The role of inferences about referential intent in word learning: Evidence from autism

Article *in* Cognition · September 2005

DOI: 10.1016/j.cognition.2005.01.008 · Source: PubMed

2 authors:


Melissa L Allen
University of Bristol


Susan Carey
Harvard University

Available online at www.sciencedirect.com
SCIENCE DIRECT
ELSEVIER
Cognition 97 (2005) B13–B23
COGNITION
www.elsevier.com/locate/COGNIT

Brief article

The role of inferences about referential intent in word learning: Evidence from autism

Melissa Allen Preissler[a,*], Susan Carey[b]

[a]*Department of Psychology, New York University, 6 Washington Place, New York, NY 10003, USA*
[b]*Department of Psychology, Harvard University, 33 Kirkland Street, Cambridge, MA 02138, USA*

Received 25 March 2004; revised 22 November 2004; accepted 4 January 2005

Abstract

Young children are readily able to use known labels to constrain hypotheses about the meanings of new words under conditions of referential ambiguity. At issue is the kind of information children use to constrain such hypotheses. According to one theory, children take into account the speaker's intention when solving a referential puzzle. In the present studies, children with autism were impaired in monitoring referential intent, but were equally successful as normally developing 24-month-old toddlers at mapping novel words to unnamed items under conditions of referential ambiguity. Therefore, constraints that lead the child to map a novel label to a previously unnamed object under these circumstances are not solely based on assessments of speakers' intentions.

Keywords: Autism; Word learning; Toddlers

Consider the following situation: a mother and child are at the zoo. Within their line of sight are a monkey, "monkey" being already in the child's lexicon, and a giraffe, which is presently unnamed for the child. The mother exclaims, "Look at the giraffe!" The child correctly infers that the tall animal without a name is in fact the giraffe. The fact that children easily map novel word onto unnamed entities is not controversial; it has been

* Corresponding author. Address: Department of Psychology, Yale University, 2 Hillhouse Avenue, New Haven, CT 06520-8205, USA.
E-mail address: melissa.preissler@yale.edu (M.A. Preissler).

0022-2860/$ - see front matter
doi:10.1016/j.cognition.2005.01.008

repeatedly been observed (e.g. Clark, 1987, 1988, 1997; Markman, 1989, 1992; Mervis & Bertrand, 1994; Markman & Wachtel, 1988; Mervis, Golinkoff, & Bertrand, 1994; Waxman & Gelman, 1986; Waxman, 1990). However, the kind of information that children use to correctly map new words to unnamed objects is hotly debated.

One theory of this phenomenon is that pragmatic considerations underlie the child's assignment of word meaning under these circumstances (Bloom, 2000; Diesendruck & Markson, 2001; Tomasello, 1998, 2000). On the Bloom/Tomasello view, the relevant pragmatic skills crucially involve monitoring speakers' referential intentions. It is this intention-monitoring view that concerns us here, not broader views of pragmatics in which any contextual information is fair game to inform conclusions about speakers' meaning (e.g. Sperber & Wilson, 1995). Indeed, very young children are sensitive to cues about referential intent present in discourse that indicate communicative intent, e.g. speaker's gaze, speaker's self-correction, and others, and that they use these cues to constrain the meanings of newly heard words (Baldwin, 1991, 1993a,b; Bloom, 2000; Diesendruck & Markson, 2001; Tomasello, 1998; Tomasello, Strosberg, & Akhtar, 1996). An intention-monitoring inference that might support mapping "giraffe" to the giraffe: "If the person wanted me to look at the monkey, surely she would have said so, therefore, she must mean the other one". If children's bias against lexical overlap has to do with intuitions about speaker's intent, this bias should not be limited to words, which is exactly what Diesendruck and Markson (2001) found.

If intention monitoring is *required* in order to map new words to novel stimuli in the environment under conditions of referential ambiguity, then individuals who are impaired in utilizing social cues and reasoning about others' intentions should be unable to correctly make such mappings. This is the hypothesis tested here. Children with autism have a general deficit in understanding others' minds, including utilizing pragmatic information and monitoring others' intentions (Baron-Cohen, 1995, 2000; Baron-Cohen, Lislie, & Frith, 1985; Klin, Schultz, & Cohen, 2000; Lord & Paul, 1997; Tager-Flusberg, 1997).

