CHAPTER 1: INTRODUCTION

How does a child learn a word? On paper, the problem seems insurmountable – each time a new word is heard, there are literally thousands of possible referents available (Quine, 1960; Wittgenstein, 1953). Yet by two years of age, children have mastered this skill and are able to acquire new words with ease (Baldwin, 2000; L. Bloom, 1973, 1993, 2000; Bloom & Tinker, 2001; P. Bloom, 2000; Hoff & Naigles, 2002; Hollich, Hirsh-Pasek, & Golinkoff, 2000; Nelson, 1985, 1996; Smith, 2000; Tomasello, 1999; Woodward, 2000). Theories explaining this paradox have ranged from principles/constraints accounts that utilize cognitive heuristics, to associationist views that rely on "dumb attentional mechanisms", to social-pragmatic explanations that focus on the role of the social environment (for a review, see Golinkoff, et al., 2000). All theories discuss the role of adults in this process; children must hear the words from *someone*. The relative importance of social information, however, varies greatly.

Under an associationist perspective, adults are no more important than any other part of the environment (Smith, 1995, 1999, 2000). While the adult may direct the child's attention to a specific object, bright colors, interesting textures, and moving components can do so as well. In stark contrast, social-pragmatic views contend that without an understanding that the adult is attempting to communicate, no word learning can occur (Baldwin, 2000; P. Bloom, 2000; Tomasello, 1995, 1999). We know that adults affect how children master vocabulary. Yet, we know precious little about the psychological mechanisms that enable this learning to take place. Is the child a sponge, absorbing all of the surrounding information; a student, being taught by the environment; or an explorer who actively seeks out new information from a knowledgeable master (L. Bloom, 1993, 1998, 2000)? How does the social context inform or buttress word learning? This dissertation investigates that question.

Is an understanding of others' intentions essential to word learning? Many theories argue that sensitivity to speaker intent is a necessary condition for mapping words onto referents (Baldwin & Tomasello, 1998; P. Bloom, 2000; Bruner, 1983; Nelson, 1985; Tomasello, 1995, 1999). Children must use an understanding of what the speaker means to communicate, i.e., an understanding of the speaker's intention, to determine the meaning of new words. In stark contrast, associationist views contend that it is the attention-directing properties of the social environment that are crucial for word learning, not the speaker's intentions (Plunkett, 1997; Samuelson & Smith, 1998; Smith, 1995, 2000). Looking at, pointing to, touching, and handling an object are all means of heightening an object's salience. Mapping of word to referent is straightforward; children simply map words onto the most salient referents. Other perspectives argue that the explanation of language learning lies somewhere between these two extremes (Hollich, et al., 2000; Hoff & Naigles, 2002; Moore, Angelopoulos, & Bennett, 1999; Woodward, 2000). While older children and adults may use social intentions to guide word learning, infants may not yet be able to do so and may instead rely more on brute association to determine the meanings of words (Hollich, et al., 2000).

In research with typically developing children, it is impossible to determine whether or not the child is responding to the speaker's intentions. The clues to understanding the speaker's intent are precisely the same behaviors (looking, pointing, touching, handling) that serve to draw the child's attention to that object. Thus for any given study, results may be interpreted as providing evidence for *any* of the theories of word learning! This dissertation examines one way to disentangle the role of *attention* to social cues from the use of these cues to determine social *intentions*. Children with autistic disorder who, by definition, cannot access the social intentions of others provide a natural test case to explore various word learning strategies. By studying a group whose word learning strategies are limited it may be possible to determine how far word learning can progress through purely attentional means as well as when social intentions become a *necessary* component of word learning.

This dissertation begins by discussing background studies that make the case for the role of social cues in theories of word learning. Autistic spectrum disorder is then described, with a focus on the role of attention to social information in theories of autism. Four experiments designed to explore how children with autistic disorder respond to various social cues and whether they can use each type of cue to help them learn new words are detailed in Chapter 2. Chapter 3 examines how these findings further our understanding of language development in this special population. Finally, this paper discusses how the learning of words in children with autistic disorder can contribute to the current debate between various theories of word learning and therefore help us to better understand word learning in typical populations.

The Role of Social Information in Word Learning

Discussions of the role of social information in word learning can be categorized into two major groups: theories that view the social environment as an attentional mechanism and those holding that children use social cues to infer the communicative intentions of the speaker. Attentional theories describe the physical motions of the speaker as a means of directing the listener's attention by heightening the saliency of various elements in the environment. In contrast, intentional theories focus on the role of language as a means to communicate our thoughts with one another. These differences in perspective not only impact on our understanding of word learning, but also on the way in which we view language. Is language but one of many human behaviors, or is language unique? Do we learn language in the same manner as we learn most other behaviors, or do we have skills that are specialized for communication with other humans?

Attentional theories discuss social information in terms of *visible* social actions (for example, pointing and line-of-regard) that direct the listener's attention to the correct object (or action or event).[1] Mere observation of the physical body of the other person could be sufficient for interpreting attentional social cues (Plunkett, 1997; Samuelson & Smith, 1998; Smith, 1995, 2000). For example, the object the speaker is presenting to the listener is likely to be the same object that the speaker is describing or

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[1] Obviously not all words are object names. Yet it becomes cumbersome to constantly list every possibly referent for words. Thus, while this text discusses objects, the claims apply to our understanding of how children learn *all* types of words.

naming. The speaker's actions, such as eye gaze or pointing, heighten the perceptual salience of certain aspects of the environment. Thus, social information merely serves as a highlighter that assists basic associative mechanisms in making the right word-to-world mappings (Smith, 1995, 1999, 2000; Woodward, Markman, & Fitzsimmons, 1994; Woodward & Hoyne, 1999).

Under this scenario, there is nothing particularly privileged about the social environment over other input sources (e.g. movement, temporal contiguity); rather it is just one additional means of attracting the child's attention. Children will attend to either the object that is the most colorful, or that has the most moving parts, or that the speaker is picking up and turning around (Samuelson & Smith, 1998). However, when the speaker is holding the most colorful object while making several of its parts move in interesting manners, the child will almost certainly find that object fascinating.

One might protest that this theory would allow children to make numerous errors when learning new words. Speakers do not always discuss the most interesting object! Yet children typically hear words more than once. So, while the referent might not be the most interesting object, it should (over time) be the most consistent object. The greatest advantage to this theory is its parsimony. There need be no language-specific abilities nor any advanced social-cognitive skills. Rather, word learning occurs in the same manner as all other learning – by associating the most frequently heard label with the most salient object (Plunkett, 1997; Schafer & Plunkett, 1998; Smith, 1995, 1999, 2000).

