participants. Thirty-two typically developing three-year-old children (M_{age} = 42.43 months, range = 36 to 48 months, 15 girls and 17 boys) were recruited from the Cognition & Development Lab Participant Database and from local preschool classrooms. Parental permission was obtained for each participant prior to the testing session.

Design and materials. As in Studies 1 and 2, children were randomly assigned to participate in either the experimental condition (N = 16, M_{age} = 42.94 months, 8 girls and 8 boys) or the control condition (N = 16, M_{age} = 41.75 months, 7 girls and 9 boys). The basic design was identical to Studies 1 and 2, consisting of four familiarization trials, two check questions, and four test trials. Stimuli were identical to those used in Studies 1 and 2. Testing sessions were videotaped via a small camera embedded in the laptop screen.

Procedure. The procedure was identical to that used in Study 2, with the exception of the test question. On each test trial, one actor labeled an object. Children were then asked, "Can you guess? Will anyone else call that something different instead?" Children's verbal and gestural responses were recorded and coded as in Studies 1 and 2. If children responded "Yes" or nodded

to the initial test question, the experimenter prompted the child to choose one or more actors by asking, "Who will call that something different?"

Children in the experimental condition should infer that the two pairs of speakers use different labels because these speakers know different labels in general. Children in the control condition should recognize that the two pairs of speakers use different labels because they are looking at different objects, and thus likely know the same labels in general. Thus, children in the experimental condition should choose the previously mismatching actor more frequently than children in the control condition.

Results

Children in both conditions were equivalently accurate in response to the two check questions ($M = 1.81$, $SD = .54$ for the experimental condition, $M = 1.38$, $SD = .89$ for the control condition), $t(30) = 1.69$, $p = .10$. An individual child's score on the check questions did not significantly predict their responses to the test questions, nor did these check scores mediate any relationship between condition and responses.

Figure 4 presents the average number of matching, mismatching, and other responses from children in the experimental and control conditions of Study 2a. When asked to guess which actors would use different labels for novel objects on test trials, children in the experimental condition chose the mismatching actor significantly more frequently than children in the control condition, $t(30) = 4.02$, $p < .001$. The two conditions did not differ in the number of trials on which children chose the matching actor, $t(30) = .00$, $p = 1.00$. Children in the control condition produced significantly more "other" responses than children in the experimental condition, $t(30) = -3.22$, $p = .003$. Out of these other responses, children in the control condition indicated that no other speakers would use a different label on an average of 1.5 trials per child

(SD = 1.75), significantly more frequently than children in the experimental condition, who

rarely gave this response (M = .06, SD = .25), $t(30) = -3.25$, $p = .003$.
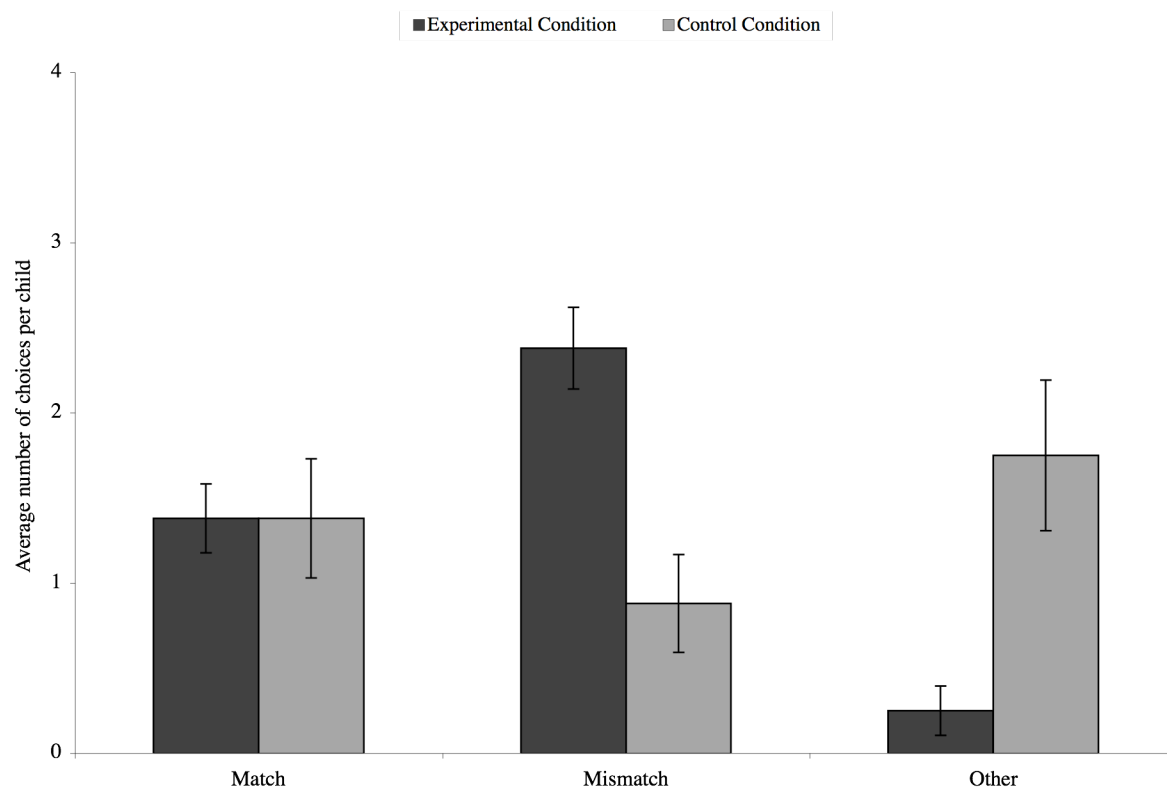
Figure 4. Children's choices of previously matching or mismatching actors, or a different response (e.g., no one, everyone), when asked "[Actor] called this a [label]. Can you guess? Will anyone call that something different instead?" in Study 2a. Error bars indicate standard error of the mean.

To assess whether individual children showed the predicted pattern of responding,

children were categorized based on whether they gave three or four mismatching responses

across the four test trials. Nine out of 16 (56.25%) children in the experimental condition

consistently chose the mismatching actor, significantly more than in the control condition (1 out

of 16 or 6.25%), χ^2 (1, N = 32) = 9.31, $p = .002$. To explore the possibility that older children

showed more consistent responding, bivariate correlations were calculated between the child's

age in months and the number of matching and mismatching responses. This analysis showed that older three-year-olds produced significantly more mismatching responses in the experimental condition, $r = .56$, $p = .02$, but that these factors were not correlated among children in the control condition, $r = -.17$, $p = .54$. In the experimental condition, age was also negatively correlated with the number of matching responses, $r = -.54$, $p = .03$. These measures were not correlated in the control condition, $r = -.18$, $p = .52$.

Discussion

The results from Study 2a confirm that the alternate label used on the test trials in Study 2 disrupted children's responses. Specifically, when an alternate label was not used, children in the experimental condition of Study 2a frequently predicted that previously inconsistent speakers would call a novel object "something different". This pattern of responding was not observed in the control condition, where children had seen the speakers use different labels for different objects. The significant difference between these two conditions in Study 2a suggests that inconsistent behavior was not sufficient to explain children's predictions in the experimental condition.

Results from the experimental condition broadly support the hypothesis that children can use the pattern of labeling across speakers to infer that they know different lexical conventions. The pattern of results across the experimental and control conditions of Studies 1, 2, and 2a suggests that children responded based on the speakers' conventional knowledge. This is the most parsimonious explanation for why children would predict that previously matching actors would use the same labels whereas mismatching actors would use different labels, while at the same time producing random responding in both control conditions. Importantly, this pattern of

results emerged even though children were unable to evaluate whether the labels were right or wrong relative to the child's own lexical knowledge.

This result is particularly striking in Study 2a because children had to override their default avoidance of overlapping labels for objects (Markman & Wachtel, 1988). The finding that children were better able to make this prediction when an alternate label was *not* supplied suggests that this default bias is particularly strong. In spite of the need to overcome this strong default bias, the results suggest that children generated a coherent, meaningful representation of the different speakers' knowledge of object labels. These findings add to a growing body of evidence that children are highly sensitive to the pragmatic (Grassmann, Stracke, & Tomasello, 2009) and conventional (Diesendruck et al., 2010) context in their interpretation of novel labels. This result also supports the conventionality account of children's bias in lexical disambiguation (Clark, 1990; Diesendruck, 2005; Diesendruck & Markson, 2001). Specifically, in the current study, children predicted that two speakers would use different labels for the same object *when* they had evidence that those two speakers know different labels in general.

Chapter 4: Reasoning about conventionality and communication

There are currently an estimated 6,900 languages in the world (Lewis, 2009), each representing a coherent system that enables communication among members of a community. Adults recognize that unfamiliar languages are nevertheless effective communicative systems. Recent research on young children's reasoning about communication, conventionality, and speakers of other languages, raises questions about how children think about communication in other languages. Do children understand that speakers of unfamiliar languages are not simply ignorant or wrong, but rather know different and equivalently valid communicative systems? Do children recognize that unfamiliar languages can be used to effectively communicate? Following on Studies 1 and 2, can children draw on their inferences about shared knowledge across speakers to reason about communication between those speakers? The current studies tested this question with monolingual English-speaking children, by asking them to interpret communicative interactions in both English and Spanish.