Baron-Cohen, Baldwin and Crowson (1997) confirmed that children with autism fail to monitor referential intent in a word learning situation. The experimenter gave each child a new, unnamed stimulus, waited until he was attending to this object, and then uttered a novel word. The experimenter, however, was looking at a different novel object in her own hand. Normally developing 24-month-old children did not map the word to the item they themselves were looking at, but rather followed the experimenter's gaze, applying the word to the item within the experimenter's line of sight. Children with autism instead mapped the word to the item within their own line of sight, failing to use gaze as a referential clue.

These results suggest that whereas normally developing toddlers know that a speaker's referential intention provides evidence for an object label's content, children with autism are not utilizing referential intent for word learning. Experiment 1 seeks to confirm an intention monitoring deficit in children with autism, and Experiment 2 will evaluate whether this ability is required for the monkey–giraffe type inference by testing the same children's capacity to use knowledge of known labels to constrain mappings of novel labels to novel entities.

1. Experiment 1

1.1. Method

1.1.1. Participants

Twenty children with autism (mean age 7.8 years; range 5.2–9.5 years) were included, with 16 males and four females. Two additional participants were excluded due to non-compliance. Participants were recruited from parent support groups in New York and Boston. The experiment was performed in the child's home, and children received a small toy for participation. All children met DSM-IV criteria for autism, as indicated by clinical records that reported diagnosis of autism on the bases of the ADOS (Lord et al., 2000) The diagnosis was confirmed by us through the Autism Screener Questionnaire (Rutter & Lord, 2000) (mean 20; range 15–28). Mean IQ as assessed by the Leiter-R (Roid & Miller, 1997) was 62 (range 37–90). Mean comprehension vocabulary as assessed by the MacArthur CDI was 23 months (Fenson et al., 1993). Half the participants were non-verbal and thus quite typical of children with autism.

Twenty normally developing toddlers (mean age 23.8 months; range 22.2–26.2 months, 11 males, nine females) recruited from the NYU Infant Cognition Laboratory database were also tested to validate the procedure.

1.1.2. Stimuli

Four familiar objects (brush, pencil, book and glove) and four unfamiliar objects (tire gauge, cheese grater magnet, door stop, and soap dish; see Fig. 1) were used. A small canvas tote bag was used to hide the items.

1.2. Procedure

One or both of the child's parents were present throughout testing, which was videotaped. Participants sat across from the experimenter by a table. Each child was in both the Follow-in and Discrepant conditions, administered in counter-balanced order.

Fig. 1. Novel stimuli for Experiment 1.

1.2.1. Pre-test

Participants were presented with two of the following items, randomly selected: brush, pencil, book, and glove. They were asked to identify each of the items (e.g. "Which one is a glove?") to ensure that they could select a labeled item at the request of the experimenter.

1.2.2. Follow-in condition

The child was given a novel object to hold, and the experimenter held a different randomly selected novel object. While the child was playing with and staring at his toy, the experimenter also looked at the child's toy and uttered a novel word (e.g. "peri"). This was repeated a second time. The experimenter collected both items and placed in a small tote bag with the two familiar items from the pre-test phase. She said "See the peri? I'm going to hide the peri! Can you find the peri?" The child was given the bag and the chance to retrieve the peri from it. The item shown (by holding up, sliding to, or giving to) the experimenter was coded as the response. This condition provides a control for novelty preferences, as the experimenter's object was slightly more novel than the object the child was interacting with when the novel word was uttered. Whether children use eye gaze as a cue for word mapping or whether they simply map newly heard words onto objects in their focus of attention, children should select as the peri the item that was in their hands at the time of labeling.

1.2.3. Discrepant condition

In this condition, the child was given a novel object to hold, and the experimenter held another different novel object. While the child was playing with and staring at his toy, the experimenter looked at the toy she herself was holding (*not* the toy the child was focusing attention upon) and uttered a novel word (e.g. "toma"), again repeating this twice. The procedure then unfolded exactly as in the Follow-in Condition. If children understand that speakers' intent determines word meaning, and if they can use gaze as a cue to intent, they should select the experimenter's object. Alternatively, if children map words to objects in their focus of attention during labeling, they should choose their own object.

1.3. Results and discussion

1.3.1. Coding

Two independent coders reviewed videotapes. Reliability was 93%, and disagreements were settled by discussion.

1.3.2. Pre-test

All participants correctly identified the two randomly selected familiar items, demonstrating they would comply with the experimenter's request for a labeled item.

1.3.3. Follow-in condition

Overall, participants with autism were 67% correct (12/18) in choosing the item both the experimenter and child were looking at during the labeling phase. This is not statistically different from the toddlers, who were 85% correct (17/20) ($\chi^2 = 1.8$, $P = 0.18$, d.f. $= 1$).