Schafer and Plunkett (1998) demonstrated that young infants could learn a novel word in the *absence* of social information. 15-month-olds watched a television screen. A novel object appeared on the screen while the soundtrack repeated a novel word (for example, "modi"). The screen went blank, then a second object appeared on the screen, and a second nonce word was heard (for example, "blicket"). This sequence was repeated to provide the children with a reasonable amount of exposure to both objects and both words. At test, the two objects were presented side-by-side on the screen for all test trials. The soundtrack was the only difference between test trials. Children heard either one of two words from training, or a third novel word (for example, "toma"). Overall, children looked longer at the object that matched the word they were hearing. That is, when they heard "modi," they looked at the first object from training, and when they heard "blicket" they looked at the second object. When the third word was heard (i.e., the word that had not been associated with either object), the children showed no preference for either object. Not only did this demonstrate that young infants could learn a word through associative processes, but also it showed that they could learn a word without *any* social information available (Schafer & Plunkett, 1998)!

Smith (2000) argued that word leraning begins with these "dumb attentional mechanisms" (see also Smith, Jones, & Landau, 1996). At first, children would acquire words slowly, needing to form an association for each new word and its referent. As children learn more words, these same associative processes would begin to form word-learning "cranes," or strategies that "speed up" word learning by creating biases about the types of things that words typically name. Cranes narrow the range of possible referents, and allow children to more rapidly determine the correct meaning of novel words.

> The proposal that word-learning cranes are built by the same associative mechanisms that govern learning in other domains implies that words are not intrinsically special in their ability to organize attention to categories. Rather, that specialness is a product of learned associations. (Smith, 2000, p. 61)

One crane that has undergone substantial investigation is the "shape bias" (Imai, Gentner, & Uchida, 1994; Keil, 1994; Landau, Smith, & Jones, 1988, 1992, 1998; Samuelson & Smith, 1999; Smith, 1999; for a review, see Smith, 2000). Young children assume that objects with the same *shape* should have the same *name*. For example, Landau and colleagues (1988) presented 2- and 3-year-olds with novel wooden objects. The children were told, "This is a *dax*." They were then shown several other objects and asked, "Is this a dax?" Some of the test objects were the same shape as the original object, but varied in size (up to 100 times the original size), or material (metal or sponge rather than wood). Other objects were the same size and material as the original object, but varied in shape. Children consistently chose objects with the same shape as having the name, regardless of variations in size and material.

How would children develop a shape bias? Smith (2000) argued that the shape bias itself is built through associative processes. The vast majority of nouns found in young children's vocabularies could be classified as count nouns referring to solid objects categorized by shape (Samuelson & Smith, 1999). Names for artifacts (such as "ball," "car," and "bottle") dominate early vocabularies, and artifact categories may be more strictly organized by shape than are other categories (Keil, 1994; Jones & Smith, 1998). The regularity by which early nouns correspond with specific shapes would provide children with sufficient information to build a shape bias. Once children form a shape bias, then they are able, from hearing the name for a single object, to extend that word to an entire category of objects (i.e., all objects with the same shape).

Thus, children's extension of novel words has also been shown to be largely based on shape – particularly for artifacts and other solid objects (Imai, et al., 1994; Keil, 1994; Landau, et al., 1988, 1992, 1998; Samuelson & Smith, 1999, 2000; Smith, 1995, 1999, 2000; Smith, et al., 2000; Smith, Jones, Landau, Gershkoff-Stowe, & Samuelson, 2002). Yet what led to the shape bias? While it is possible that the shape bias itself was built through associative mechanisms (as argued by Smith, 1999, 2000), that is not the only possibility. Children could be born with a tendency to assume that words name whole object categories (Golinkoff, Mervis, & Hirsh-Pasek, 1994; Markman, 1989). Or, the social environment could teach the child to attend to the shape of objects. To demonstrate that the shape bias is itself an "associative crane," it would be necessary to show that it could be built through purely associative learning.

Smith and colleagues (2002) followed toddlers once a week for nine weeks, beginning when they were 17-months-old. At the beginning of the study, the children productively used an average of 14 count nouns (based on parental report). During the first seven weeks, the children were trained on four different novel categories – each defined by shape. The experimenter would show the children two exemplars from the same category – identical in shape but varying in color and material. She would name both objects (e.g., "This is a zup. Here is another zup."). The children were permitted to play with the objects for five minutes, during this play session, the experimenter repeatedly named the objects (e.g., "You put the zup on the truck."). During the play session, the experimenter introduced a third object that matched in color or material to the two objects, but not in shape. She informed the child, "That is not a zup" and quickly withdrew the object. The child was never permitted to play with the third object. The same sequence was repeated with the remaining three categories of exemplars.

During weeks eight and nine, the children were not trained on the categories, but rather were tested to assess if they had formed a shape bias (Smith, et al., 2002). In the eighth session, the children were tested on their ability to generalize to new members of the four categories from training. The child was shown one of the objects from training (test exemplar) and three new objects. Of the three new objects, one matched the test exemplar in material, one matched it in color, and one matched it in shape. The experimenter picked up the test exemplar and identified it (e.g., "This is a zup"). She then asked the child, "Get me another zup." The children selected the object that matched in shape almost 90% of the time! For the final session (week 9), the children were again tested on their ability to generalize a word. However, this time, the children were presented with groups of novel objects and not the objects from training. Even when presented with objects that the children had never seen, the children still selected the object with the same shape 65% of the time. In contrast, a control group, who participated in just the testing sessions, selected the object with the same shape only 40% of the time (Smith, et al., 2002).

For associationist theories, these results present compelling evidence that word learning can progress through "dumb attentional mechanisms" (Smith, 1999, 2000; Smith, et al., 1996). Statistical regularities not only lead children to the meanings of individual words, but also enable children to construct mechanisms that can "speed up" the learning process – such as the shape bias. The processes function with or without social information (Schafer & Plunkett, 1998; Smith, 1999, 2000). Adults do not impede word learning, and, in fact, they can even aid word learning by directing the child's attention to relevant information. But, social information is not necessary for language development – children can learn word-to-world mappings based solely on the regularities in their environments.

In direct contrast to the associative theories lie the social-pragmatic theories, contending that social information is the bedrock of language (Baldwin, 2000; Baldwin & Tomasello, 1998; P. Bloom, 2000; Bruner, 1983; Carpenter, Nagell, & Tomasello, 1998; Nelson, 1985, 1996; Tomasello, 1995, 1999). "…language learning is inherently social in that it is acquired (1) in interactions with others and (2) for the purpose of communicating with others (Akhtar & Tomasello, 2000, p. 117)." At its essence, language is a form of communication. Children are able to communicate months before their first words appear (Adamson, 1995; Bates, Camaioni, & Volterra, 1975; Bloom & Tinker, 2001; Carpenter, Nagell, & Tomasello, 1998; Nelson, 1996; Tomasello, 1999; Vandenberg, 1999). To learn new words, children must first recognize that the speaker is attempting to communicate and only then can they begin to determine what the speaker intends to say.

