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Labels increase attention to novel objects in children with autism and comprehension-matched children with typical development

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ABSTRACT This study used an intact group comparison to examine attention following in 34 children aged 2 years diagnosed with autism spectrum disorder (ASD) matched pairwise for vocabulary comprehension with a group of typically developing toddlers. For both groups of children, the presence of verbal labels during a referential task increased attention to a novel object over and above the attention-facilitating effect of child-directed talking without labeling. The typically developing children displayed more attention following than comprehension-matched children with ASD across experimental conditions and there was no significant difference between the groups in the facilitative effect of hearing verbal labels. Implications for word-learning theory, intervention strategies and future research are considered.

KEYWORDS *attention following; autism; language development; word learning*

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Learning new words presents a special problem for children diagnosed with autism spectrum disorder because these children have core deficits in joint attention behaviors, including attention following. By attention following, we mean the child's ability to turn his or her head or change direction of gaze in order to monitor and respond to verbal and non-verbal cues that indicate the referential focus of a social partner. A deficit in following adult

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attentional directives is among three primary indicators for the early diagnosis of autism spectrum disorder (Baird et al., 2000; Baron-Cohen et al., 1996).

According to a social pragmatic approach to language acquisition, attention following represents one of a number of social-cognitive behaviors that children use to understand the referential intentions of conversational partners (Tomasello, 2001). Theoretically, the ability successfully to follow adult indicating behaviors should increase the efficiency with which children determine the correspondence between labels they hear and object referents they see in the environment. Children who can follow into the focus of adult attention should learn more words and avoid mapping errors during word learning (Baldwin, 1991; 1993a; 1993b).

A concurrent relationship between attention following and vocabulary comprehension has been well documented for typically developing children (Carpenter et al., 1998; Landry and Loveland, 1988; Mundy and Gomes, 1998; Mundy et al., 1995; Slaughter and McConnell, 2003) as well as children with autism (Charman et al., 2003; Landry and Loveland, 1988; Mundy et al., 1987). A positive relationship between attention following and the number of words children understand may be observed for children with autism as early as 20 months of age (Charman et al., 2003). Thus, we have support from both word-learning theory and research that attention following represents a behavior worthy of detailed examination by those interested in improving language outcomes for children with autism spectrum disorders.

For children with autism, there is indirect evidence that learning the conventional meanings of words may be primarily restricted to situations in which adults follow into the child's current focus of attention. Baron-Cohen and colleagues (1997), using a modified version of the Baldwin (1993a; 1993b) paradigm, demonstrated that school-aged children with autism made mapping errors in word learning because they incorrectly used their own direction of gaze when making word–object associations, rather than following the speaker's gaze to the intended referent (Baron-Cohen et al., 1997). Only 29 percent of children with autism, between 7 and 12 years of age, were able correctly to map verbal labels to novel objects when the speaker's direction of gaze was discrepant from their own, while almost 80 percent of typically developing 24-month-olds were able correctly to complete the experimental task. When the speaker's direction of gaze coincided with their own, children with autism were able to make word–object associations as often as typically developing, language-matched controls. Assuming these findings generalize to very young children with autism, then identifying ways to support attention following should have a positive impact on word-learning outcomes.

Typically developing infants demonstrate a preference for listening to lexical word forms early in development (Shi and Werker, 2003; Tincoff and Jusczyk, 1999). There is also evidence that listening to verbal labels increases both visual attention to objects and manual object exploration in typically developing toddlers. Baldwin and Markman (1989, study 1) observed that children aged 10–14 months spent significantly more time looking at and touching a single novel object when the examiner labeled the object than when a novel object was presented with no speech directed toward the infant. Neither age nor vocabulary comprehension were significantly related to the attention-facilitating effect of adult labeling. In this experiment, the examiner stood several feet away and only gazed or smiled at the infant as the infant played with the toy. Hearing a label heightened infant attention to a novel object, compared to a condition in which the adult did not provide any language input, although the adult was not interacting with the infant in a proximal context in either condition. In another more recent study, typically developing 18-month-olds spent a longer duration of time looking at single unfamiliar objects when adults directed infant attention using verbal encouragement in addition to the use of gaze shifts and pointing, compared to when adults directed attention using gaze shifts and pointing alone (Flom and Pick, 2003). Both of these studies suggest that adding a verbal label to other non-verbal indicating behaviors has a facilitative effect on attention following in typically developing children at the earliest stages of word learning. However, both of these studies compared a condition in which labels were presented to a condition in which the adult was silent and used only eye gaze and gestural cues to support attention following.