1.3.4. Discrepant condition

Participants with autism were 39% (7/18) correct overall in choosing the item the experimenter was looking at during the labeling phase. The correct response in this condition is the item the child was NOT focusing attention upon when the new word was uttered). This differs significantly from the normally developing population, who were 80% correct (16/20) ($\chi^2 = 6.7$, $P < 0.01$, d.f. = 1). In fact, 19/20 of the normal toddlers looked up at the experimenter's eyes during the labeling component, whereas only 3/18 of the children with autism did so ($\chi^2 = 23.9$, $P < 0.001$, d.f. = 1).

Unlike normally developing toddlers, the choice of the experimenter's object in the Discrepant condition (39%) did not differ from that in the Follow-in condition (33%). Overall, the children with autism chose the object they had been looking at when they heard the novel word 64% of the time, which is statistically different from a chance level of 25% ($P < 0.001$, *t*-test, 2-tailed).

Taken together, the results from the Follow-in and Discrepant conditions yield a child-specific strategy. For the children with autism, 39% chose the object they had been looking at on both trials, which was coined the "Listener's Direction of Gaze" (LDG) strategy by Baron-Cohen et al. (1997). Twenty-eight percent (28%) selected the object the speaker was looking at for both trials (the "Speaker's Direction of Gaze" strategy—SDG), and 11% selected the more novel toy on both trials (the experimenter's toy, Novel Toy Strategy—NTS. The remaining 22% followed a pattern never seen in normal children in which the child chose the experimenter's object in the Follow-in condition and their own object in the Discrepant condition.

Seventy percent (14/20) of the normally developing participants abided by an SDG strategy, replicating the results obtained by Baron-Cohen et al. in which 79% of normally developing toddlers used the SDG strategy. The LDG strategy was adopted by 15% (3/20) of the participants, and the remaining 15% (3/20) preferred the more novel object in each test trial (NTS). The difference between the number of normally developing children using a SDG strategy and those using a LDG strategy is statistically significant ($\chi^2 = 3.88$, $P < 0.05$, d.f. = 1, see Fig. 2).

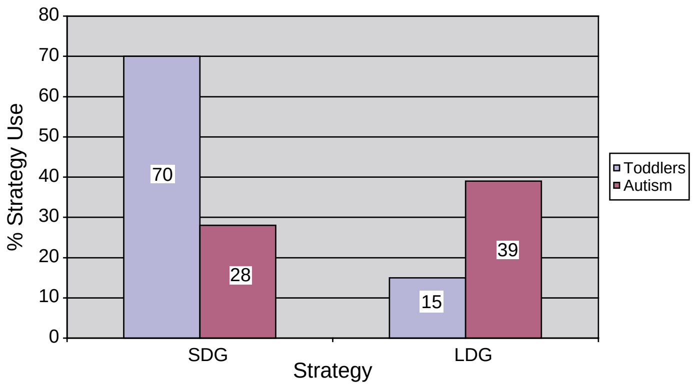

Fig. 2. Results of Experiment 1. Strategy use (SDG or LDG) by toddlers and children with autism.

The results obtained in Experiment 1 confirmed that whereas normally developing children will monitor referential intent and actively use the gaze of an adult speaker to determine the referent of a novel word, children with autism will not. Further, children with autism are much more likely to map words to items within their own focus of attention when the new word was heard, which is consistent with an underlying associative structure supporting or guiding the mapping. The children were not at chance—they did overall choose the object they had been looking at 64% of the time, irrespective of what object the experimenter was attending to. Also, they never chose one of the two familiar foils in the choice of four objects in the bag. This suggests either that they encoded both of the unfamiliar objects during the labeling condition and were simply unsure which one the label mapped on to, or else they knew to map the novel label onto a previously unlabelled object.

Experiment 2 explores whether the same group of children with autism included in Experiment 1 will use the fact that one object already has a known label to constrain their hypotheses about the meaning of a newly heard word under conditions of referential ambiguity. If inferences about intentions are required to establish such mappings, the present population should fail this word learning task.

2. Experiment 2

2.1. Method

2.1.1. Participants

The same children with autism who participated in Experiment 1 were included in the study. As a procedural validation, 20 new normally developing toddlers were included (mean age 24.0 months; range 22.2–27.3 months; nine males and 11 females).