This explanation of word learning requires more than a surface analysis of the speaker's physical motion. "…it is impossible to explain how children learn the meaning of a word without an understanding of …how children think about the minds of others…(P. Bloom, 2000, p. 2)." Children must understand *why* the speaker acted in such a manner – what the speaker *intended* to convey. This understanding of "communicative intentions" develops out of earlier nonlinguistic communication skills and from the child's growing understanding of their *own* intentions (Tomasello, 1999). From birth, infants are social creatures (Schaffer, 1984), who are born prepared to recognize the rhythms of human communication (Jaffe, Beebe, Feldstein, Crown, & Jasnow, 2001; Messer, 1994; Scaife & Bruner, 1975). During the first six months of life, infants learn to take turns, to maintain eye contact, and bring the two together to create *proto-conversations* in which infants use eye gaze and grunting to fill in their turns in the "conversation" (Argyle & Cook, 1976; Bates, et al., 1975; Brazelton, Koslowski, & Main, 1974; Jaffe, et al., 2001; Stern, 1985; Trevarthan, 1979, 1993; for a review see Adamson, 1995).

One key piece of the puzzle develops when infants learn not only to pay attention to adults, but also to simultaneously attend to the object of the adult's attention (Tomasello, 1999). This forms a "referential triangle" among the child, adult, and an object and is most commonly called *joint attention* (Moore & Dunham, 1995; P. Bloom, 2000; Bruner, 1983; Carpenter, Nagell, & Tomasello, 1998; Corkum & Moore, 1995; Dunham, Dunham, & Curwin, 1993; Tomasello, 1999). Extensive research has investigated the role of joint attention in language development (for reviews see

Carpenter, & Tomasello, 2000; Moore & Dunham, 1995; Tomasello, 1999). For example, Carpenter, Nagell, and Tomasello (1998) followed twenty-four infants from nine to fifteen months of age. Each month, the children were tested on nine measures of joint attention, including gaze following, point following, joint engagement, and use of declarative gestures. Carpenter and colleagues found that all nine skills emerged (for most children) by twelve months of age, and that, for each child, the skills typically emerged over a four-month time span. Further, there was a developmental progression, with children first learning to *share* attention with the adult, then to *follow* the adult's attention to a target, and only later to *direct* the adult's attention to the child's interests (Carpenter, Nagell, & Tomasello, 1998).

But joint attention provides only one part of the understanding of social intentions. It provides the means of "entering" the other's mind, but the child must still learn to recognize the intentions that lie within. Research by Gergely and colleagues indicates that a general understanding of intentional action develops concurrently with joint attention skills (Gergely, Csibra, Bíró, & Koós, 1994; Gergely, Nádasdy, Csibra, & Bíró, 1995). Nine- and twelve-month-olds watched a film of two circles separated by a barrier. The circles (balls) pulsed intermittently. One ball approached the barrier, paused, and returned to its initial position. The ball then approached the barrier at a faster speed, jumped the barrier, and struck the other ball. Both balls then pulsed together. During test trials, the barrier was removed. Infants dishabituated to the ball repeating the same motion (forward, back, forward, and over), but not to the ball moving directly to the other ball. The authors interpreted this as evidence that infants perceived the direct action as fulfilling the *intention* to contact the other ball (Gergely, et al., 1995; Gergely, et al., 1994).

Once children have learned to engage in joint attention and have begun to recognize intentions in others' actions, they must then pull these two skills together to be able to use joint attention as a means of determining communicative intentions.

> … if infants appreciate that speakers tend to supply action clues regarding their referential intentions – clues such as line-of-regard, gestures (pointing, showing), voice direction and body posture – they might note the discrepancy between their own and the speaker's focus and utilize the action clues to locate the correct referent of the label. (Baldwin & Baird, 1999, p. 220)

Numerous studies by Baldwin, Tomasello and their colleagues suggest that children learn to do so by18 to 24 months of age (Akhtar, Carpenter, & Tomasello, 1996; Akhtar, Dunham, & Dunham, 1991; Akhtar & Tomasello, 1996; Baldwin, 1991, 1993, 2000; Baldwin & Tomasello, 1998; Carpenter, Akhtar, & Tomasello, 1998; Tomasello & Barton, 1994; Tomasello & Farrar, 1986; for reviews, see Akhtar & Tomasello, 2000; Tomasello, 1999).

In one study, Akhtar and Tomasello (1996) tested if children could use the speaker's actions to map a word to an object *even if the object was never seen after the name was given*. For example, in the context of a finding game, toddlers were shown four different novel objects and were taught that each object was kept in one of four distinct hiding places. One location was a very unique toy barn. While the child was learning which object belonged in which place, no names were given for any of the objects (Akhtar & Tomasello, 1996). Once the children demonstrated that they remembered what object belonged in each location, the experimenter said, "let's find the gazzer." She went directly to the toy barn, but was unable to open the barn – it was "locked." She frowned at the barn then moved to a new location saying, "let's see what else we can find." She then smiled as she took out the object in the new location. Children were then permitted to play with this object. At test, all four objects were present, and children were asked to "find the gazzer." Children correctly selected the object that had been in the barn even though it was never shown after the name was given (Akhtar & Tomasello, 1996; see also Tomasello, Strosberg, & Akhtar, 1996).

In another experiment, children were allowed to explore several novel objects, each of which was placed into a separate bucket (Tomasello & Barton, 1994). Then, the experimenter said she would "find the toma." She proceeded to search each bucket in turn. As each object was removed from its bucket, the experimenter did one of two things. Either she scowled, replaced the object, and continued with the next bucket or she smiled and stopped searching. At test, when presented with all of the objects, children correctly selected the target object regardless of how many other objects had been rejected (Tomasello & Barton, 1994).

Baldwin and colleagues have demonstrated that 18- to 20-month-olds will only learn a word if there is some evidence that the speaker *intended* to name the object (Baldwin, Markman, Bill, Desjardins, Irwin, & Tidball, 1996). For example, imagine that little Tommy is playing with a brand new toy whose name he does not know. While he is actively attending to the toy, his mother is talking on the phone with her friend. How does Tommy know that what his mother is saying is *not* the name for his new toy? Baldwin and colleagues (1996) tested children in two separate situations. For both the children were given a novel object to explore. In one condition, the experimenter looked at the object the child was holding while providing a new object label. In the other condition, the speaker was out of view when she said the new word (and thus more akin to the situation found when mother is speaking on the phone). Toddlers only demonstrated word learning in the first condition, when they were able to see that the speaker was attending to the same object as they were. Mere pairing of sight and sound – hearing the word while seeing the object – was insufficient for word learning; children in the second condition did *not* learn the word when they could not see what the speaker was attending to (Baldwin, et al., 1996; see also Baldwin 1993).

In all of these studies, the authors contend that the only means of identifying the correct referent is through an analysis of the speaker's intentions (Baldwin & Tomasello, 1998; Tomasello, 1999; but see Samuelson & Smith, 1998). These studies have led to the current understanding of language as founded upon social intent. By learning to understand adults' actions and motivations, children become enmeshed in their social environment. As language is inherently social, the key to unlocking language must be an understanding of social intent. "Sounds become language for young children when and only when they understand that the adult is making that sound with the intention that they attend to something" (Tomasello, 1999, p. 101). The implications are, as Tomasello (1999) says, that no "true" words, in fact, no true language can exist without social intent, without becoming enmeshed in human culture. This enables them to learn the meanings of words, and these words form the currency that buys them further entry into the culture (Tomasello, 1999).