A great deal of recent research suggests that children's own early communicative development is supported by a coherent understanding of communication as a joint intentional action, encompassing a speaker's intention to update a listener's knowledge state in specific ways (Tomasello et al., 2005). Infants actively monitor the speaker's perceptual access and direction of gaze (Baldwin, 1991, 1993), the speaker's familiarity with different potential referents (Akhtar et al., 1996; Moll et al., 2006), and prior conversational context (Akhtar & Montague, 1999; Tomasello & Akhtar, 1995). Children's own communicative acts suggest that they intend to update their listeners' knowledge state. Evidence for this expectation comes from young children's tendency to repeat themselves when their requests are misunderstood, even if they have received the requested object (Grosse et al., 2010; Shwe & Markman, 1997). Further,

while these attempts may be rudimentary, young children can also modulate their speech based on the listener's previous knowledge, providing relatively more informative utterances for relatively less informed listeners (Matthews et al., 2006; Wittek & Tomasello, 2005). These conversational skills go beyond simple turn-taking; rather they seem to reflect a communicative goal to impart certain information to the listener.

Young children also coherently interpret others' interactions observed from a third-person perspective. Basic components of this ability emerge around the first birthday, when infants expect a person to speak toward another person rather than toward an inanimate object (Beier & Spelke, 2012), and look toward listeners in anticipation of their response to speech (Thorgrímsson, Fawcett, & Lizskowski, 2010). A recent study by Martin and colleagues (2012) suggests that infants go beyond simply expecting any sort of contingent reaction from the listener. In this study, twelve-month-old infants' were shown several types of interactions between a speaker and a listener. Infants' patterns of looking toward these events indicated that when the speaker produced an informative utterance (i.e., an object label), infants expected the listener to respond appropriately. If the speaker's utterance was not informative (i.e., she coughed), infants did not show this expectation. The authors claim that infants expect speech to convey information between speaker and listener. Support for this interpretation comes from the finding that slightly older infants (eighteen-month-olds) expect informative speech to update an agent's previously-held false belief (Song et al., 2008). While more work is needed to clarify infants' understanding of others' communicative interactions, these recent studies converge with earlier findings that toddlers can learn new words when overhearing others' conversations (Akhtar, 2005; Akhtar, Jipson, & Callanan, 2001; Floor & Akhtar, 2006), suggesting that children recognize the content of speech even when it is not ostensively directed toward them.

Linguistic communication can effectively convey information between people because speakers and listeners share knowledge of the arbitrary relationships between words and their meanings (Saussure, 1916/1983). This shared knowledge enables speakers and listeners to anticipate and interpret each others' actions, given the forms conventionally used to accomplish particular communicative intentions. Young children's understanding of the conventionality has recently been proposed as a driving force in certain aspects of language acquisition (Diesendruck & Markson, 2001, 2011; Sabbagh & Henderson, 2007). Evidence from this proposal comes from infants' tendency to generalize object labels across individuals (Buresh & Woodward, 2007; Graham et al., 2006; Henderson & Graham, 2005; Koenig & Echols, 2003). Children appear to harness these expectations to guide their word learning in at least two ways. First, children can leverage their knowledge of conventional labels to infer that speakers likely use novel labels to refer to novel objects instead (Diesendruck & Markson, 2001). Second, preschoolers selectively learn novel object labels offered by previously accurate speakers, and avoid learning from inaccurate (Birch et al., 2008; Koenig et al., 2003; Koenig & Harris, 2005) or ignorant speakers (Sabbagh & Baldwin, 2001; Sabbagh et al., 2003). If children become skeptical of inaccurate or ignorant speakers' conventional knowledge, they may judge that a new label offered by that person is unlikely to be conventional and should be avoided (Diesendruck & Markson, 2011; Sabbagh & Henderson, 2007).

These results raise questions about children's understanding of the role of conventionality in communication. If children recognize that communication is a function of shared conventional knowledge between a speaker and a listener, then they may expect speech to communicate information even if they themselves cannot produce or comprehend that speech. Children might observe this kind of communicative exchange if they interact with speakers of other languages.

Several recent studies have demonstrated that infants and young children differentiate between speakers of their own language and speakers of foreign languages, showing a basic social preference for speakers of their own native language over speakers of another language (Kinzler, Dupoux, & Spelke, 2007, 2009; Shutts, Kinzler, McKee, & Spelke, 2009). For example, when explicitly asked with whom they would like to be friends, five-year-old children choose a native speaker of their own language over a speaker of another language (Kinzler et al., 2007; Kinzler, Shutts, DeJesus, & Spelke, 2009). One reason for this preference may be that children expect to be able to better communicate with a speaker of their own language than with a speaker of another language. However, beyond this work demonstrating early preferences for native speakers, relatively little is known about how children think about unfamiliar languages and speakers of foreign languages.

One potential source of evidence for children's reasoning about unfamiliar language conventions comes from their ability to learn words in other languages. Koenig and Woodward (2011) recently found that 24-month-old monolingual English-speaking children are capable of learning an object label, at least in the short term, from a fluent interaction with a Dutch speaker. This result suggests that children do not simply ignore words used by other-language speakers. However, children failed to accurately identify the referent of this word when tested after a brief delay, or when tested by an English-speaking experimenter (Koenig & Woodward, 2011). Children may have recognized the utility of this label for communicating with the Dutch speaker specifically, but did not encode this label into long-term memory because they recognized that it might not be conventional knowledge within their own language community.

However, Akhtar and colleagues (Akhtar, Menjivar, Hoicka, & Sabbagh, 2012) recently found that both monolingual and bilingual preschoolers had difficulty explicitly identifying a

word as part of a foreign language. Children were familiarized with video recordings of an English speaker and a speaker of a novel language, Nordish, which had been created by the experimenters. When these speakers each used a different label for the same novel object, and children were asked "What is this called in Nordish?", both monolingual and bilingual children were likely to choose the English speaker's label. Interestingly, a third group of children, who were monolingual but regularly exposed to a second language, was better able to choose the Nordish label. The authors suggest that regular but limited exposure to a second language helped these monolingual children recognize the possibility that there could be words another language. In contrast, both monolingual and bilingual children may experience their own language system or systems, without being confronted by further unfamiliar languages.

Learning words ostensibly provides children with tools for communicating with others. Thus, learning words in other languages might be uniquely challenging for children if they cannot anticipate using those words in future communicative interactions. Further, the ability to learn words in other languages is separable from the understanding that other conventional language systems can be used to communicate. Young children's understanding of conventionality may influence their reasoning about unfamiliar languages in several ways. On one hand, children's understanding of conventionality may rest on their consistent and pervasive experience that everyone in their environment speaks the same way. This experience may lead children to treat unfamiliar language speakers as equivalent to atypical, inaccurate, or ignorant speakers. This tendency may be particularly strong for monolingual children, and is likely reflected in monolingual children's social preferences for native language speakers (e.g., Kinzler et al., 2007). On the other hand, children's concept of language as a conventional system may be integrated with their understanding of communicative interactions. Thus, children may recognize

that shared knowledge of language conventions enables effective communication, whether or not they themselves know the conventions being used. This integrated understanding may help children recognize that other languages can be effective means of communicating among speakers of that language.

Rather than contend with children's understandably limited ability to communicate in an unfamiliar language, Study 3 tested children's reasoning about communicative interactions between two people from a third-person perspective. The main question of interest was whether monolingual English-speaking three- and four-year-old children recognize that another language, in this case Spanish, could support effective communication. Children participated in a live interaction with three adults; one adult spoke exclusively English, one spoke exclusively Spanish, and one switched between English and Spanish. After being familiarized with these speakers, children watched the bilingual speaker request a needed object, using either English or Spanish. By directing her gaze toward a neutral point between the two monolingual speakers, the bilingual speaker did not provide any indication to whom she was speaking, other than by her use of a particular language. If children recognize that conventional knowledge enables communication, then they should recognize that the bilingual's use of a particular language constitutes a communicative interaction with the appropriate monolingual speaker. Specifically, children should recognize that requests made in English are directed toward the English-monolingual speaker, and that requests made in Spanish are directed toward the Spanish-monolingual speaker. If children recognize that communication is equally effective in either language, regardless of their own understanding of the request, they should approach the appropriate monolingual speaker whether the request is spoken in English or Spanish.

Method

Participants. Thirty typically-developing monolingual three- (N = 15, M_{age} = 42.7 months, range 37 to 47 months, 7 girls and 8 boys) and four-year-old (N = 15, M_{age} = 53.9 months, range = 48 to 58 months, 8 girls and 7 boys) children participated. Participants were recruited from a database of local families that had expressed interest in participating in developmental research. Parental consent and child assent was obtained for each participant prior to the testing session, and children received a small toy after participating. Children's status as monolingual was assessed via parent questionnaire. An additional six children participated but were excluded from analyses, three because they chose the same experimenter on all six trials, and three because they failed to complete the procedure.