2.1.2. Stimuli

The stimuli used were black-and-white line drawings and real objects confirmed as unfamiliar or familiar by parental report.

2.2. Procedure

2.2.1. Baseline trials

Children were presented with six trials consisting of two familiar items each. Items were either both pictures (e.g. picture of monkey and picture of carrot) or both objects (e.g. flower and comb). Children were instructed to show the experimenter an item (e.g. "Show me a monkey!") (Fig. 3). Showing included holding up, pointing to, or sliding an item to the experimenter.

2.2.2. Test trials

Each participant received two test trials. One trial consisted of one familiar, labeled, picture and one unfamiliar, unlabeled, picture, and the second trial consisted of one familiar, labeled, object and one unfamiliar, unlabeled, object (see Fig. 4). The known

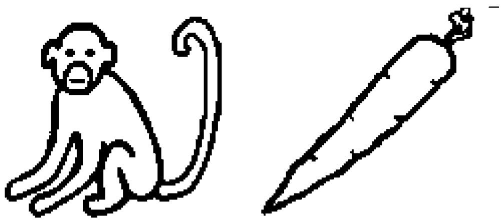

Fig. 3. Example of baseline stimuli for Experiment 2.

items (duck, apple) and the unfamiliar items (noisemaker, air pump) were counterbalanced as both pictures and objects. The participants were asked to show the experimenter a 'blicket'/'gorp', randomized between trials.

2.3. Results and discussion

2.3.1. Baseline trials

For children with autism, there was no response on two (1.7%) of the trials; of the remaining trials, children were 89% correct overall (105/118). There was no significant difference between performance on picture trials (86.4%) and object trials (91.5%),

Fig. 4. Example of test stimuli for Experiment 2.

$P = 0.21$, paired t-test. These results do not differ significantly from normally developing toddlers, who were 93% correct overall (92% correct picture trials and 94% object trials).

2.3.2. Test trials

For children with autism, there was no response on one (2.5%) of the test trials. Preliminary analysis revealed no order or stimuli effects, so results were combined across trial types. Overall, they were 82% correct (32/39 trials) in choosing the unnamed, unfamiliar object as the referent of a novel word, which differs significantly from a chance level of 50% ($P = 0.002$, paired t-test). The results were not statistically different for trials in which children were presented with pictures (75% correct, 15/20 trials) and objects (89% correct, 17/19 trials), ($P = 0.19$, paired t-test).

Normally developing toddlers were 79% correct in choosing the unnamed, unfamiliar object as the referent of a novel word, which differs significantly from a chance level of 50% ($P < 0.01$, t-test). Importantly, children with autism did not perform statistically different than the normally developing children ($P = 0.74$, 2-tailed t-test).

2.3.3. Overall results

Experiment 1 replicates the finding that children with autism fail to use speaker's gaze as a clue to speaker's intention to solve the problem of referential ambiguity when presented with a new word. However, the very same children are able to use the fact that they already know the labels for some objects as a basis for restricting their hypotheses to other objects (see Fig. 5).

2.4. General discussion

Taken together, the results of Experiments 1 and 2 support the argument that inferences about a speaker's referential intentions are not required for children to map new words to

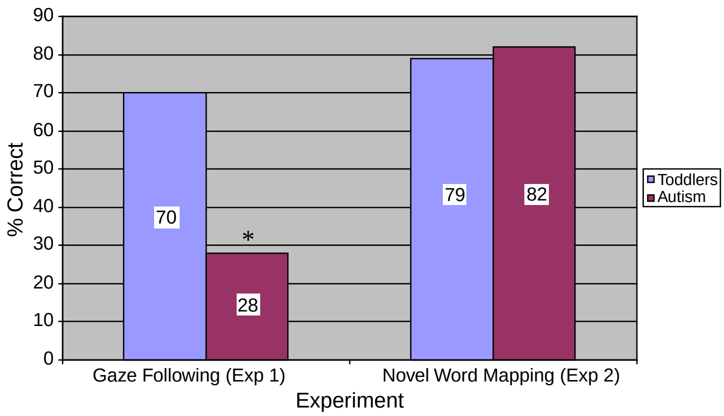

Fig. 5. Overall results from Experiments 1 and 2. Percent of children using gaze following for novel word mapping (Experiment 1) and percent of children using a known label to infer the meaning of an unknown label (Experiment 2).

novel stimuli in the world. Even high functioning children with autism are impaired at making such inferences, and Experiment 1 confirmed that the present sample would fail to consider speaker's intent in mapping words to objects. Still, the same children with autism were able to succeed at the novel word-mapping task of Experiment 2. These results suggest that pragmatic inferences about communicative intent are not necessary for the implementation of a strategy to map new labels to unnamed, unfamiliar objects.