Parents usually introduce novel words to their children within the more naturalistic context of connected speech (Woodward and Aslin, 1990; as cited in Jusczyk, 1997). Despite strong theoretical support for the notion that labels increase attention to novel objects in typically developing children, no study in the extant literature has directly considered whether hearing verbal labels can support child attention following over and above the effects of talking about an object without labeling. This is an important empirical question for typically developing children and a question that has important practical implications for young children with autism as well. If we are able to identify cues that enable children with autism to follow adult attentional directives more efficiently, we might then use such strategies to increase word learning outside of 'follow-in' labeling situations. The construct of adult 'follow-in' labeling (Baldwin, 1993a; Tomasello and Farrar, 1986) characterizes a triadic interaction in which the adult labels the object toward which the child is already attending. In such an interaction, it is not necessary for the child to shift their own focus of

attention to locate the referent labeled by the adult. In the contrasting discrepant labeling condition, the adult labels an object that does not correspond to the child's attentional focus. A discrepant labeling condition requires that the child actively locate the referent for the adult's label, presumably by responding to social cues that indicate the adult focus of attention. Typically developing children are able to learn words under a condition of follow-in labeling several months earlier than they are able to learn words under a condition of discrepant labeling (Baldwin, 1993a).

Studies have consistently reported a deficit in gaze following when children with autism are compared to typically developing children (Leekam et al., 1998; Mundy et al., 1994; Sigman and Ruskin, 1999) as well as to children with developmental delays (Leekam et al., 1998; Sigman and Ruskin, 1999). These studies have used both individual and group matching techniques to control for variables such as chronological age, IQ, verbal mental age and performance mental age. Even when controlling separately for receptive and expressive language, only one empirical study has attempted individually to match participants for vocabulary comprehension rather than using an aggregate language score (Leekam et al., 1998). Participants in the Leekam et al. (1998) study ranged in age from 5 to 12 years. No previous study has directly compared the attention following skills of very young children with autism to those of typically developing children, while closely matching all participants for vocabulary comprehension alone. Doing so would address the question of whether children who have acquired the same number of word meanings also demonstrate similar expertise in responding to behaviors that indicate the focus of adult attention.

Research questions

The current study addressed the following questions within the context of a referential task in which the experimenter used verbal and non-verbal indicating behaviors to direct child attention to a novel object:

1 Is there a significant difference in attention following for typically developing children compared to children with autism matched pairwise for vocabulary comprehension?
2 Is there a significant difference in attention following when adult referential cues include labels compared to referential cues without labels, regardless of diagnostic group membership?
3 Is the attention-facilitating effect of labels during a referential task greater for typically developing children than for children with autism?

Method

Participants

Thirty-four children with autism spectrum disorder (ASD group) participated in this study. The mean chronological age for these children was 35.4 months (SD 6.48 months; range 24–48 months). The children had received a clinical diagnosis of either autism (N = 24) or PDD-NOS (N = 10) from a licensed psychologist with extensive experience in the assessment of young children. Clinical diagnoses of autism spectrum disorder were based on criteria provided in the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV-TR: American Psychological Association, 2000) and confirmed for all participants according to the Autism Diagnostic Observation Schedule–Generic (ADOS–G: Lord et al., 1999). Two of the 24 children with a clinical diagnosis of autism had a diagnosis of PDD-NOS according to the ADOS–G. Three of the 10 children with a clinical diagnosis of PDD-NOS had a diagnosis of autism according to the ADOS–G.

Children with ASD were recruited from several sources: a university-based diagnostic evaluation center, a state network providing early identification services, parents or other community agencies. Eligibility requirements for participation included: (1) existing or suspected diagnosis of autism or PDD-NOS; (2) chronological age between 24 and 48 months; (3) absence of identified genetic or metabolic disorder; and (4) absence of severe sensory or motor impairment.