Design and materials. Each child participated in one test session consisting of a familiarization phase followed by six test trials. The main factor of interest, the language used by the bilingual experimenter on each test trial, was varied within subjects, with the experimenter using English on three trials and Spanish on three trials. The primary dependent measure was children's choice to approach and retrieve an object from one of two experimenters. The six test trials were presented to each child in one of three quasi-randomized orders, with the objects used on each trial counterbalanced across children. Whether English or Spanish was used on a particular trial was randomized within a child and counterbalanced across children, with three constraints: Spanish was always used on the first trial, English was always used on the second trial, and across the four subsequent trials, the same language was used on no more than two trials in a row. The decision to always present the first trial in Spanish, rather than counterbalancing the language used on the first trial across children, was made for several reasons. Given previous findings that children prefer to receive objects from speakers of their own language over speakers of another language (Kinzler, Dupoux, & Spelke, 2012), the English-speaking children

in the current study may have shown a default tendency to approach the English speaker. By presenting the first trial in Spanish to all children, this default tendency (if present) would work against the current prediction that children's choice will be guided by the language being used by the bilingual experimenter. If English was used during the first trial, it would be impossible to determine whether children approached the English speaker because of their understanding of communication, or because of a default bias in favor of speakers of their own language. Finally, if English was used on the first trial and children approached the English speaker because of a default bias, this choice would be rewarded by receiving the requested object, possibly causing children to perseverate and continue to make this choice regardless of their reasoning about language used on a particular trial.

During the familiarization phase, children were presented with a "Favorites" book, constructed from a standard three-ring binder. Each page of this book displayed several full-color photographs of familiar objects. During the test phase, children played a game presented via a MacBook laptop computer. A tray, to which with three clear plastic cups had been attached, covered the laptop keyboard. On each test trial, the laptop screen displayed analogous images of three cups, with an image of a familiar object hovering over each cup. The objects used during the test trials are listed on Table 2. When the child placed the appropriate object in each cup on the tray, the experimenter activated an animation on screen that showed the object floating down into the cup. If the child placed the appropriate objects in all three cups, a short video clip was activated, showing a puppet playing with that object. These videos were designed to provide motivation for the child's actions throughout the test trials. Testing sessions were recorded using two small video cameras in the testing rooms as well as the small camera embedded in the screen of the laptop.

Table 2

Items Presented During Familiarization and Test Trials for Studies 3 and 3a

Images presented in "Favorites" book during familiarization

Category	Items	Example statements
Snacks	Carrots, muffin, cookie, banana	"Las zanahorias son mis favoritos. Hay zanahorias en mi jardin."
Meals	Macaroni, grilled cheese sandwich, soup	"I had macaroni for dinner last night. Macaroni is my favorite."
Colored circles	Red, blue, yellow, green, pink, purple, orange	"Amarillo es mi favorito. El amarillo me recuerda al sol."
Wild animals	Panda, mallard duck, fox, elephant	"I love pandas, they are really cute. Pandas are my favorite."
Pets	Puppy, cat, rabbit, goldfish	"Me gusta jugar con mi perro. Perros son mis favoritos."
Playground activities	Sandbox, swings, slide, see-saw	"I like to build sandcastles in the sandbox. The sandbox is my favorite."
Birds	Bluejay, hummingbird, toucan, parrot	"Me gusta el picaflor porque me encanta colores brilliantes."
Ocean animals	Dolphin, clownfish, seahorse, turtle, sunfish	"I like the turtle best so I always go to visit the turtles when I go to the zoo."
Outdoor places	Beach, forest, meadow, park	"Me gusta el parque porque hay mucho espacio para corer. El parque es mi favorito."

Objects presented in "George" game during test trials

Car (always presented during warm-up trial)

Duck (*Pato*)	Balls (Pelotas)
Chair (*Cilla*)	Shoes (Zapatos)
Shells (*Conchas*)	Trucks (Camions)

Frogs (always presented during final trial)

Three experimenters interacted with the child. One experimenter established herself to be bilingual in English and Spanish (referred to henceforth as BE for bilingual experimenter), while the other two experimenters spoke only English (EE for English-monolingual experimenter) or Spanish (SE for Spanish-monolingual experimenter).

Procedure. Prior to the familiarization phase, the BE played with the child to establish rapport. When the child was comfortable, the BE introduced the child to the two monolingual experimenters. To introduce the EE, the BE said, "This is my friend [name]. She goes to my school." To introduce the SE, the BE said, "This is my friend [name]. She is visiting from a town far away from here." After this introduction, the child was invited to go with the three experimenters into the testing room, accompanied by the parent. Throughout the testing session, the parent was seated at the side of the room and was instructed to respond neutrally to any interaction from the child.

Familiarization phase. The BE first presented the child with the "Favorites" book, explaining that everyone could pick their favorite object on each page. The BE also explained this to the EE using English, and to the SE using Spanish. On each of six familiarization trials, the BE began by asking the child to point to or name his or her favorite object on that page. The BE then asked this of each monolingual experimenter, using the appropriate language (i.e., "Which is your favorite, [EE]?" and "Cual es tu favorito, [SE]?"). The order with which the BE addressed each monolingual experimenter varied randomly across trials, with each experimenter addressed first on half of the trials. Given that the child was always asked to chose his or her favorite on each page before the two monolingual experimenters, it was possible for the monolingual experimenters to choose the same object as the child. Therefore, on two trials, the EE matched the child; on two trials, the SE matched the child; on one trial, both monolingual experimenters matched the child; and on one trial, neither experimenters matched the child. The order of these trials was randomized. After looking at the "Favorites" book, the BE told the child that they would now play another game in the next room. She then asked each monolingual

experimenter, using the appropriate language, whether she had work to do. Each monolingual experimenter replied that she did have work to do, and remained in the original testing room.

Test phase. After the familiarization phase, the child and the BE walked into an adjacent room, leaving the door to the original room open. The BE then showed the child the laptop set-up, explaining that now they would play a game with George the puppet, who appeared in a short introductory video clip on the computer screen. The BE explained that if they put the right toys in the cups, then George got to play with those toys. The child then saw one pre-test trial, where the BE provided all three needed objects and demonstrated how to put the objects into the cups. When this was completed, children saw a short video clip of the puppet playing with that toy, and were praised by the BE for helping find toys for George.

On each of six subsequent test trials, the BE presented children with only two of the three needed toys. Upon discovering that one toy was missing, the BE told the child that her friend in the other room had the third needed toy, so the BE would ask her for it, but the child must go retrieve the object. The BE then told the child, "Pay attention to who I'm asking, because you only get one chance." The BE and child then walked to the door of the original room, where the two monolingual experimenters were seated equidistant from the door, each with an opaque bag under her chair. When the BE and the child entered the door, both monolingual experimenters were looking down at papers they were holding. First, the BE said, "Hey!" and the speakers looked up at her ("Hey" can be used to attract attention in both English and Spanish). The BE then made a request using English (on three trials) or Spanish (on three trials). To do this, she said, "We need another [object]! We need one more [object]." or "Necessitamos autro/a [object]! Necessitamos [object] mas." While making these requests, the BE looked toward a point on the wall equidistant between the two monolingual experimenters. After making each request, the BE

encouraged the child to approach one of the monolingual experimenters to retrieve the object, saying, "Can you go get it?" If children were reluctant to approach the monolingual experimenters, the BE waited for 5 seconds before asking again, "Can you go get it?", then after an additional five seconds, "Who should you go get it from?" If necessary, the BE encouraged the child to point to one of the monolingual experimenters.

The monolingual experimenters continued to look at BE (not at the child) until the child approached one of them or provided an indication of his or her choice. The indicated monolingual experimenter then retrieved an object from the bag under her chair and handed it to the child. If the child approached or indicated the appropriate experimenter (e.g., the SE when the request was in Spanish), she gave the child the requested object. If the child approached or indicated the other experimenter (e.g., the SE when the request was in English), she gave the child a foil object.

After approaching or indicating an experimenter, and receiving an object, BE encouraged the child to return to the computer game. If the child retrieved the requested object, this was placed into the third cup and the puppet video was played. If the child had retrieved a foil object, the experimenter skipped the puppet video and said, "I guess we didn't get the toy that George needed. We'll try again next time." On the final post-test trial, the BE again gave the child all three needed objects, and the puppet played with that toy. This final successful trial was included because it was possible for the child to approach the wrong monolingual experimenter on all six test trials, and thus never see the puppet video. This final trial ensured that the testing session ended positively. Children therefore saw eight total trials during the test phase: the pre-test, six test trials, and the post-test.

Coding. The testing session was recorded by three video cameras: two in the original testing room, one directed toward the child's face during the test trials and one directed toward the monolingual experimenters' faces, and one embedded within the screen of the laptop in the second testing room, capturing the child and BE while they play the laptop-based game. Video recordings from the three cameras were edited and combined into one video file for each child. Children's choices were coded offline from this video file with the sound muted, by a coder who was blind to the experimental condition and to the language used by the BE on each trial. This coder recorded which experimenter the child chose. When possible, the coder also recorded the time (via video timestamp) at which the child's choice of one monolingual experimenter became clear. To do this, the coder used the orientation of the child's face and body and his or her trajectory of approach toward the experimenters, as well any gestures the child produced. Given that the monolingual experimenters relied on their own interpretation of the child's behavior during the test trials to generate their responses, it is possible that these experimenters could have "reacted" to a child prior to his or her choice being clear (although the experimenters were trained not to do this). Therefore, the coder also recorded the time (via time stamp) the time at which the "chosen" experimenter reacted to the child by putting down her paper and retrieving the object. Trials on which the "chosen" experimenter reacted to the child prior to the child's choice becoming clear were coded as mistrials.