How might children with autism be solving this referential puzzle? One possibility is an innate or learned constraint such as mutual exclusivity (Markman & Wachtel, 1988; Merriman & Bowman, 1989; Woodward & Markman, 1991) or N3C (Mervis & Bertrand, 1994). According to mutual exclusivity, every object has only a single category label, whereas N3C posits that novel words refer to objects without a name. The proponents of these constraints agree that hypotheses about a newly heard word's referents are restricted by innate or learned regularities governing world-word mappings. These regularities in turn guide inferential processes, whether Bayesian (e.g. Tenenbaum & Xu, 2000), associative (e.g. Rieger, 1980, 1989; Plunkett, 1997) or deductive (e.g. Halberda, 2003; Markman, 1992). These classes of models have in common that they do not deploy any information about the speaker's intentions when assigning a meaning to a newly heard word.

These results show that inferences about referential intent are not *required* to map new words to unnamed objects, but they leave open the possibility that the two populations are solving the mapping problem by two different mechanisms. Normally developing children are certainly sensitive to cues about speakers' intentions in solving problems of referential ambiguity (Meltzoff, 1988; Tomasello, 2000). Impairments in this capacity very likely play an important role in the language impairments characteristic in autism.

However, a parsimonious account of the child's use of information about known labels to constrain hypotheses about the application of a new word is that a single underlying process is responsible for the equal success of both groups of children. It seems likely that both normally developing children and children with impairments at making inferences about speakers' intentions are equipped with some basic language constraints or inferential abilities that do not depend on social cues, which support our ability to apply new category labels to objects in the world.

Acknowledgements

We thank the parents and children who generously volunteered their participation, Jessica Savage and Lucas Butler their assistance, and Paul Bloom for assistance with manuscript revisions.

References

Baldwin, D. A. (1991). Infants' contribution to the achievement of joint reference. *Child Development*, *62*, 875–890.

Baldwin, D. A. (1993a). Early referential understanding: Infant's ability to recognize referential acts for what they are. *Developmental Psychology*, *29*, 832–843.

Baldwin, D. A. (1993b). Infants' ability to consult the speaker for clues to word reference. *Journal of Child Language*, *20*, 395–418.

Baron-Cohen, S. (1995). *Mindblindness: An essay on autism and theory of mind*. Cambridge, MA: MIT Press.

Baron-Cohen, S. (2000). Theory of mind and autism: A fifteen year review. In S. Baron-Cohen, H. Tager-Flusberg, & D. J. Cohen (Eds.), *Understanding other minds: Perspectives from developmental cognitive neuroscience* (pp. 1–20). Oxford: Oxford University Press, 1–20.

Baron-Cohen, S., Baldwin, D. A., & Crowson, M. (1997). Do children with autism use the speaker's direction of gaze strategy to crack the code of language? *Child Development*, *68*, 48–57.

Baron-Cohen, S., Leslie, A. M., & Frith, U. (1985). Does the autistic child have a "Theory of mind"? *Cognition*, *21*, 37–46.

Bloom, P. (2000). *How children learn the meanings of words*. Cambridge, MA: MIT Press.

Clark, E. V. (1987). The principle of contrast: A constraint on language acquisition. In B. MacWhinney (Ed.), *Mechanisms of language acquisition* (pp. 1–34). Hillsdale, NJ: Erlbaum, 1–34.

Clark, E. V. (1988). On the logic of contrast. *Journal of Child Language*, *15*, 317–335.

Clark, E. V. (1997). Conceptual perspective and lexical choice in acquisition. *Cognition*, *64*, 1–37.

Diesendruck, G., & Markson, L. (2001). Children's avoidance of lexical overlap: A pragmatic account. *Developmental Psychology*, *37*, 630–641.

Fenson, L., Dale, P. S., Reznick, J. S., Thal, D., Bates, E., Hartung, J. P., et al. (1993). *The MacArthur communicative development inventories: User's guide and technical manual*. San Diego: Singular Publishing Group.

Halberda, J. (2003). The development of a word-learning strategy. *Cognition*, *87*, B23–B34.

Klin, A., Schultz, R., & Cohen, D. (2000). Theory of mind in action: Developmental perspectives on social neuroscience. In S. Baron-Cohen, H. Tager-Flusberg, & D. Cohen (Eds.), *Understanding other minds: Perspectives from developmental neuroscience*2nd ed. (pp. 357–388). Oxford: Oxford University Press, 357–388.