Each child with autism was paired with a typically developing child recruited from a university database. The pairing was determined by matching for number of words in the child's comprehension vocabulary according to a standardized parent report instrument (CDI: Fenson et al., 1994). The mean chronological age for the 34 typically developing children (TD group) was 15.4 months (SD 2.2 months; range 10.5–20 months). Typically developing status was confirmed through administration of the Ages and Stages Questionnaire (ASQ: Bricker and Squires, 1999). Typically developing children were eliminated from participation if they scored below the 10th percentile for their age on the vocabulary measure or failed any section of the Ages and Stages Questionnaire.

Design

The questions of whether labels can help children comply with adult attentional directives and whether this attention-facilitating effect is dependent on diagnostic group membership were addressed with a repeated measures analysis of variance with two within-participant factors: diagnostic group (pairwise-matched intact groups) and attention following condition (labeling versus talking). A measure of attention

following was administered and a parent report vocabulary checklist was completed for each participant.

Stimuli

Eight stimulus objects were constructed by gluing together a variety of small wooden shapes. The objects were approximately 5–7 inches tall and were attached to a 4 inch diameter circular wooden base, enabling each object to stand on a table without rolling. Each object, including the base, was painted a glossy, bright color. The objects were constructed so that they did not resemble any objects that would be familiar to young children. This was confirmed through pilot testing. The objects were sorted into pairs based on maintaining a color and shape contrast between each pair member.

Four nonsense labels were used to label the target objects within each pair during the experimental task: *modi*, *dawnoo*, *koba*, *tooko*.

Procedure

Attention following The child's ability to attend to a novel object while being continuously directed to do so by an adult was used as the measure of attention following in this study. Many studies of attention following employ a frequency metric or report the percentage of trials administered in which the child accurately responds to a single adult attention-directing cue. The challenge of measuring attention following in a developmentally young group of children with autism is the likelihood that many will score a zero, thereby reducing the utility of the measure. The current paradigm was designed to scaffold the highest possible level of attention following by providing a proximal context for triadic interaction. In addition, several strategies for redirecting and maintaining child attention to the target object were used: (1) presenting only a single object at a time; (2) placing the object close to the child and encouraging the child to handle the object; (3) using child-directed speech; (4) using proximal gestures (e.g. pointing); (5) using adult eye gaze and head turns toward the object; and (6) moving the object. Manipulations such as these have been shown to increase attention following in young children with autism (Leekam et al., 1998; 2000). We reasoned that measuring attention following under such conditions might be necessary to obtain sufficient variability in performance to test the associations of interest. A duration measure was used to quantify attention following because the examiner continually redirected the child's attention back to the object during each trial.

The attention following procedure consisted of four pairs of 30 second trials (i.e. eight trials) and usually took less than 6 minutes to administer. For both groups of children, the examiner was seated across the table

approximately 24 inches from the child. The typically developing children were seated in their caretaker's lap at a rectangular table or in an infant seat, attached to the table, with the caretaker seated to one side and slightly behind the child. The children with ASD were seated or stood behind a curved table that was positioned against a corner of the testing room. A parent or research assistant helped the children with ASD to stay in the general area behind the table. For both groups, the parents were instructed to refrain from interacting with the child during the trials.

Each participant was tested with the same four pairs of objects and one object within each pair was assigned to the labeling condition. The labeled object, side and order of presentation were counterbalanced across children. Within a pair, each object was presented to the child for approximately 30 seconds and only one object was visible to the child at a time. The examiner attempted to get the child's attention, then introduced the object from the designated side by bringing the object up from below the table. The examiner moved the object diagonally across the table until the object was centered in front of the child and close enough for the child to reach out and touch it.

During the labeling condition, presentation of the novel object was accompanied by 10 repetitions of a nonsense label embedded in child-directed, connected speech in sentence final position ('Look! I have a *modi*! You can see my *modi*! I like how you are playing with my *modi*! Wow, it's a great *modi*!'). During the talking condition, presentation of the other novel object in the pair was accompanied by child-directed, connected speech without labeling ('Look! See what I have? It's mine! And you can play with it! You're looking at my favorite one!').

The examiner attempted to establish a game-like routine with the child. After continuing attempts to redirect the child's attention to the object for approximately 30 seconds, the examiner removed the object and presented the second object of the pair. Once both objects in a pair had been presented and removed, the trial was complete and the next trial began.