If children recognize that successful communication depends on shared knowledge of linguistic conventions, they should selectively approach the appropriate monolingual experimenter, who had previously used the language being spoken by the BE on each trial. Therefore, children should chose the matching experimenter significantly more than chance, calculated at three trials out of six, given the two-alternative forced choice paradigm. This

overall result would indicate that children's reasoning about interactions between others is influenced by their understanding of both shared conventional knowledge and relevant communicative intentions.

Results

Coding of the child's and experimenters' response time was possible for thirteen participants, seven three-year-olds and six four-year-olds (for the other participants, the camera orientation did not allow the coder to observe the child's and experimenters' faces). These thirteen children completed 78 test trials, out of which three trials were coded as mistrials because the monolingual experimenter reacted before child's choice was clear to the coder. The rarity of these mistrials indicates that children's responses could not have been guided by unintentional cuing from the monolingual experimenters. The results of the following analyses did not differ when these trials were included or excluded, so the results reported below include these trials.

Choice of the matching experimenter.

Figure 5 shows the mean number of trials on which children chose the matching monolingual experimenter (i.e., English when the bilingual experimenter had used English, and Spanish when she had used Spanish) for three- and four-year-old children, as well as the mean number of overall choices for the English and Spanish monolingual experimenters. In Figures 5 and 6, results from Study 3 are labeled "Communicative" while results from Study 3a (see below) are labeled "Non-communicative".
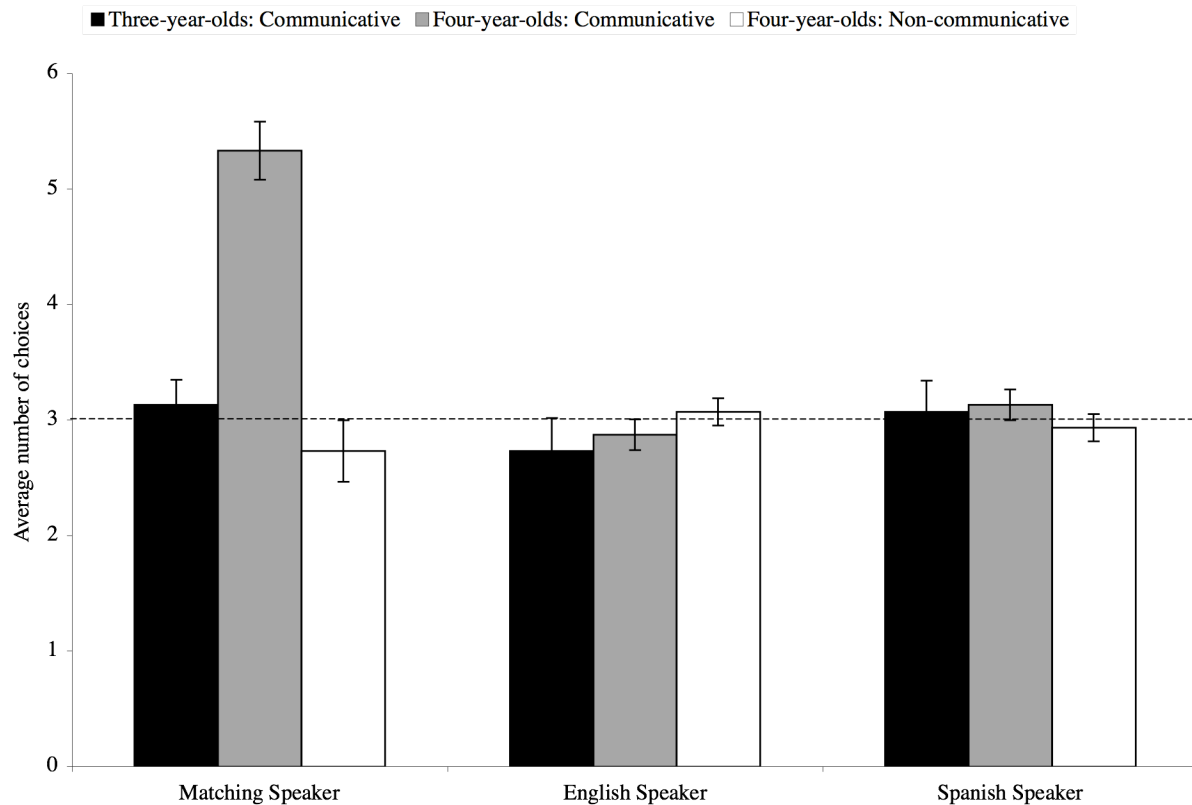
Figure 5. Children's choices of matching speaker, English speaker overall, or Spanish speaker overall, across the six test trials of Studies 3 (Communicative bars) and 3a (Non-communicative bars). Error bars indicate standard error of the mean.

Children participated in six trials, each requiring them to choose between the two monolingual experimenters. Thus, random performance would produce an average of three matching choices per child. A one-sample *t*-test against chance performance of three out of six trials revealed that, overall, children chose the matching experimenter significantly more than would be expected by chance, $t(29) = 4.72$, $p < .001$. However, performance was also significantly positively correlated with age across the overall range tested, $r = .66$, $p < .001$. Therefore, separate one-sample *t*-tests were performed for the two age groups, which revealed that four-year-olds, but not three-year-olds, chose the matching speaker significantly more than would be expected by chance (3-year-olds: $M = 3.13$ matching choices out of six, $SD = .834$,

$t(14) = .619$, $p = .546$; 4-year-olds: $M = 5.33$ matching choices out of six, $SD = .252$, $t(14) =$ 9.26, $p < .001$). Thus, four-year-olds' choices were guided by the bilingual experimenter's language use on the majority of trials, whereas three-year-olds' choices were not.

Given these differences between three- and four-year-old children, one possibility is that performance increases at a relatively consistent rate across the age-range as a whole. However, when separate bivariate correlations were calculated for each age group, age was not significantly correlated with performance for either three-year-olds, $r = -.334$, $p = .224$, or four-year-olds, $r = .198$, $p = .475$. The majority of four-year-olds, 9 out of 15, chose the matching speaker on all six trials. In contrast, no three-year-olds chose the matching speaker on more than five trials. Figure 6 shows the performance of individual children as a function of the child's age in months.
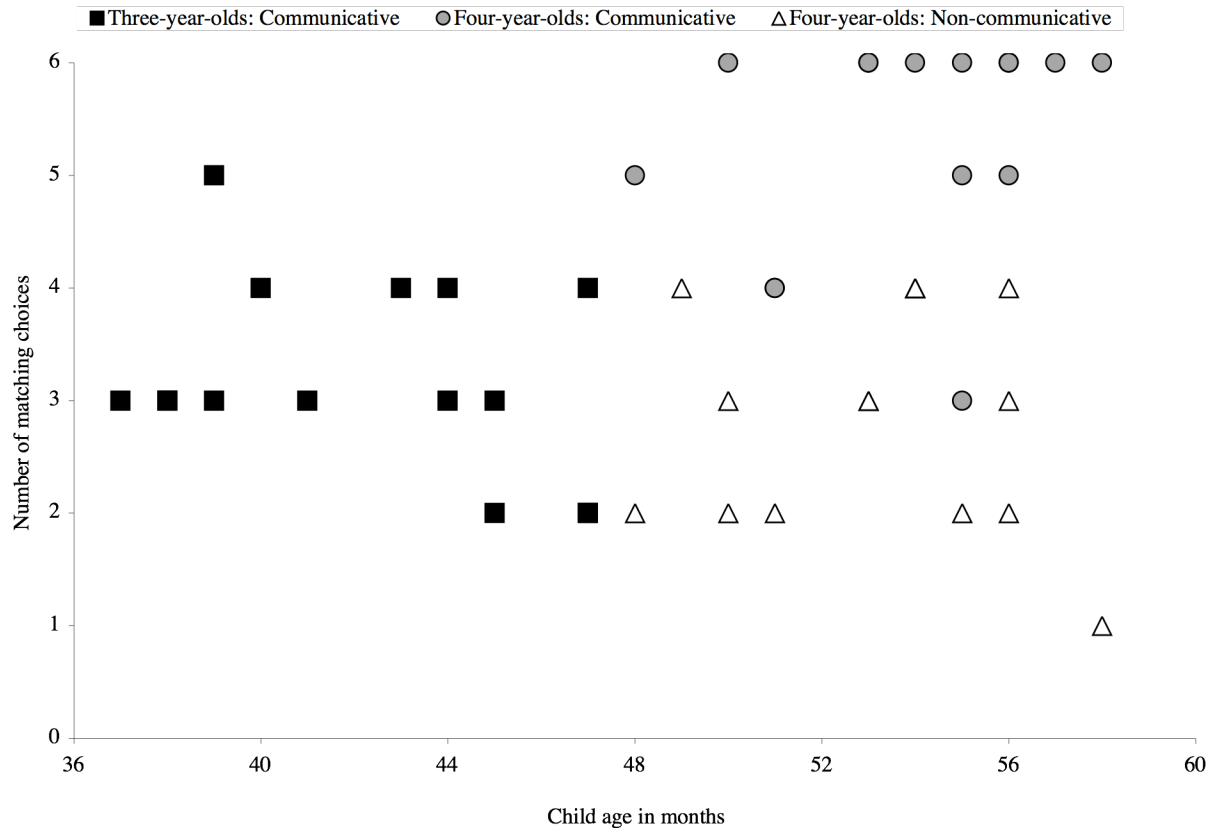
Figure 6. The number of matching choices made by each child, as a function of the child's age in months, for Studies 3 (Communicative) and 3a (Non-communicative).