This distinction between language learning using social cues as *attention* and social cues as *intention* suggests a fundamentally different understanding of the role of the social context for establishing the link between words and their referents; a different understanding of the way in which social information contributes to the building blocks for language. Under a social-cues-as-attention understanding, the child is presented with clear visual information by the social environment that guides word to world mapping (Plunkett, 1997; Samuelson & Smith, 1998; Schafer & Plunkett, 1998; Smith, 1995, 1999, 2000). Under the social-cues-as-intention interpretation, the child is seen as actively interpreting the visual information so as to derive the invisible – the speaker's intent. Pointing, eye gaze, and other visible social cues serve as windows onto communicative intent, the *essential* foundation for language learning (Baldwin, 1993, 2000; Baldwin & Baird, 1999; Baldwin & Tomasello, 1998; Carpenter, Akhtar, & Tomasello, 1998; Tomasello, 1995, 1999). Within theories of word learning, this distinction, between attentional and intentional interpretations, marks the two endpoints of a continuum describing precisely how young children are *using* social information (see Figure 1). Thus, the "poles" of the continuum both include attention to social information, but the ***interpretation*** by the listener varies greatly across the continuum.

Attentional ⟷ **Intentional**

Visible cues: Pointing, eye gaze, touching, et cetera

Invisible cues: what did the speaker **mean** to do?

Examples:

Smith, 1995, 2000	Hollich, Hirsh-Pasek, & Golinkoff, 2000	Tomasello, 1997, 1999
Samuelson & Smith, 1998	L. Bloom, 1993, 2000	P. Bloom, 2000
Plunkett, 1997	Moore, Angelopolous, & Bennett, 1999	Baldwin & Tomasello, 1998
Schafer & Plunkett, 1998		Akhtar, Carpenter, & Tomasello, 1996

Figure 1: Interpretations of social information in word learning.

As with any continuum, the majority of all theories lie in the middle (Bloom & Tinker, 2001; Golinkoff, et al., 1994; Golinkoff, et al., 1999; Hirsh-Pasek, Golinkoff, Hennon, & Maguire, in press; Hirsh-Pasek, et al.; Hollich, et al., 2000; Moore, et al., 1999; Woodward, 2000). These theories do not rule out intentional social information, but they also do not require it for word learning to occur.

> … the acquisition of the novel word may occur through the child mapping the word on to the most salient object or event without the child being aware of the adult's referential intention… Young children are sensitive to the referential behavior of adults, but this sensitivity may not entail an understanding that adults intend to refer to referents. (Moore, et al., 1999, p. 60-61)

Theories falling in the middle of the continuum typically claim that while it may not be essential that children derive the speaker's intentions, that doing so could only be beneficial to the word learning process (Hollich, et al., 2000; Moore, et al., 1999; Woodward, 2000).

For example, the Emergentist Coalition Model (ECM) of word learning offers a developmental account, claiming that very young infants begin word learning by relying exclusively on attentional social information and move towards a time at which they use these attentional cues as guides to social intent (Golinkoff, et al., 1999; Hirsh-Pasek, et al., in press; Hirsh-Pasek, et al., 2000; Hollich, et al., 2000). Within the ECM, children may be capable of attending to visible social cues before they are capable of recognizing the intentions that underlie the social actions (Golinkoff, et al., 1999; Hirsh-Pasek, et al., 2000). "An ability to detect social information … is not the same as the ability to use social information in the service of word learning" (Hollich, et al., 2000, p. 20). Rather, there may exist a progression such that infants (a) respond to social information on purely attentional grounds, (b) learn to use attentional social information in the service of word learning, (c) begin to recognize social intentions in general, but cannot yet use them for word learning, then (d) learn to use communicative intentions to guide them to the correct word-to-world mapping (Golinkoff, et al., 1999; Hirsh-Pasek, et al., 2000; Hollich, et al., 2000).

Evidence for this progression comes from a series of experiments investigating infants' abilities to acquire a novel word (Hennon, et al., 2001; Hollich, et al., 2000). Ten-, 12-, 19-, and 24-month-olds were given two novel objects to explore. The objects were chosen so that one object was substantially more interesting than the other (e.g., a sparkling wand and white safety latch). After exploration, salience trials verified that the interesting object was, indeed, more salient than the boring object.[2] During training, the experimenter labeled the interesting toy for half of the children (coincidental condition) and the boring toy for the remaining children (conflict condition). That is, when naming the interesting toy, perceptual salience and social cues are in alignment – they both direct the child to the same object. In contrast, when naming the boring toy, the cues compete with one another for the child's attention (Hollich, et al., 2000).

In training, the experimenter looked at the child and then at the target object while naming it five times (e.g., "Look at the modi!"). Three types of test trials followed. In the first, the child was asked to look at the labeled object (e.g., "Where's the modi?"). Then, the child was asked for a second novel word (e.g., "Where's the glorp?"). Finally the child was asked to again find the labeled object (e.g., "Where's the modi?). If the children have learned the label as a word, then they should look longer at the labeled object on the first trial, look away from the labeled object when asked for a new word, but then recover their attention to the labeled object on the final trial. Nineteen- and 24-month-olds did precisely that, regardless of condition. In contrast, 12-month-olds were only able to learn the name for the interesting toy. When the boring object was labeled, they did not mis-map the name to the interesting object, but they also did not correctly link it with the boring one (Hollich, et al., 2000). This finding suggests that while the 12-month-olds were *sensitive* to the social information

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[2] Given the age of the youngest groups, these experiments utilized the Interactive Intermodal Preferential Looking Paradigm (IIPLP; Hollich, et al., 2000). In the IIPLP, children are shown two objects side-by-side on a flip board and asked to look at one object. A looking response minimizes the physical demands on the participants and allows researchers to accurately assess the abilities of very young infants.

provided, they could not use it to direct their word learning. While the 12-, 19-, and 24-month-olds all showed that they were at least *attending* to the social information, 10-month-olds did not. The youngest infants attached the label to the interesting object – even when the experimenter named the boring toy (Hennon, et al., 2001).

These results demonstrate a striking progression in the use of social information for word learning. The 10-month-olds relied on perceptual information and were not yet attuned to the speaker's intentions. Twelve-month-olds began to utilize social cues. However, at this point, mere eye gaze was insufficient to direct the child's attention away from the interesting toy. Only at 19 months of age did children demonstrate a willingness to rely on the guidance of the speaker. Interestingly, this was precisely the same age at which Tomasello and colleagues found children could demonstrate word learning from communicative intentions (Akhtar, et al., 1996; Akhtar & Tomasello, 1996; Baldwin, 1991, 1993, 2000; Baldwin & Tomasello, 1998; Tomasello, 1999; Tomasello & Barton, 1994; Tomasello & Farrar, 1986). The ECM argued that social acumen develops during the course of the second year at which point children not only recruit social cues for word learning, but also come to see social cues as windows onto speaker intent. The learners began word learning by mapping words onto objects based on their point of view and then shifted to attaching labels to objects from the speaker's perspective (Hollich, et al., 2000; Golinkoff, et al., 1999; Hennon, et al., 2001; Hirsh-Pasek, et al., 2000).