Comprehension vocabulary Parents of all participants were asked to complete the infant version of the MacArthur Communicative Development Inventory (MCDI: Fenson et al., 1994). The totals of *words understood* and *words understood and said* were combined to yield a comprehension score. The mean CDI comprehension score for the participants with autism was 155.2 words (SD = 97.9, range 11–390 words). The mean comprehension score for the typically developing participants was 153.7 words (SD = 97.2, range 19–396 words). The mean difference between the CDI comprehension scores for the matched pairs of children was 6.47 words (SD = 6.2 words, range 0–25 words).

Coding and reliability

Session videotapes of the attention following procedure were converted into digital format and coded to determine the duration of child visual attention to each object. Coding was completed using ProcoderDV (Tapp, 2003), a software system that allows accurate frame-by-frame collection of observational data from digital media. Coded data files were exported into MOOSES software (Tapp et al., 1995) for calculation of cumulative durations of looking time and interobserver reliability. Two types of child looking behavior contributed to the measure of visual attention: (1) the child looked directly at the object with or without touching, and (2) the child looked at the examiner while simultaneously touching the object. Looking behavior was not coded as attention following if the child touched the object but looked somewhere else besides at the object or the examiner.

For the children with ASD, the mean trial length was 23.35 seconds (range 13.87–33.58 s, SD = 3.44 s). For the typically developing children, the mean trial length was 26.82 s (range 21.42–38.25 s, SD = 4.24 s). Preliminary analysis confirmed that trial duration was positively associated with duration of object attention. To adjust for this, percentage looking times were used as the metric for this analysis, with the length of each individual trial calculated from the digitized videotapes. For each participant, the average proportion of looking time was separately calculated for labeling and talking trials and these summary level variables were used in the analyses.

Interobserver reliability was calculated for 20 percent of the experimental sessions for each diagnostic group using intraclass correlation coefficients. Sessions coded for reliability were randomly selected. Intraclass correlation coefficients express the proportion of total variance that is accounted for by true differences between subjects as compared to other sources of error, in particular, disagreement between observers and random error (Suen and Ary, 1989). Reliability coefficients were computed for the total sample, as the pooled group was used in the repeated measures analysis. The reliability coefficients were 0.97 and 0.98 for attention following during labeling and talking trials, respectively. Intraclass correlation coefficients of 0.6 and above are considered acceptable (Mitchell, 1979).

Results

Adult labeling and child attention following

Results of the intact group comparison yielded a significant main effect of diagnostic group ($F(1) = 42.17$, $p < 0.001$, partial eta squared = 0.561), indicating that typically developing children displayed more attention

Table 1 **Mean values of the study variables**

Group	*Mean*	*SD*	*Range*
Autism Spectrum Disorder (*n* = 34)			
Labeling trials	0.56	0.22	0.23–0.98
Talking trials	0.52	0.22	0.10–0.92
Typically developing (*n* = 34)			
Labeling trials	0.82	0.09	0.67–0.96
Talking trials	0.79	0.08	0.62–0.92

following than children with autism during the experimental task. There was also a significant main effect of condition ($F(1) = 6.42$, $p < 0.016$, partial eta squared = 0.163), indicating that both groups of children displayed more attention following during the labeling trials than the talking trials. There was no significant interaction between group membership and attention following. These results indicated that the presence of labels did increase the likelihood that children would comply with adult attentional directives, regardless of diagnostic group. Typically developing children demonstrated a longer relative duration of attention following across conditions than did the children with autism. The absence of a diagnostic group by experimental condition interaction indicated that the facilitating effect of hearing verbal labels during the referential task was not significantly different for the children with autism than for the typically developing children.