To test whether children tended to choose the matching speaker increasingly over the course of the experiment, a mixed-model ANOVA compared the number of matching responses on the first block of three trials to the number of matching responses on the second block of three trials, with age as a covariate. No effect of trial block nor any interaction between trial block and age was present, $p = .602$ and $p = .535$ respectively.

Choice of one monolingual experimenter versus the other.

A mixed-model ANOVA analyzed children's total number of choices for each speaker (regardless of whether these represented a matching choice for a particular trial), with language (English or Spanish) as a within-subject variable and child's age as a covariate. This analysis

revealed no significant effect of language, $p = .38$, and no interaction between language and age, $p = .45$. Children across the age range were equivalently likely to choose the English speaker and the Spanish speaker overall. Children also did not approach either speaker more than would be predicted by chance, $t(29) = -1.93$, $p = .206$ for the English speaker; $t(29) = .682$, $p = .501$ for the Spanish speaker. This was likewise true within each age group, such that both three- and four-year-olds did not differ from chance in their overall tendency to approach either the English speaker (3-year-olds: $M = 2.73$, $SD = 1.10$, $t(14) = .619$, $p = .546$; 4-year-olds: $M = 2.87$, $SD = .516$, $t(14) = -1.00$, $p = .334$) or the Spanish speaker (3-year-olds: $M = 3.07$, $SD = 1.03$, $t(14) = .250$, $p = .806$; four-year-olds: $M = 3.13$, $SD = .516$, $t(14) = 1.00$, $p = .334$). This null result is expected for the four-year-olds, because when children chose the matching speaker on the majority of trials, it is necessarily the case that they chose the English speaker on (approximately) half of trials and the Spanish speaker on the other half. However, this analysis indicates that three-year-olds' tendency to choose the matching speaker at chance levels was not caused by a preference for one speaker over another.

Children's preference for a particular speaker might also be apparent in their choice on the first trial. The bilingual speaker always used Spanish on the first trial, so if children's choices are guided by her language use, the majority of children should have approached the Spanish speaker on the first trial. This was the case with four-year-olds: 12 out of 15 chose the (matching) Spanish speaker on the first trial, significantly more than would be expected if they were choosing randomly, binomial test, p = .04. In contrast, nine three-year-olds chose the English speaker on the first trial, while six chose the Spanish speaker. This distribution of children is the opposite of what would be expected if children's choices were guided by the bilingual experimenter's language use. However, a binomial test indicates this distribution is not

significantly different from what would be expected if children chose randomly between the speakers on the first trial, p = .607. It is therefore not the case that three-year-olds show a significant preference for the English speaker based on their choices on the first trial.

Choices of the matching speaker given the language used.

To test whether children's choices were more accurate when the request was made in English or in Spanish, a mixed-model ANOVA was conducted with trial language (English or Spanish) as a within-subject factor, child age as a covariate, and number of matching choices as the dependent measure. Results revealed no significant effect of language, and no significant interaction between age and language, p = .377 and p = .466 respectively. Children across the age range were equivalently likely to choose the matching speaker whether the request was made in either English or Spanish.

Discussion

Study 3 tested whether children recognize that an unfamiliar language can effectively be used to communicate among speakers of that language. Children were asked to approach one monolingual speaker to retrieve a requested object. The key manipulation was which language a bilingual speaker had used to make the request. To succeed at this task, children needed to recognize that requests in English were directed toward the English monolingual speaker, and that requests in Spanish were directed toward the Spanish monolingual speaker. Results indicated that this task was challenging for three-year-old children, who performed at chance overall. Specifically, three-year-old children's choice to approach the English speaker or the Spanish speaker on a particular trial was independent of the language used by the bilingual speaker. In contrast, four-year-old children approached the appropriate monolingual speaker, with the majority of children doing so on all six test trials.

There are several possible explanations for four-year-old children's success in this task. First, children may have considered the bilingual speaker's communicative intentions. Namely, children may recognize that by using English, she intended to communicate with the English-monolingual speaker, and when she used Spanish, she intended to communicate with the Spanish-monolingual speaker. Thus, children may treat the bilingual speaker's choice of language as a cue to her communicative intention. Second, children may consider the monolingual speakers' conventional knowledge. Namely, the English-monolingual speaker understands speech in English, and the Spanish-monolingual speaker understands speech in Spanish. Thus, children may expect to receive the requested object from the monolingual speaker who understands language used to make the request. Both of these explanations rest on children's reasoning about the communicative interaction in mentalistic terms, using their inferences about the speaker's intentions, about the listener's knowledge, or about both. Future studies are needed to explore whether four-year-olds' success in the current task hinges on the ability to reason about either or both of these factors.

However, there is a third possibility that would enable children to approach the appropriate monolingual speaker without reasoning about either the bilingual speaker's intentions or the monolingual listeners' knowledge. Specifically, during the familiarization, children likely associated the English-monolingual speaker with a typical, familiar way of speaking, and the Spanish-monolingual speaker with an atypical and unfamiliar way of speaking. During the test trials, children heard the bilingual speaker use English or Spanish, and may have simply approached the monolingual speaker who had been associated with that type of speech. If this association is the primary motivation for children's choices, then children may show a

similar tendency to approach a particular speaker whenever they hear the matching language, regardless of the communicative context.

Study 3a was designed to assess whether children's choices could be guided guided by a simple association between a particular speaker and a particular language. As in Study 3, children heard the bilingual speaker use English or Spanish on each test trial. However, this speech was not intended to communicate with either monolingual speaker. Rather, the bilingual speaker addressed the character of Curious George displayed on the laptop computer. Further, the bilingual speaker did not request a needed object, but rather commented (in English or Spanish) that she had an extra object. Children were then asked to approach one of the monolingual speakers to give her this extra object.

As in Study 3, children in Study 3a hear the bilingual speaker use a particular language and are subsequently asked to approach one of two monolingual speakers. However, in Study 3a the bilingual speaker's use of Spanish or English is not intended to communicate with either monolingual speaker. If children's choices are driven primarily by an association between one monolingual speaker and a particular language, then that language should cue children to approach that speaker, as they did in Study 3. In contrast, if children's choices are guided by the relevance of a particular language for communication, then they should choose randomly between the monolingual experimenters in Study 3a.

Method

Participants. Fifteen typically-developing monolingual four-year-old children participated (M_{age}=53.1 months, range 48 to 58 months, 7 girls and 8 boys). Children were recruited, and parental consent and child assent was obtained, as in Study 3. Children received a small toy after participating. Children's status as monolingual was assessed via parent questionnaire. An

additional 1 child participated but was excluded from analyses because he chose the same experimenter on all six trials.

Design and materials. The basic design, consisting of a familiarization phase followed by a test phase, was identical to that used in Study 3. The language used on each test trial was presented in the same quasi-randomized orders used in Study 3. The materials and experimenters were identical to those in Study 3.

Procedure. The overall structure of the procedure was the same as Study 3, with the only difference coming during the test phase, described below. Children were introduced to the experimenters, and familiarized with their language use via the "Favorites" book, as in Study 3.

Test phase. A pre-test trial identical to that used in Study 3 was followed by six test trials. On each test trial, the BE presented children with all three toys needed to activate the puppet video. After watching George play with the toy, the BE then showed an extra instance of that toy to the child and held it up to the laptop screen. The BE "spoke" to the still image of George on the laptop screen using either English or Spanish, saying, "George! We have an extra [object]! We have one more [object]." or "George! Tenemos otro/otra [object]. Tenemos [object] mas." The BE pronounced the name "George" using an English accent in both cases, to minimize confusion as to whom she was speaking. The puppet did not speak at any time during the experiment. After showing the extra toy to George, the BE then looked at the child and said, "We should give this to one of my friends. Pay attention to who you give it to, because there's only one extra." The BE and child then walked to the door of the original testing room, where the two monolingual experimenters were seated reading a paper (equidistant from the door), each with an opaque bag under her chair. First, the BE said, "Hey!" and the speakers looked up at her. The BE then encouraged the child to approach one of the monolingual experimenters to give her the

object, saying, "Can you go give it?" As in Study 3, if children were reluctant to approach the monolingual experimenters, the BE waited for 5 seconds before asking again, "Can you go give it?", then after an additional five seconds, "Who should you give it to?" If necessary, the BE encouraged the child to point. If the child only pointed, the BE brought the object to the indicated monolingual experimenter.

The monolingual experimenters continued to look at the BE (not at the child) until the child approached one of them or indicated a choice. At this time, the "chosen" monolingual experimenter put out her hand to receive the object, and placed it in the bag under her chair. Throughout the testing session, the parent was seated at the side of the room and was instructed to respond neutrally to any interaction from the child. After approaching or indicating an experimenter and giving the object to her, BE encouraged the child to return to the computer game. On the final post-test trial, the BE and child again had only the three needed objects. As in Study 3, children saw eight total trials during the test phase: the pre-test, six test trials, and the post-test.