From a theoretical point of view, the attentional and intentional theories have made very different predictions about the nature of the learner and the mechanisms behind word learning. From a practical point of view, however, it has been virtually impossible to dissociate one explanation of learning from the other. Quite simply, pointing to an object to highlight it would have the same consequence for the learner as does pointing to it to denote intentional reference. Thus, it has been difficult to determine *what* is guiding the child's responses. In fact, the confusion has been such that almost every study can be interpreted as providing support for either attentional or intentional theories.

Perhaps the most compelling example came from Samuelson and Smith (1998; see also Smith 2000). They replicated a study by Akhtar, Carpenter, and Tomasello (1996) that had originally been interpreted as demonstrating the importance of recognizing social intentions. In the Akhtar and colleagues (1996) study, 20-month-olds played with three novel objects while their mother and two experimenters were present. While the mother and one experimenter were temporarily out of the room, the second experimenter presented the child with a fourth object. All of the objects were placed into a box before the mother and first experimenter returned. Upon their return, they looked into the box and commented, "I see a *gazzer*!" but did not indicate which object they were naming. When tested, the children consistently selected the fourth object as the "gazzer."

Akhtar and colleagues (1996) argued that this performance indicated that the children possessed substantial knowledge of others' communicative intentions. They concluded that the children must have inferred that "gazzer" referred to the object the speaker had not yet seen. Samuelson and Smith (1998) argued that the finding could also be explained as occurring through memory, attention, and novelty. The fourth object was the most novel at the time of labeling as it was the *only* object that had never before been present in the same situation (i.e., when all three adults were in the room). To test their hypothesis, they created additional situations in which the target object was the most "novel-in-context" during labeling. However, each of their situations used non-social means of increasing novelty. For example, they placed the fourth object on a glittering blue tablecloth, while the remaining objects were simply in view on a table (Samuelson & Smith, 1998). In this situation, children assumed that the "gazzer" was the object on the blue tablecloth.

This is but one example of an experiment that has been interpreted in radically different manners by these two positions. While children may be able to read *our* minds, we cannot read *theirs*. We cannot know whether the children merely attended to the pointing finger, or if they recognized that the speaker pointed as a means of conveying her intentions. Both interpretations could be supported by the existing data. Although the line between attention and intentional roles for social cues has been blurred in studies of typically developing children, it might be sharpened in studies involving children who do not to understand even basic concepts of other's intentions – for children with autistic disorder.

Autistic Disorder, Social Information, and Language

Autistic disorder is a relatively rare (affecting approximately one in 2000 individuals), neuro-developmental disorder, characterized by impairments in language, communication, imagination, and social relations (American Psychological Association, 1994; Hertzig & Shapiro, 1990; Howlin & Yule, 1990). Males are four to five times as likely to be diagnosed as autistic as are females (APA, 1994; Hertzig & Shapiro, 1990). Diagnosis requires symptoms of autism prior to age 3, although the diagnosis can be made at a later age (APA, 1994; Howlin & Yule, 1990).

Individuals with autism are typically diagnosed through three key features of the syndrome: a failure to develop normal language skills, an impairment in social interaction skills, and the use of inflexible, repetitive behaviors. An autistic child might literally spend hours watching his or her own fingers drum on a table or staring at a blank television screen. In milder forms, autistic individuals are most notable for a lack of recognition of other humans as *people*, as being in a class separate from trees, furniture, and machines (Kanner, 1943; Hobson, 1993; Klin & Volkmar, 1993; Mundy, 1995). This failure to recognize that people are unique is related to difficulties in establishing "joint attention," which occurs when a child and an adult simultaneously attending to the same object, and to each other (Baron-Cohen, 1989; Baron-Cohen, Baldwin, & Crowson, 1997; Butterworth & Grover, 1990; Klin & Volkmar, 1993; Leekham, Lopez, & Moore, 2000). Indeed, one of the first signs of autism is a failure to develop joint attention skills (APA, 1994; Baron-Cohen, 1989; Baron-Cohen, Allen, & Gillberg, 1992; Baron-Cohen, et al., 1997; Baron-Cohen, Tager-Flusberg, & Cohen, 1993; Hobson, 1993; Kanner, 1943, 1946; Kasari, Mundy, & Sigman, 1990; Klin & Volkmar, 1993; Leekham, et al., 2000; Lewy & Dawson, 1992; Long, 1994; Loveland & Landry, 1986; Tager-Flusberg, 1986, 1997, 1999, 2001). Even older children with autism never overcome this impairment (Brown & Prelock, 1995; Brown, Hobson, Lee, & Stevenson, 1997; Loveland & Landry, 1986; Mundy, Sigman, & Kasari, 1994; Mundy, Sigman, Ungerer, & Sherman, 1986; Rutter & Schopler, 1987; Simmons & Tymchuk, 1973).

Individuals with autism are not simply normally developing people who possess no social skills. The impairments in social interaction may be primary (Baron-Cohen, 1989, 1993, 1995; Baron-Cohen, et al., 1997; Griffin, 2002; Landry & Loveland, 1988; Leekham, Baron-Cohen, Perrett, Milders, & Brown, 1997; Leekam, et al., 2000; Mundy, 1995; Sigman & Ruskin, 1999; Tager-Flusberg, 1999, 2001), but still be linked to many of the other impairments. For example, a majority of individuals with autism score in the mentally retarded range on standardized intelligence tests, indicating an impairment in general cognitive abilities as well (Leekham, et al., 2000; Long, 1994; Prizant, Wetherby, & Roberts, 2000; Sigman & Ruskin, 1999). Rather than having a specific impairment in one component of language, autism seems to be a disturbance in the social influences that affect *all* components of language.

Children with autistic disorder are often described as fully asocial. Their behavior toward other people is often indistinguishable from their actions toward animals and even furniture (Kanner, 1943; for a review, see Baron-Cohen, et al., 1993). Thus, these children were not expected to even attend to attentional social information. That is, children with autistic disorder were thought to fall completely off the continuum for understanding social information. Recent evidence, however, suggests that the earlier conception of these children might have been incorrect. Children with autistic disorder are capable of following a pointing gesture, or looking at an object that the speaker is handling (Klin & Volkmar, 1993; Leekham, Hunnisett, & Moore, 1998; Leekham, et al., 2000; Meltzoff, 2000), but might be incapable of going beyond that surface information to determine the "hidden" intentions of the speaker (Baron-Cohen, 1993, 1995; Baron-Cohen, et al., 1997; Baron-Cohen, et al., 1993; P. Bloom, 2000; Gopnik & Meltzoff, 1994; Klin & Volkmar, 1993; Loveland, 1993; Phillips, Baron-Cohen, & Rutter, 1992; Tomasello, 1999).