Lord, C., & Paul, R. (1997). Language and communication in autism. In D. J. Cohen, & F. R. Volkmar (Eds.), *Handbook of autism and pervasive developmental disorders*2nd ed. New York: Wiley.

Lord, C., Risi, S., Lambrecht, L., Cook, E. H., Leventhal, B. L., DiLavore, P. C., et al. (2000). The autism diagnostic observation schedule-generic: A standard measure of social and communication deficits associated with the spectrum of autism. *Journal of Autism and Developmental Disorders*, *30*(3), 205–223.

Markman, E. M. (1989). *Categorization and naming in children*. Cambridge, MA: MIT Press.

Markman, E. M. (1992). Constraints on word learning: Speculations about their nature, origins, and domain specificity. In M. R. Gunnar, & M. P. Maratsos (Eds.), *Modularity and constraints on language and cognition: The Minnesota symposium on child psychology*. Hillsdale, NJ: Erlbaum.

Markman, E. M., & Wachtel, G. F. (1988). Children's use of mutual exclusivity to constrain the meaning of words. *Cognitive Psychology*, *20*, 121–157.

Meltzoff, A. N. (1988). Infant imitation after a one-week delay: Long-term memory for novel acts and multiple stimuli. *Developmental Psychology*, *24*, 470–476.

Merriman, W. E., & Bowman, L. L. (1989). The mutual exclusivity bias in children's word learning. *Monographs of the Society for Research in Child Development*, *54*(3–4) (Serial No. 220) 1–129.

Mervis, C. B., & Bertrand, J. (1994). Acquisition of the novel name–nameless category (N3C) principle. *Child Development*, *65*, 1646–1662.

Mervis, C. B., Golinkoff, R. M., & Bertrand, J. (1994). Two-year-olds readily learn multiple labels for the same basic level category. *Child Development*, *65*, 971–991.

Plunkett, K. (1997). Theories of early language acquisition. *Trends in Cognitive Science*, *1*, 146–153.

Rieger, B. (1980). Fuzzy word meaning analysis and representation, Proceedings of COLING 80, Tokyo (pp. 76–94).

Rieger, B. (1989). *Unscharfe semantic. Farnkfurt/M*. Bern, New York: Verlag Peter Lang.

Roid, G. H., & Miller, L. J. (1997). *Leiter international performance scale-revised*. Wood Dale, IL: Stoelting Co..

Rutter, M., & Lord, C. (2000). *Autism screener questionnaire*. London, England: Institute of Psychiatry.

Sperber, D., & Wilson, D. (1995). *Relevance: Communication and cognition*. Oxford: Blackwell.

Tager-Flusberg, H. (1997). The role of theory of mind in language acquisition: Contributions from the study of autism. In L. Adamson, & M. A. Romski (Eds.), *Research on communication and language disorders: Contributions to theories of language development* (pp. 133–158). Baltimore, MD: Paul Brookes Publishing, 133–158.

Tenenbaum, J. B., & Xu, F. (2000). Word learning as Bayesian inference. In L. Gleitman, & A. Joshi (Eds.), *Proceedings of the 22nd annual conference of the cognitive science society* (pp. 517–522). Hillsdale, NJ: Erlbaum, 517–522.

Tomasello, M. (1998). Reference: Intending that others jointly attend. *Pragmatics and Cognition*, *6*, 229–243.

Tomasello, M. (2000). Perceiving intentions and learning words in the second year of life. In M. Bowerman, & Levison (Eds.), *Language acquisition and conceptual development* (pp. 132–158). Cambridge: Cambridge University Press, 132–158.

Tomasello, M., Strosberg, R., & Akhtar, N. (1996). Eighteen-month-old children learn words in non-ostensive contexts. *Journal of Child Language*, *23*, 157–176.

Waxman, S. R. (1990). Linguistic biases and the establishment of conceptual hierarchies: Evidence from preschool children. *Cognitive Development*, *5*, 123–150.

Waxman, S. R., & Gelman, R. (1986). Preschooler's use of superordinate relations in classification and language. *Cognitive Development*, *1*, 139–156.

Woodward, A. L., & Markman, E. M. (1991). Constraints on learning as default assumptions: Comments on Merriman and Bowman's "The mutual exclusivity bias in children's word learning". *Developmental Review*, *11*, 137–163.