The children's choices and choice times, as well as the monolingual experimenters' response times, were coded offline from video as in Study 3.

Study 3a instantiates the same pattern of language use across test trials—the bilingual experimenter used English on three trials and Spanish on three trials—but these utterances were not directed toward or intended to communicate with either of the monolingual experimenters. Thus, if a simple association between a language and a monolingual experimenter drives children's choices during the test trials, then children in Study 3a should show the same pattern of selective choices that children in Study 3 showed. Namely, children should approach the matching monolingual experimenter based on the language used by the bilingual experimenter,

even though that speech was used to communicate with someone else (George). However, if children's responses are guided by the speaker's use of a particular language to communicate with a particular listener, then the bilingual experimenter's use of English or Spanish in Study 3a should not be relevant. Therefore, children in Study 3a could show one of at least two patterns of responding. First, children could approach both speakers at random and equivalently, either within a particular child, or across children if individual children show a preference for one speaker over another. Alternatively, children could show an overall preference for the English monolingual experimenter, and could choose to give the extra toy to her on the majority of trials.

Results

Preliminary analyses indicated equivalent performance by both genders, so gender was not included in further analyses. Coding of the child's and experimenters' response time was possible for fourteen participants (the camera orientation for the other participant did not enable the coder to observe the child's and experimenters' faces). One trial was coded as a mistrial because the monolingual experimenter reacted prior to the child's choice being clear to the coder. The results of the following analyses did not differ when this trial was included or excluded, so the results reported below include this trial.

In Figures 5 and 6, the results from children in Study 3a are labeled "Four-year-olds: Non-communicative".

A one-sample t-test against chance performance (three out of six trials) revealed that four-year-olds in Study 3a did not choose the matching experimenter more than would be expected by chance, $t(14) = -1.00$, $p = .334$. Paired-samples t-tests revealed that children chose the English speaker and the Spanish speaker on an equivalent number of trials overall, $t(14) = .564$, $p = .582$. Children also chose the matching speaker on an equivalent number of trials when

English or Spanish was used, $t(14) = 564$, $p = .582$. Children's tendency to choose the matching speaker during the first block of three trials did not differ from their tendency to do so during the second block of three trials, $t(14) = -1.50$, $p = .156$. Ten out of fifteen children chose the English speaker on the first trial, compared to five children who chose the Spanish speaker on the first trial. However, as with the three-year-olds in Study 3, this distribution did not differ from what would be predicted if children chose randomly between the speakers, binomial test, $p = .302$.

Comparison between Study 3 and Study 3a reveals that children chose the matching speaker more when the bilingual speaker was attempting to communicate with her. Specifically, four-year-olds chose the matching speaker significantly more frequently in Study 3 than in Study 3a, $t(28) = 7.09$, $p < .001$. Consistent with the general result that children approached the English and Spanish speakers equivalently overall, the two groups of four-year-olds in Studies 3 and 3a did not differ from each other in this tendency, $t(28) = -1.12$, $p = .271$ for choices of the English speaker, $t(28) = 1.12$, $p = .271$ for choices of the Spanish speaker.

Discussion

The results from Study 3a indicate that when the bilingual experimenter was not directing her speech toward the monolingual experimenters, her use of a particular language did not influence children's subsequent choices. This suggests that simple association between a monolingual speaker and a particular language could not have been sufficient to explain four-year-olds' tendency to choose the matching experimenter in the communicative task of Study 3. Rather, children appear to have recognized when the bilingual speaker's language use was relevant to the communicative interaction. This ability suggests that children can reason about the use of a particular language to communicate between speakers of that language, and recognize that two speakers can successfully communicate when they share knowledge of the

language being used. This reasoning is consistent with a relatively abstract understanding of the role of conventionality in communication between speakers. Specifically, four-year-old children successfully interpreted communicative interactions between two others, and did so whether the speaker used the child's own language or an unfamiliar language.

In contrast, three-year-old children showed striking difficulty with this task. Their choices during the test trials were not influenced by the bilingual experimenter's use of a particular language, and their performance did not improve over the course of six test trials. It is likely that the current task was more challenging in many ways for three-year-olds than it was for four-year-olds. Children interacted with three unfamiliar experimenters, and were required to remember which language each experimenter spoke from the familiarization phase into the test phase. Pilot testing had suggested that three-year-old children were capable of encoding which experimenters used English or Spanish after reading the "Favorites" book with them. However, it is possible that moving into another room to play the computer game disrupted children's recall of this memory. Further, during the test trials, children needed to differentiate between the two languages used by the bilingual experimenter to make her requests, and to recruit their memory of the monolingual speakers' language use to guide their choices. Any of these capacities may be more limited in three-year-olds than in four-year-olds.

However, two aspects of the results suggest, if indirectly, that limited memory does not completely account for the three-year-olds' performance. First, despite the fact that the bilingual experimenter used Spanish on the first trial, the majority of three-year-olds approached the English speaker. While analyses indicated that this pattern did not differ from what might be expected by chance, it is at least consistent with the possibility that those three-year-olds remembered, and showed a default preference for, the English monolingual experimenter. If

these children did remember which experimenter spoke which language, they failed to recognize the relevance of this information for interpreting the target of the bilingual speaker's request. Second, children's age was not correlated with performance *within* either age group. Given the small sample size in the current study, little can be drawn from this null result. At the moment, these results suggest that four-year-old children recognize the relevance of the speakers' shared language use within communicative interactions, whereas three-year-olds may not. It is possible that this understanding is in place earlier, given the many possible reasons why three-year-old children may not have succeeded in the current task. Further research is necessary to determine exactly what concepts and capacities are required to reason about communicative interactions between speakers of unfamiliar languages. These studies will need to develop more sensitive, and possibly simpler, designs to test the cognitive and social structures that support this type of reasoning in younger children.

Interestingly, very few children in this study showed even a slight preference to approach the English speaker overall, and there were equivalent numbers of children across the studies who showed a similar slight preference for the Spanish speaker. In the non-communicative sharing task of Study 3a, eleven children (out of fifteen) alternated between the two monolingual experimenters across all six trials, approaching each experimenter on exactly every other trial and distributing the toys exactly equitably across the experimenters. This pattern is consistent with previous findings that children distribute resources equally among recipients when such a distribution is possible (Olson & Spelke, 2008). However, the current result contrasts with findings from Kinzler and colleagues (Kinzler et al., 2012) that 2.5-year-old children were more likely to give a single present to a speaker of their own language than to a speaker of an unfamiliar language.

Several differences between these studies may help to explain this apparent discrepancy. Children in the Kinzler study were familiarized with life-sized video recordings of the two speakers, and the authors point out that this display did elicit social behaviors from children while enabling all the participants to experience exactly the same familiarization. In contrast, children in current study interacted with the experimenters in person, instantiating a more naturalistic, if less controlled, social situation. Further, during the familiarization phase of the current study, the monolingual Spanish experimenter expressed her preferences for some of the same familiar items that the child preferred. While the English-speaking participants did not understand the experimenter's speech in Spanish, the structure of the game made it clear that she was expressing her preference, and she pointed toward her preferred item on each page. Anecdotally, several children commented on the experimenters' choices, clearly recognizing which items they chose. Thus, it is likely that children were aware that the Spanish monolingual experimenter shared some of their preferences, which in turn may have increased their liking of her (Fawcett & Markson, 2011; it is important to note that the same was true for the English speaker, who also shared the child's preferences on several trials). Given this familiarization, children did not show preference for the speaker of their own language, and approached both experimenters equally across both age groups and in both studies. It is possible that minimal personal interaction with unfamiliar, atypical speakers, particularly those who have positive communicative interactions with others, may help children overcome a default bias toward speakers of their own language or against speakers of another language.

Chapter 5: Conclusion

The present studies explored young children's understanding of the conventionality of language, and the role that shared knowledge of language conventions plays in communication. Studies 1 and 2 tested children's ability to evaluate whether two speakers share knowledge of object labels – even when those labels are unfamiliar to the child. The results indicate that three-year-old children are able to use the pattern of consistent labeling across speakers to infer when speakers share knowledge of object labels in general. Specifically, children in Study 1 predicted that previously consistent speakers would use the same novel label for a new novel object. Further, half of the children in Study 2 accurately predicted that previously inconsistent speakers would use two different novel labels for a new novel object. However, the task in Study 2 may have been particularly challenging given children's default assumption that different people will use the same label for a novel object. To address this concern, Study 2a presented children with a nearly identical task, but one that did not offer a potential contrasting label. In this case, the majority of children predicted that previously inconsistent speakers would say "something different" when labeling the same novel object. Control conditions in all three studies indicated that simple behavioral consistency, such that the pairs spoke differently because they were labeling different objects, was insufficient evidence for children to generate systematic predictions. When two speakers share knowledge of lexical conventions, and have the same communicative intention (to refer to a particular object), children expect them to use the same word. When two speakers know different lexical conventions, children expect them to use different words to accomplish the same communicative intention.