Discussion

The current study demonstrated that the presence of verbal labels in the child-directed talking of conversational partners increased child attention to a novel object over and above the effects of child-directed talking without labeling. The facilitative effect of hearing verbal labels was observed for typically developing children as well as children with autism who were at an early stage of vocabulary acquisition. One previous study with typically developing toddlers has compared the effects of labeling with conditions in which the adult either did not talk to the child or produced pointing gestures to direct attention (Baldwin and Markman, 1989). Another study of typically developing toddlers has compared the effects of adult pointing and shifts of gaze direction with the effects of verbal encouragement added to these two cues (Flom and Pick, 2003). The current study contributes to the literature for typically developing children by providing the first direct comparison of the effect of labeling on child

attention to a novel object over and above the effects of adult talking without object labeling. Baldwin and Markman (1989) also demonstrated that children looked longer at novel objects during a play period that followed exposure to verbal labels and pointing than they looked at objects that had been indicated with pointing alone. While the current study did not examine the effects of verbal labels on subsequent attention to objects, over and above the effects of child-directed talking without labels, this important comparison should be addressed in a future study. This new finding adds to previously identified strategies that can be implemented to support attention following in children with ASD (Leekam et al., 1998; 2000) and typically developing children (Fernald, 1989; Hollich et al., 2000) and has important implications for interventions that seek to support attention following behaviors.

Previous studies have shown that individual differences in attention following are concurrently related to word-learning outcomes for children with autism as well as typically developing children. However, the current findings suggest that children who have learned the same number of words do not necessarily demonstrate equivalent levels of attention following. Children with ASD, who were closely and individually matched with typically developing children for comprehension vocabulary size, demonstrated significantly less attention following even in a referential situation structured to facilitate the greatest possible compliance to adult verbal and non-verbal attentional cues. These findings suggest that children with ASD may not rely on attention following to make an initial pairing between a verbal label and an object or event in the environment to the same extent as do typically developing children. Children with ASD may differentially rely on an alternative process or mechanism to support the acquisition of new word meanings. For example, word learning in these children may be confined primarily to situations in which adults follow into the child's current focus of attention and provide descriptive talking. That is, as suggested by Baron Cohen et al. (1997), children with ASD may learn words most efficiently when the adult label and the child's attentional focus correspond and the child does not carry the burden of determining the label–object correspondence. In such a situation, the requirement that the child use social-cognitive skills would be reduced and the word-learning process would depend on simple associative learning.

However, child commenting (i.e. initiating joint attention) may also be a good candidate for a social-cognitive behavior that facilitates vocabulary acquisition in children with ASD. If children initiate joint attention for the pragmatic purpose of sharing attention or positive affect, adults may respond by labeling the focus of the child's interest. Yoder and Warren (1999) demonstrated that contingent maternal linguistic mapping

mediated the relationship between child intentional communication and word learning in children with developmental delays.

Other authors (Call and Carpenter, 2002; Carpenter et al., 2002; Tomasello and Rakoczy, 2003) have suggested that children with autism may rely on alternative social learning mechanisms, such as motor imitation, to support the acquisition of referential language. Motor imitation of actions with objects provides a context within which children can maintain object-focused interaction with a social partner (Nadel, 2002). Linguistic information, by its arbitrary nature, must somehow be transmitted from adult to child. Attention to both object and adult within the triadic context of an imitative interaction may increase the probability that the adult will be talking about the child's focus of attention and that the child will access the adult's linguistic message. If motor imitation supports coordinated attention to object and person, a type of attention following, then a portion of the variance predicting the effect of motor imitation on word learning may actually be mediated by or accounted for by coordinated attention behaviors. That is, motor imitation may not represent an actual mechanism for social learning, but may scaffold coordinated attention to object and person such that word learning can occur. This question has not yet been tested empirically.

Because there is replicated evidence for a predictive relationship between attention following and word learning, increasing attention following is a potentially important treatment goal. When children comply with adult directives by following into the adult focus of attention, they are more likely to map a heard label to the appropriate referent. In addition, adults may respond to child compliance by providing children with verbal and behavioral models that support the acquisition of new words.

Targeting attention following as a treatment approach for improving word-learning outcomes in children with ASD remains only potentially important because an intervention study has not yet demonstrated that successfully treating attention following results in increased word learning for children with ASD. In this type of study, using random assignment of participants, the treatment for one group would specifically target attention following and word-learning goals while the treatment for the other group would target word-learning outcomes alone. Treatment effects on vocabulary comprehension in both groups could then be directly compared to allow us to confirm the efficacy of targeting attention following as one method of supporting word acquisition in children with ASD.