Evidence from older children with autistic disorder suggests that eye gaze may be insufficient to direct their attention (Baron-Cohen, et al., 1997). Eight- to 13-year-olds with autistic disorder were required to learn a name for a novel object. In one condition, the speaker looked at the object of the *child's* attention and proceeded to name that object (listener's direction of gaze, LDG). In a second condition, the speaker looked at and named the other object (speaker's direction of gaze, SDG). Language-matched and mental age-matched control children readily formed the correct word-to-world mapping (79% and 71% accuracy rates, respectively, for the SDG condition). However, children with autistic disorder were correct only 29% of the time in the SDG condition. This suggests that while children with autistic disorder may be capable of attending to some forms of attentional social information, they cannot rely on eye gaze alone (Baron-Cohen, et al., 1997).

Children with autistic disorder are capable of noticing visual social information, and even of responding to simple cues (such as following a point, or looking to an object that another person is handling). This suggests that investigations of word learning in children with autism might provide the perfect natural experiment for looking at the role of attentional versus intentional social information in word learning. Thus, if **attentional** social cues are sufficient for word learning, then children with autistic disorder should demonstrate reasonably intact word learning abilities. In contrast, if **intentional** social information is necessary for all but the most basic, initial words, then children with autistic disorder should be capable of mastering the word learning skills of a 12-month-old, but fail to meet the advances made by an 18-month-old.

Children with autistic disorder do acquire some words (Baron-Cohen, 1995; Hobson, 1993; Leekham, et al., 2000; Klin & Volkmar, 1993). However their language development and vocabulary growth is extremely slow, and often even therapy has difficulty in establishing a substantial vocabulary (Owens, 1982, 1992). The thesis developed in this paper is that the reason language development is depressed in children with autistic disorder is that early language development is dominated by attention to social cues. Thus, autistic children can build a minimal vocabulary in the same manner as a typically developing 12-month-old might. Yet the inability of children with autistic disorder to demonstrate the vocabulary growth that is typical of normal development (often even while undergoing intensive language therapy) would indicate that advanced language skills might become increasingly dependent on an understanding of other's intentions.

In the case of autism, the continuum may be bifurcated. Thus, children with autistic disorder may rely only on the visible social information when learning words.

Intentional social information may not be available to them. Stating that attentional social cues are detectable, however, is not enough to establish the role of these cues in word learning. It is not sufficient to claim that children with autistic disorder can <u>see</u> a point; research must also demonstrate that they can <u>see</u> the point, <u>find</u> the target, <u>hear</u> a word, and <u>yoke</u> all of this together to form a word to world mapping. Children with autistic disorder might notice the visual correlates of intentional actions. Yet they may **not** be capable of using that information to guide word learning.

Four Experiments to Test Attentional and Intentional Word Learning Strategies

In this study, word learning in an autistic population is used as one means to hone in on the role of social cues and communicative intentions in early language development. The abilities of these children to recognize and respond appropriately to social actions and intentions in non-word learning tasks will be assessed along with parallel skills to notice, respond to, and utilize these forms of social information in a word learning situation (see Figure 2). Typically developing children, matched to the children with autistic disorder based on either mental abilities or language skills, will allow for an assessment of possible developmental influences on the importance of social cues versus social intentions.

The most basic of the tasks assessed the children's ability to notice and respond to visible social actions in isolation (Experiment 1). For example, the participants were required to follow a pointing finger to find the indicated object. Based on previous research (e.g., Butterworth & Grover, 1990; Charman, 2000; Leekham, et al., 1998;

Is word learning involved?

	No	Yes
Attentional cues required	Experiment 1: follow points, touches	Experiment 2: learn a word from points, touches
Attentional & intentional cues required	Experiment 3: use failed action to discern intended action	Experiment 4: learn word from failed search

Figure 2: Summary of the four experiments.

Leekham, et al., 2000; Meltzoff, 2000), all of the children – both typically developing and autistic – were expected to succeed on this task. This ability to notice attentional social information was then tested in a word learning situation (Experiment 2). Experiment 2 allowed for a test of whether the children were capable of using basic social information to guide the word learning process, that is, if attentional social cues can lead to word learning in an autistic population. Given Baron-Cohen and colleagues (1997) finding that 8- to 13-year-olds with autistic disorder could *not* use eye gaze alone to determine the meaning of a new word, it was assumed that 3- to 7-year-olds would likewise fail. By providing the children with additional forms of social information, it was possible to test if the failure documented by Baron-Cohen and colleagues (1997) was due to a specific difficulty in following the speaker's eye gaze. If they can use alternate types of social information to guide word learning, then they should succeed.

Experiment 3 assessed children's abilities to comprehend the intentions that underlie social actions. This task did not require the children to learn a word, but rather assessed their basic skills at inferring another's intentions. Experiment 3 was based on Meltzoff's (1995) failed imitation task that required that children perform the intended action, rather than imitate the demonstrated action. Children with autistic disorder were not expected to be able to deduce the experimenter's intentions. Based on Meltzoff's (1995) findings, all of the typically developing children should be able to pass this task. Experiment 4 examined whether the children could use social intentions to determine the meaning of a novel label. This task was derived from the series of studies that Tomasello and colleagues designed to measure social intentions and word learning (Baldwin & Tomasello, 1998; Tomasello, 1999; Tomasello & Barton, 1994). Failure on Experiment 3 coupled with success on Experiment 4 would suggest that this task does *not* require the use of social intentions, but rather can be solved by relying exclusively on attentional social cues (as argued by Samuelson & Smith, 1998). If this task *does* require the inference of intentions in a word learning situation, then both the autistic children and the youngest typically developing children should not succeed on this task.

In summary, typically developing children who were matched on nonverbal mental age to the children with autistic disorder were expected to pass all four tasks. Those matched based on language abilities were anticipated to demonstrate a developmental progression, with the youngest children able to succeed on the first three tasks, but unable to use social intentions to learn a novel word and with the oldest children able to succeed on all tasks. Children with autistic disorder were predicted to succeed on Experiment 1. Their performance on Experiment 2 was unclear. If the problems identified by Baron-Cohen and colleagues (1997) were specific to the use of the speaker's eye gaze, then children should succeed when addition types of social information are provided. If, however, children with autism have a general problem in using social information to guide word learning, then they should be unable to pass Experiment 2. Due to the reliance on social intentions, children with autistic disorder were expected to fail at Experiments 3 and 4.