Study 3 tested whether children recognize that communication is possible when two people share knowledge of language conventions. This study moved away from using novel

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objects and speakers displayed on video, as in Studies 1 and 2, and situated monolingual English-speaking children within a live interaction between three adults: a monolingual English speaker, a monolingual Spanish speaker, and a bilingual speaker of English and Spanish. After being familiarized with these speakers, children participated in a third-person communication task. Specifically, children observed while the bilingual speaker made an utterance in either English or Spanish. Results indicate that four-year-old children recognized that the bilingual speaker was using a particular language to communicate with a particular monolingual speaker. Specifically, these children approached the appropriate monolingual speaker when the bilingual experimenter requested an object in their shared language, but not when the bilingual experimenter had addressed another, unrelated listener using that language. Four-year-old children were equivalently successful whether the target language was English or Spanish, suggesting that they recognize the validity of an unfamiliar language as a mode of communication. Three-year-old children, in contrast, failed to use the bilingual speaker's language use as a cue to which monolingual experimenter she was addressing. Further studies are needed to pinpoint the source of three-year-olds' difficulty in this task. However, the current results suggest a shift across the preschool years in children's ability to track shared conventional knowledge across individuals, and to use that information to interpret and reason about communicative interactions among those people.

Overall, these studies provide clear evidence for children's understanding of conventionality and communication because in all of the present tasks, children were unable to use their own knowledge of language conventions, or their own communicative motivations, to generate their responses. Children's success suggests that they understand that language conventions are shared knowledge among different speakers, over and above their expectation

that others will know and use familiar conventions. Children can use different speakers' pattern of consistent language use to evaluate their shared knowledge of conventions, and recognize that consistent language users can effectively communicate, even in a language that is unfamiliar to the child.

All three of the studies presented here tested three-year-old children, and the results provide interesting comparisons across the tasks. Studies 1 and 2 found that three-year-olds succeed in tracking consistent and inconsistent labeling of novel objects across speakers. However, Study 3 found that three-year-olds were unable to draw on the shared language used by two speakers to interpret a communicative interaction between them. All three of these studies required children to recognize relationships among other people, rather than judging whether those people were different from or similar to themselves. However, the speakers in Studies 1 and 2 demonstrated their conventional knowledge by labeling *novel* objects, whereas the monolingual experimenters in Study 3 provided fluent speech about their preferences for *familiar* objects. Thus, while the speakers in Studies 1 and 2 were equivalently different from (or similar to) children themselves, the Spanish speaker in Study 3 was much more different from children than was the English speaker. It is possible that the Spanish speaker's use of unfamiliar labels for familiar objects disrupted children's ability to track the shared knowledge between the bilingual speaker and the monolingual speakers.

Preliminary evidence for this interpretation comes from a pilot study using the same procedure as in Study 1, but where the speakers labeled familiar rather than novel objects. Specifically, the stimuli showed four speakers labeling a cup, a shoe, a chair, and a hammer; two of the speakers used the English labels for each of these objects, while the other two speakers used novel labels. This is essentially what would happen if children observed two speakers of

their own language, and two speakers of another language, label these objects. The test trials were identical to those in Study 1: children were asked to predict which of these speakers would use the same label for a series of novel objects. Note that this required children to generalize from the speakers' labeling of familiar objects to their labeling of novel objects. However, in contrast with the results of Study 1, three-year-old children in this pilot study did not predict that the previously matching speakers would use the same label for a novel object. Even more surprisingly, children were no more likely to make this prediction for the English speakers than they were for the speakers who used novel labels. That is, children did not systematically predict that two speakers, who had previously used English labels for familiar objects, would be particularly likely use the same label for a novel object. The speakers' use of novel labels for familiar objects during the familiarization may have been particularly surprising if children expected all four speakers to know and use the English labels for these objects (Koenig & Echols, 2003). This may have disrupted children's ability to track consistency across the speakers. Interestingly, a pilot group of four-year-old children were more successful at this task, predicting consistent labeling of novel objects from speakers who had previously used consistent novel labels for familiar objects.

Importantly, this use of novel labels for familiar objects was also present during the familiarization phase of Study 3, when the Spanish monolingual experimenter was expressing her preferences. If this unexpected labeling disrupted three-year-old children's ability to track the use of Spanish by both the monolingual and bilingual experimenters, then children would not have had this information to guide their choices during the test trials. This difference between three- and four-year-olds' ability to track unfamiliar labeling of familiar objects may explain some aspects of the age differences observed in Study 3. Further research is needed to explore

how children integrate their observation of speakers of unfamiliar languages with their own knowledge of language conventions, and with their understanding of communicative interactions.

These results have several implications for our understanding of children's notions of conventionality. First, the ability to track consistent use of labels across individuals could help children recognize that language use is a conventional behavior in the first place, based on repeated observations of different speakers using the same labels to refer to the same objects. Preliminary evidence that this might be possible comes from work by Xu and colleagues, who have explored infants' reasoning about the underlying causes of repeated events. These studies find that even before their first birthdays, infants interpret repeated actions relative to the actor's underlying mental state (Xu & Denison, 2009), and recognize the higher-order rules that generate repeated patterns of events (Dewar & Xu, 2010). As infants observe different speakers labeling objects the same way over time, these abilities could support the higher-order generalization that different people know the same labels for objects. Further work is needed to explore whether younger children or infants are sensitive to consistent labeling across different speakers, and what role this sensitivity might play in their lexical and communicative development.

Second, sensitivity to consistency across individuals could help children differentiate between conventional and non-conventional behaviors. In addition to words, children seem to assume that certain communicative gestures (Sullivan, Markson, Diesendruck, & Wohlgelernter, under review), artifact functions (Defeyter, Hearing, & German, 2009; Siegel & Callanan, 2007), and game rules (Rakoczy, Brosche, Warneken, & Tomasello, 2008; Rakoczy, Warneken, & Tomasello, 2008) are shared knowledge among different individuals. In all of these domains,

different individuals perform the same behaviors in order to accomplish the same goals. Young children might recognize that certain kinds of behavior are conventional based on repeated observation of consistent mappings between behaviors and goals across time and people.

The results from Study 3 in particular raise several interesting questions for future research. First, four-year-old children could have succeeded at this task by reasoning about the bilingual speaker's communicative intentions, about the monolingual experimenter's comprehension of the requests, or both. Future studies could disentangle whether children recognize that both of these factors are crucial for the success of a communicative interaction. Similarly, the current study leaves open whether children believe that shared conventional knowledge facilitates communication, or that this shared knowledge is essential for communication. That is, do children understand that communication *doesn't* work when people don't speak the same language?

The finding that four-year-old children could fluidly modulate their own behavior based on the bilingual speaker's language use suggests that they recognized her knowledge of two languages. Future research should explore children's reasoning about both monolingual and bilingual speakers of other languages, and how children fit bilingual speakers into their social category reasoning. Do children differentiate between monolingual speakers of their own language, and bilinguals who speak the child's own language as well as another language? Do children recognize that bilingual speakers may also know other unfamiliar cultural conventions, such as games or practices?

Finally, Study 3 focused on monolingual children, but raises important questions about the role of language exposure in children's reasoning about conventional communication. Would bilingual children be better able to negotiate the task used in Study 3, perhaps earlier than

monolingual children? If so, what capacities might support this ability? The ability to evaluate another person's knowledge of language conventions is particularly relevant for bilingual and multilingual children. Bilingual preschoolers' pragmatic differentiation, or the ability to select which of their languages to speak with others, is correlated with children's developing metacognitive and theory-of-mind reasoning (Tare & Gelman, 2010). This relationship suggests that children's own language use may be supported by the ability to consider another person's language knowledge.

Several studies of word learning in bilingual and multilingual children suggest that bilingual children may recognize that different languages use different words to refer to the same objects. In other words, bilingual children show some understanding that translation equivalents exist. Bilingual and monolingual children both assume that novel labels refer to novel objects, when it is clear that one language is being used (Davidson & Tell, 2005; Merriman & Kutlesic, 1993). However, bilingual children will accept two labels for an object when it is clear that two languages are being used (Au & Glusman, 1990; Diesendruck, 2005). Intriguingly, a greater degree of language diversity in children's environment may cause weaker or stronger intuitions about word-object mappings. Byers-Heinlein and Werker (2009) used eye-tracking to compare monolingual, bilingual, and trilingual 18-month-olds' tendency to look toward pictures of novel rather than familiar objects when they heard a novel label. Results indicated a linear relationship between the number of languages infants were exposed to (one, two, or three) and their preference for novel objects, such that monolingual infants showed the strongest preference while trilingual infants showed no preference at all. One possible explanation for these results is that monolingual children hold a strong expectation that familiar words will be used for familiar

objects, while multilingual children's experience learning two or more languages raises the possibility that different words can be used to refer to the same objects.

Several aspects of broader social and cognitive skills may also support bilingual children's reasoning about communicative interactions in unfamiliar languages. Bilingual children likely have experience interacting with monolingual speakers who understand only one of the child's own languages. This experience may help bilingual children to understand that the monolingual speakers in the current task only understand one or the other of the languages used by the bilingual speaker. Children may also generalize their own experience with code-switching to the bilingual speaker's behavior, and recognize that her use of a particular language is directed toward a particular listener. Bilingual preschoolers outperform monolingual peers on both standard theory-of-mind tasks (Goetz, 2003) and modified theory-of-mind tasks that focus on language comprehension (Kovács, 2009). This enhanced social-cognitive reasoning may enable bilingual children to better track the different languages used by each speaker, and draw on that experience to predict selective comprehension of a particular message by a particular monolingual.