This study showed that providing verbal labels within a referential context could help both groups of children to follow adult attentional directives over and above the attention-facilitating effect of infant-directed talking without labeling. Thus, one way to increase the probability that

children will comply with our attentional directives is for conversational partners to include the object label when talking to children about objects and events. An attentional directive that includes a verbal label could easily be used by interventionists prior to presenting many types of teaching techniques as well as by parents when interacting with their children in everyday situations.

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References

AMERICAN PSYCHOLOGICAL ASSOCIATION (2000) *Diagnostic and Statistical Manual of Mental Disorders*, 4th edn text rev. (DSM-IV-TR). Washington, DC: APA.

BAIRD, G., CHARMAN, T., BARON-COHEN, S., COX, A., SWETTENHAM, J., WHEELWRIGHT, S. & DREW, A. (2000) 'A Screening Instrument for Autism at 18 Months: A 6-Year Follow-Up Study', *Journal of the American Academy of Child & Adolescent Psychiatry* 39: 694–702.

BALDWIN, D. (1991) 'Infants' Contribution to the Achievement of Joint Reference', *Child Development* 62: 875–90.

BALDWIN, D. (1993a) 'Early Referential Understanding: Young Children's Ability to Recognize Referential Acts for What They Are', *Developmental Psychology* 29: 1–12.

BALDWIN, D. (1993b) 'Infants' Ability to Consult the Speaker for Clues to Word Reference', *Journal of Child Language* 2: 395–418.

BALDWIN, D.A. & MARKMAN, E.M. (1989) 'Establishing Word–Object Relations: A First Step', *Child Development* 60: 381–98.

BARON-COHEN, S., COX, A., BAIRD, G., SWETTENHAM, J., NIGHTINGALE, N., MORGAN, K., DREW, A. & CHARMAN, T. (1996) 'Psychological Markers in the Detection of Autism in Infancy in a Large Population', *British Journal of Psychiatry* 168: 158–63.

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.

BRICKER, D. & SQUIRES, J. (1999) *Ages and Stages Questionnaire (ASQ): A Parent-Completed, Child-Monitoring System*, 2nd edn. Baltimore, MD: Brookes.

CALL, J. & CARPENTER, M. (2002) 'Three Sources of Information in Social Learning', in K. DAUTENHAHN & C.L. NEHANIV (eds) *Imitation in Animals and Artifacts: Complex Adaptive Systems*, pp. 211–28. Cambridge, MA: MIT Press.

CARPENTER, M., NAGELL, K. & TOMASELLO, M. (1998) 'Social Cognition, Joint Attention, and Communicative Competence from 9 to 15 Months of Age', *Monographs of the Society for Research in Child Development* 63: v–143.

CARPENTER, M., PENNINGTON, B. & ROGERS, S. (2002) 'Interrelations among Social-Cognitive Skills in Young Children with Autism', *Journal of Autism and Developmental Disorders* 32: 91–106.

CHARMAN, T., BARON COHEN, S., SWETTENHAM, J., BAIRD, G., DREW, A. & COX, A. (2003) 'Predicting Language Outcome in Infants with Autism and Pervasive Developmental Disorder', *International Journal of Language and Communication Disorders* 38: 265–85.

FENSON, L., DALE, P., REZNICK, J., BATES, E., THAL, D. & PETHICK, S. (1994) *Variability in Early Communicative Development*. Monographs of the Society for Research in Child Development, 59 (5, serial no. 242).

FERNALD, A. (1989) 'Intonation and Communicative Intent in Mothers' Speech to Infants: Is the Melody the Message?', *Child Development* 60: 1497–510.

FLOM, R. & PICK, A.D. (2003) 'Verbal Encouragement and Joint Attention in 18-Month-Old Infants', *Infant Behavior and Development* 26: 121–34.

HOLLICH, G., HIRSH-PASEK, K. & GOLINKOFF, R. (2000) *Breaking the Language Barrier: An Emergentist Coalition Model for the Origins of Word Learning*. Monographs of the Society for Research in Child Development, 65 (3, serial no. 262).

JUSCZYK, P. (1997) *The Discovery of Spoken Language*. Cambridge, MA: MIT Press.

LANDRY, S.H. & LOVELAND, K.A. (1988) 'Communication Behaviors in Autism and Developmental Language Delay', *Journal of Child Psychology and Psychiatry and Allied Disciplines* 29: 621–34.