CHAPTER 2: FOUR EXPERIMENTS

General Method for All Experiments

Participants

Participants in this study included 38 children with autistic disorder (AD group) and 40 control children with no known developmental problems. For the AD group, 21 children were discarded due to a failure to meet diagnostic criteria (n=14) or a failure to complete all of the tasks (n=7). Children were originally selected based on parental report of a diagnosis of autistic disorder. During the first session, a release of confidential information form was signed, and a copy of the clinician's diagnostic report was then obtained. A review of the diagnostic report documented that each child met DSM-IV (Diagnostic and Statistical Manual, 4th edition; APA, 1994) criteria for autistic disorder. Only children who had previously been diagnosed with autistic disorder and who had documented evidence that they met DSM-IV criteria were included in the sample. The high discard rate for a failure to meet criteria was due to a large number of children diagnosed with pervasive developmental disorder – not otherwise specified (PDD-NOS). Thus, the final AD group consisted of 17 children, 12 males and 5 females.

The AD group had a mean age of 5.08 years. They had been in therapy for an average of 30 months and spent an average of 30.17 hours per week in therapy.[3] The

[3] The children were primarily in applied behavior analysis (ABA) or discrete trial training forms of therapy, although most of the children were also involved in occupational

AD group included a range of functioning levels, as is noticeable in the range of scores on the standardized measures. The mean PPVT raw score for the group was 23.12, which equates to an average age-equivalency level of 21 months.[4] Their mean DAS nonverbal standard score was 76.06, with an average age-equivalency level of 3.99 years.

For purposes of matching the control groups, each child with autistic disorder completed the Differential Abilities Scales (DAS; Elliott, 1990) and the Peabody Picture Vocabulary Test-3rd edition (PPVT; Dunn & Dunn, 1997). The DAS provided a battery of tests to assess verbal and nonverbal cognitive skills (e.g., following directions, recognizing "same as" associations, constructing patterns from pictures; see materials section). The PPVT, an extensively used test of vocabulary skills, asked children to point to a requested picture (e.g., "Where's the cow?" see materials section). Each control child was matched individually to an AD child on gender and either DAS (nonverbal cluster) or PPVT scores. From the original 40 children, 6 control children were discarded due to fussiness (n=2), not matching any child from the AD group (n=3), and the presence of a developmental disability (n=1). The remaining 34 control children were divided into two groups of 17 children each: one matched to the AD group on vocabulary level (LA group) and one matched on nonverbal mental ability

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therapy, speech therapy, sensory integration therapy, and socialization therapy (information from parental report and clinician's notes).

[4] The PPVT does not specify ages for raw scores lower than 23; rather it lists those scores as being equivalent to "less than 1 year, 9 months." However, as raw scores, and not age equivalencies, were used for matching purposes, children whose raw score was less than 23 were included in the sample, resulting in an unfortunately vague estimate for this range.

(MA group). Each group included 12 males and 5 females. All of the children (AD, LA, and MA groups) came from middle- or upper-class homes in the greater Philadelphia area and were recruited either through a newspaper article describing the research or through a letter mailed to the parent(s).[5]

Both control groups were significantly younger than the AD group. The LA group had a mean age of 2.57 years. Their mean PPVT score was 24.06, or an average performance level of a 22-month-old. Their PPVT scores did not differ from that of the AD group ($p = .990$). As seven members of the LA group were less than 30 months of age (the minimum age for the DAS), these seven children were tested on the lower preschool core subtests.[6] Ten children in the LA group were 30 months or older (and were tested on either the lower or the upper preschool core, depending on age), and the ten had an average DAS nonverbal standard score of 113.10.[7] The overall LA group had an average nonverbal mental age of 3.26 years, which while somewhat lower did not significantly differ from the AD group ($p > .30$).

The MA group had a mean age of 3.12 years. Their mean PPVT score was 45.35, or an average performance level of a 43-month-old. Their PPVT scores differed from that of the AD group ($p = .001$). For the two children who were less than 30 months of age, the same procedures were followed as in the LA group. Fifteen children

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[5] All parents for all children had at least a Bachelor's degree (based on parental report).

[6] This was done for two reasons. First, it seemed most logical to test them on the tests designed for the youngest children. Second, it was desired to maintain the greatest degree of consistency in the types and amounts of tasks given to all participants.

in the MA group were 30 months or older (and were tested on either the lower or the upper preschool core, depending on age), and they had an average DAS nonverbal standard score of 116.07. The overall MA group had an average nonverbal mental age of 4.02 years, which did not differ from the AD group ($p > .99$) (see Table 1 for means and ranges for all groups).

Materials

Differential Abilities Scale (DAS). The DAS is a battery of cognitive and achievement tests that assess the verbal and nonverbal abilities of children from 2 years 6 months to 17 years 11 months of age. The test is designed to measure a variety of mental abilities and to provide a comprehensive assessment of the individual's strengths and weaknesses (Elliott, 1990). The portions of the DAS used in the present study were the lower and upper preschool core subtests. The lower preschool core is intended for children between 30 and 42 months of age and includes the block building, verbal comprehension, picture similarities, and naming vocabulary subtests. The upper preschool core is for children between 42 months and 6 years of age. It includes the verbal comprehension, picture similarities, naming vocabulary, pattern construction, early number concepts, and copying subtests (see Appendix A for a description of each subtest). Internal and external validity and reliability have been well established for the overall DAS as well as for both the lower and upper preschool cores (Elliott, 1990).

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[7] It was impossible to calculate a standard score for the 7 youngest children. However their scores *were* included in estimates of age-equivalency levels (which are based on raw scores and not standard scores) and in the group comparisons with the AD group.

Peabody Picture Vocabulary Test-3rd edition (PPVT). The PPVT assesses receptive vocabulary across all levels of language development. The test probes a wide variety of names for objects, actions, and events (see Appendix B for a list of sample probes). Internal and external validity and reliability have been firmly established. This test has been normed for use with the age groups studied (Dunn & Dunn, 1997).

Familiar and novel objects. Across the four tasks, there were a variety of familiar and novel objects. Familiar objects (for example, a children's picture book, a toy telephone, and a plastic cup) were chosen based on words known to exist in a large proportion of very young children's vocabularies (Fenson, Dale, Reznick, Bates, Thal, & Pethick, 1994). Examples of novel objects included kitchen utensils (e.g., a safety latch used to hold cupboard doors closed), office devices (e.g., flat staple remover), or lab-created objects (e.g., carved wooden shapes). The objects' names were not among typical vocabulary items for children of this age (Fenson, et al., 1994). Parental report suggested that even the oldest children would not have a name (either expressive or receptive) for the objects. Further evidence of the objects novelty came from the children themselves, who frequently asked, "what's this" when provided with the objects. Novel objects also were required to be safe for the youngest children to play with and distinct one from another.