Finally, much research has investigated the proposal that bilingualism enhances inhibitory control, given that bilingual speakers must inhibit production of one language when speaking in their other language (Green, 1998). Evidence for this bilingual advantage has been found in young children (Bialystok, Barac, Blaye, & Poulin-Dubois, 2010; Carlson & Meltzoff, 2008) and even preverbal infants (Kovács & Mehler, 2009). In the third-person communicative task used in Study 3, this inhibitory control may help bilingual children to suppress their own knowledge of the label for the requested object, and consider which monolingual speaker knows the unfamiliar language being used by the bilingual speaker. However, close examination of this literature

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suggests that these benefits reflect a broader enhancement of executive function in bilinguals, rather than specific effects on inhibitory control, and that these benefits are more reliably found in adults and older adults than in children (Hilchey & Klein, 2011). Nevertheless, any or all of these capacities could generate earlier success for bilingual children on this third-party communicative task. Future studies could assess bilingual and monolingual children's executive functioning and experience interacting with other language speakers, as well as other social cognitive capacities like theory of mind. These measures would help to clarify the cognitive processes and structures that facilitate children's reasoning about communication. Interestingly, the recent finding that limited but regular exposure to other languages helps monolingual children recognize the possibility of words in other languages (Akhtar et al., 2012) raises the possibility that this experience might also influence monolingual children's performance in this communicative task.

The current studies demonstrate that young children are capable of tracking shared conventional knowledge across different speakers. Three-year-old children use consistent labeling of novel objects to infer whether two speakers share knowledge of object labels more generally. Further, four-year-old children understand that this shared knowledge enables communication among speakers, recognizing that speakers of another language can effectively communicate. These studies disentangle children's understanding of the conventional nature of words from their expectations about the accuracy of those words, providing evidence that, under supportive conditions, monolingual children can recognize multiple conventional language systems. They also bridge previous findings that young children understand that communication is an interaction between the speaker's mind and the listener's mind, with studies of children's understanding of conventionality. The results reported here support the proposal that children

possess an implicit, abstract understanding of the conventionality of language, and suggest that this understanding becomes enriched across early childhood. Importantly, these results ground children's understanding of language in the context of their broader social reasoning, because they demonstrate that children understand that shared knowledge enables communication between speaker and listener.

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Thorgrímsson, G. B., Fawcett, C. A., & Liszkowski, U. (2010, April). 12-month-olds expect speech to provoke a response in others' interactions. Poster presented at the Society for Research in Child Development, Montreal, QC, Canada.

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Curriculum Vita

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Education

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	Dissertation: "Young Children's Understanding of the Relationship Between Conventionality and Communication"
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M.A.	**University of California, Berkeley**, Psychology, 2010
	Thesis: "Young Children's Understanding of the Conventionality of Words and Gestures"
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B.A.	**State University of New York at Geneseo**, Psychology, 2002
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Awards and Honors

Dean's Dissertation Fellowship (tuition, stipend, and travel), Washington University in St. Louis, 2011-2012
Student Travel Award, Society for Research in Child Development, 2011
Block Grant (tuition and stipend), UC Berkeley Psychology Department, Fall 2007
Graduate Research Grant, UC Berkeley Institute for Human Development, 2007
Honorable Mention, NSF Graduate Research Fellowship, 2006
Travel Award, UC Berkeley Graduate Assembly, Fall 2005

Manuscripts in Preparation

Sullivan, K. R., Markson, L., Diesendruck, G., & Wohlgelernter, S. (submitted to *Developmental Psychology*)
Young children's understanding and learning about conventional gestures.
Sullivan, K. R., & Markson, L. Children infer shared lexical conventions based on consistent
labeling across speakers.
Sullivan, K. R., Afshordi, N., & Markson, L. Children's developing ability to reason about communicative
interactions in familiar and unfamiliar languages.
Markson, L., **Sullivan, K. R**., & Diesendruck, G. Young children's expectations about
conventionality across domains.

Presentations

Sullivan, K. R., & Markson, L. (2012, January). Children's reasoning about consistent
language production and comprehension across individuals. Poster presented at the Budapest CEU
Conference on Cognitive Development, Budapest, Hungary.
Sullivan, K. R., & Markson, L. (2011, April). Children's sensitivity to consistent labeling
across speakers. Poster presented at the Society for Research in Child Development, Montreal, QC.
Diesendruck, G., **Sullivan, K. R**., & Markson, L. (2011, April). Children's appreciation of the
conventionality of gestures. Presentation at the Society for Research in Child Development, Montreal, QC.

Sullivan, K. R. (2010, June). Children's sensitivity to consistent labeling across speakers. Presentation at the Show Me Mental State Conference, St. Louis, MO.

Sullivan, K. R. (2009, April). Children's assumptions of conventionality. Presentation to the Aging & Development area, Psychology Department, Washington University in St. Louis, St. Louis, MO.

Sullivan, K. R., & Markson, L. (2009, October). Conventionality grounds word learning in social reasoning. Presentation at the Cognitive Development Society, San Antonio, TX.

Sullivan, K. R., & Markson, L. (2009, April). Children update assumptions of conventionality based on an individual's past behavior. Poster presented at the Society for Research in Child Development, Denver, CO.

Sullivan, K. R. (2008, May). Children's understanding of the conventionality of words and gestures. Presentation to the Berkeley/Stanford/Santa Cruz Annual Conference on Developmental Psychology, Palo Alto, CA.

Sullivan, K. R., Markson, L., & Diesendruck. G. (2008, April). Children's assumptions of conventionality across domains. Poster presented at the International Conference for Infant Studies, Vancouver, BC.

Sullivan, K. R., Markson, L., & Singh, A. (2007, October). Children's expectations about the conventional use of words and gestures. Poster presented at the Cognitive Development Society, Santa Fe, NM.

Chavez, V., **Sullivan, K**., Pipe, M-E., Orbach, Y., & Lamb, M. E. (2004, March). 'Spontaneous' disclosure in forensic interviews. Poster presented at the American Psychology-Law Society Annual Conference, Scottsdale, AZ.

Stauffacher, K., DeHart, G., **Sullivan, K**., & Lee, C. (2002, July). Relational aggression between siblings and friends in early and middle childhood. Poster presented at the International Society for Research on Aggression Biennial Meeting, Montreal QC.

DeHart, G., **Sullivan, K**., Stellrecht, L., Messner, A., DiNuovo, P. Raimer, K., & Peterson, J. (2002, June). The role of gender in mothers' perceptions of sibling and friend relationships. Poster presented at the American Psychological Society Annual Convention, New Orleans, LA.

DeHart, G., Stauffacher, K., Dobreva, M., Brownstein, S., DiNuovo, P., Keats, S., Stellrecht, L., & **Sullivan, K**. (2001, June). Social engagement in 7-year-olds' interactions with siblings and friends. Poster presented at the Americal Psychological Society Annual Convention, Toronto, ON.

DeHart, G. B., Kilpatrick, L., Betjemann, S., Brenadt, M., Stenger, S., & **Sullivan, K**. (2001, April). Conflict and averted conflict between siblings and friends in early and middle childhood. Poster presented at the Society for Research in Child Development Biennial Meeting, Minneapolis, MN.

Positions Held

Research Associate, University of Chicago, August 2012 - present
Development of Social Cognition Lab, Principle Investigator: Katherine Kinzler

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Experimental Psychology, Professor Sandra Hale, Spring 2011
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        Guest Lecture: Attachment, Nov 2010

Graduate Student Instructor, University of California, Berkeley, August 2004 - May 2008
Developmental Psychology
        Professor Alison Gopnik, Spring 2008 and Spring 2006
        Professor Jane Brooks, Fall 2006
                Guest Lectures: Research Methods, Jan 2008; Language Development, Sept 2006; Social
                Development in Preschool, Apr 2006
History of Psychology, Professor Steven Glickman, Spring 2007
Cognitive Psychology, Professor William Prinzmetal, Fall 2005
                Guest Lecture: Cognitive Development, Nov 2005
Research and Data Analysis in Psychology
        Professor Frederic Theunissen, Spring 2005
        Professor Thomas Wickens, Fall 2004

Post-baccalaureate Intramural Research Training Award Fellow, August 2002 - July 2004
National Institute of Child Health & Human Development, Section on Social & Emotional Development, Principle Investigator: Margaret-Ellen Pipe

Service

Graduate Peer Mentor Coordinator, Washington University in St. Louis, 2010-2011
Secretary, UC Berkeley Graduate Assembly of Students in Psychology, 2007-2008
Organizer, Berkeley/Stanford/Santa Cruz Annual Conference on Developmental Psychology, Berkeley, CA, May 2007
Fundraising coordinator, UC Berkeley Graduate Assembly of Students in Psychology, 2006-2007
Co-president, UC Berkeley Graduate Assembly of Students in Psychology, 2005-2006

Professional Affiliations

American Psychological Association, Cognitive Development Society, International Society on Infant Studies, Society for Research in Child Development

Pedagogical Training

Washington University Teaching Center seminars: Designing and Evaluating Writing Assignments; Designing a Course; Mentoring Undergraduate Researchers
UC Berkeley semester-long seminar: Teaching of Psychology