LEEKAM, S.R., HUNNISETT, E. & MOORE, C. (1998) 'Targets and Cues: Gaze-Following in Children with Autism', *Journal of Child Psychology and Psychiatry and Allied Disciplines* 39: 951–62.

LEEKAM, S.R., LOPEZ, B. & MOORE, C. (2000) 'Attention and Joint Attention in Preschool Children with Autism', *Developmental Psychology* 36: 261–73.

LORD, C., RUTTER, M., DILAVORE, P. & RISI, S. (1999) *Autism Diagnostic Observation Schedule*. Los Angeles, CA: Western Psychological Services.

MITCHELL, S. (1979) 'Interobserver Agreement, Reliability, and Generalizability of Data Collected in Observational Studies', *Psychological Bulletin* 86: 376–90.

MUNDY, P. & GOMES, A. (1998) 'Individual Differences in Joint Attention Skill Development in the Second Year', *Infant Behavior & Development* 21: 469–82.

MUNDY, P., SIGMAN, M., UNGERER, J. & SHERMAN, T. (1987) 'Nonverbal Communication and Play Correlates of Language Development in Autistic Children', *Journal of Autism and Developmental Disorders* 17: 349–64.

MUNDY, P., SIGMAN, M. & KASARI, C. (1994) 'Joint Attention, Developmental Level, and Symptom Presentation in Autism', *Development and Psychopathology* 6: 389–401.

MUNDY, P., KASARI, C., SIGMAN, M. & RUSKIN, E. (1995) 'Nonverbal-Communication and Early Language-Acquisition in Children with Down-Syndrome and in Normally Developing Children', *Journal of Speech and Hearing Research* 38: 157–67.

NADEL, J. (2002) 'Imitation and Imitation Recognition: Functional Use in Preverbal Infants and Nonverbal Children with Autism', in A. MELTZOFF & W. PRINZ (eds) *The Imitative Mind: Development, Evolution, and Brain Bases*, pp. 42–62. New York: Cambridge University Press.

SHI, R. & WERKER, J. (2003) 'The Basis of Preference for Lexical Words in 6-Month Old Infants', *Developmental Science* 6: 484–8.

SIGMAN, M. & RUSKIN, E. (1999) 'Continuity and Change in the Social Competence of Children with Autism, Down Syndrome, and Developmental Delays', *Monographs of the Society for Research in Child Development* 64 (1): v–144.

SLAUGHTER, V. & MCCONNELL, D. (2003) 'Emergence of Joint Attention: Relationships between Gaze Following, Social Referencing, Imitation and Naming in Infancy', *Journal of Genetic Psychology* 164: 54–71.

SUEN, H. & ARY, D. (1989) *Analyzing Quantitative Behavioral Observation Data*. Hillsdale, NJ: Erlbaum.

TAPP, J. (2003) *ProcoderDV* (computer software and manual). http://kc.vanderbilt.edu/pcdv/.

TAPP, J., WEHBY, J. & ELLIS, D. (1995) 'A Multiple Option Observation System for Experimental Studies: MOOSES', *Behavior Research Methods, Instruments and Computers* 27: 25–31.

TINCOFF, R. & JUSCZYK, P. (1999) 'Some Beginnings of Word Comprehension in Infants', *Psychological Science* 10: 172–5.

TOMASELLO, M. (2001) 'Perceiving Intentions and Learning Words in the Second Year of Life', in M. BOWERMAN & S. LEVINSON (eds) *Language Acquisition and Conceptual Development*, pp. 133–58. New York: Cambridge University Press.

TOMASELLO, M. & FARRAR, M.J. (1986) 'Joint Attention and Early Language', *Child Development* 57: 1454–63.

TOMASELLO, M. & RAKOCZY, H. (2003) 'What Makes Human Cognition Unique? From Individual to Shared Collective Intentionality', *Mind and Language* 18: 121–47.

WOODWARD, J. & ASLIN, R. (1990) 'Segmentation Cues in Maternal Speech to Infants', paper presented at the meeting of the International Conference on Infant Studies, Montreal, Quebec.

YODER, P. & WARREN, S. (1999) 'Maternal Responsivity Mediates the Relationship between Prelinguistic Intentional Communication and Later Language', *Journal of Early Intervention* 22: 126–36.