Recording equipment. All sessions were recorded on a digital camcorder. The camcorder was placed slightly behind and to the side of the experimenter. The camera

Table 1: Demographic information by group

	AD group Mean (SD)	LA group Mean (SD)	MA group Mean (SD)
Chronological age in years	5.07 (1.25)	2.57 (0.90)	3.12 (0.81)
Time in therapy			
Duration in months	30.1 (15.1)	0 (0)	0 (0)
Hours per week	30.2 (10.9)	0 (0)	0 (0)
PPVT scores			
Raw score	23.12 (20.57)	24.06 (21.32)	45.35 (16.77)
Standard score	62.82 (21.94)	92.82 (20.07)	107.13 (7.07)
Age equivalent	21 months	22 months	43 months
DAS scores for the nonverbal cluster			
Standard score [a]	76.06 (22.89)	113.10 (11.70) [b]	116.07 (16.59) [c]
Nonverbal mental age	3.99 (1.33)	3.11 (1.38)	4.02 (1.29)

[a] For the lower preschool core, this was based on scores on the block building and picture similarities subtests. For the upper preschool core, the nonverbal cluster included the picture similarities, pattern construction, and copying subtests (Elliott, 1990).

[b] Seven children were too young (i.e., less than 30-months-old) to calculate standard scores. Means and SD are based on the remaining 10 children.

[c] Two children were too young for standard scores; means and SD reflect the performance of the remaining 15 children.

was focused so that the child's head, arms, and torso, as well as the table, were visible on the film.

Design and Procedure

Families were recruited for the study through two means: a brief article in the Sunday edition of the local newspaper and a letter mailed to the parent(s). Letters were mailed to parents of typically developing children who had previously participated in research on cognitive development at the Temple University Infant Labs. Parents were selected to receive the letters based on the chronological age of their children. The children's age was used as an estimate for their vocabulary level and nonverbal mental ability; only children whose age indicated a likelihood of matching a child in the AD group were selected to receive a letter. Both the article and the letter provided details concerning the goals of the research, the requirements for participation, and a phone number to call if the family was interested in participating. Any interested families were invited to participate with the following restrictions: for the AD group, the child must have been between three and seven years of age and have been diagnosed with autistic disorder;[8] for the control groups the child must have no known developmental problems.

Children were tested at three locations. All of the control children (40 children) and a majority of the AD group (26 children) came to the Temple University Infant

[8] At the time of scheduling, parental report of diagnosis was accepted however the parents were informed that the diagnosis would be verified through contact with the child's doctor.

Labs at the Ambler campus. Two additional groups of children with autistic disorder arranged for testing at alternative locations. One group (4 children) was tested at the Timothy School – a school exclusively for children with autistic disorder located in Berwyn, PA. All four children were currently enrolled at the Timothy School. A second group (8 children) was tested in Reading, PA. In both cases, this change was done to accommodate the needs of the families.

Testing was spaced across two sessions (mean time between sessions for all groups was 18.38 days). On each occasion, upon entering the laboratory space, the children first played in a toy room, while all relevant procedures were explained to the parent, all questions that the parent had were answered, and informed consent was obtained. This playtime also served as an introduction time for the child and experimenter, giving the child a chance to become more comfortable around this new person. For the older children, the experimenter also briefly explained the tasks to them, and informed them that they could stop the game at any point. Then, if both the caregiver and the child agreed to participate, the caregiver, experimenter, and child moved to the testing room. In the testing room, the child sat either alone or on the caregiver's lap.

For the first testing session, the procedure began with the experimenter administering either the PPVT or the DAS (with the remaining test to be administered at the beginning of the second day of testing). All assessments were conducted according to the examiner's manuals. There was substantial variability in how long each test required. The PPVT was typically the quicker test to administer, taking between 15 and

30 minutes. The DAS required between 20 and 50 minutes. The variability in duration was due primarily to two factors: the ability level and the attention span of the child. Children with larger vocabularies (in the case of the PPVT) or with higher cognitive functioning levels (for the DAS) successfully passed a greater number of questions, thereby requiring a larger number of sets to be administered. Also, while some children were content to answer successive questions without a break, other children had difficulty remaining "on-task." For children who were more distracted, a greater amount of time was spent re-focusing them on the task.

After completing these tasks, the experimenter provided the child with an "intermission object." This intermission object (for example, a teddy bear) was not a part of the study, but rather was provided to entertain the child before and between tasks. While the child and caregiver played with the object, the experimenter prepared for Experiment 1 by arranging the required objects and starting the video recording of the session. Immediately before beginning Experiment 1, the experimenter asked the child for the intermission object.

The first testing session included, in order, Experiments 1, 2, and 4 (see below for detailed descriptions of each task). For Experiments 2 and 4, only half of the task was administered on the first day (with the remainder given during session two). That is, for Experiment 2, the children were tested on two pairs each of familiar and boring objects (see below). Similarly, for Experiment 4, the children were tested on one set of objects. The experiments were split to equate the number of new words that the child was required to learn during either testing session (three new words per session).

Moreover, as the children would be more familiar with the experimenter and the testing environment during session two, splitting the tasks enabled the children to have a second chance on both tasks. At the end of Experiment 4, the child was warmly congratulated on his/her participation. Any remaining questions were answered, and the child was given a small toy as a reward for participation. Prior to leaving, the caregiver was reminded of the date for the next testing session.

The second testing session started much like the first. The child and caregiver entered the playroom, the child was encouraged to play with the toys, and any relevant procedures were explained to them. Any questions the caregiver or child may have were answered, and informed consent was again obtained (from both the caregiver and the child if necessary). After moving to the testing room, the experimenter administered either the DAS or the PPVT, depending on which was completed during the first testing session. Experiments 2, 3, and 4 (in order) comprised the second day of testing. Again, for Experiments 2 and 4, this was only half of the full experiment; the first half of each experiment had been conducted during session one. At the completion of Experiment 4, the child was again warmly congratulated on his/her performance. Any final questions were answered, and the child was given a second small toy as a token of appreciation.

Experiment 1: Social Attention Without Word Learning

Although the focus of this paper has been on the role of social information in word learning, when considering children with autistic disorder, it is necessary to take a step back – to first test if autistic children are capable of using social information at all. Historically, psychologists have argued that children with autism disregard social information; that they do not even notice, let alone respond to, the actions of others (Hobson, 1993; Kanner, 1943, 1946; Landry & Loveland, 1988; Leekham, et al., 1997; Loveland & Landry, 1986; Mundy, 1995; Mundy, et al., 1986). This impairment is most marked in their failure to achieve joint attention (Baron-Cohen, 1989; Baron-Cohen, et al., 1992; Baron-Cohen, et al., 1997; Butterworth & Grover, 1990; Hobson, 1993; Kasari, et al., 1990; Klin & Volkmar, 1993; Leekham, et al., 2000; Lewy & Dawson, 1992; Loveland & Landry, 1986; Tager-Flusberg, 1999, 2001). Even older children with autism never overcome this impairment (Baron-Cohen, et al., 1997; Brown & Prelock, 1995; Brown, et al., 1997; Loveland & Landry, 1986; Mundy, et al., 1994; Mundy, et al., 1986; Rutter & Schopler, 1987; Simmons & Tymchuk, 1973).

Recent evidence, however, suggests that individuals with autism may possess some rudimentary social skills (Aldridge, Stone, Sweeney, & Bower, 2000; Carpenter, Pennington, & Rogers, 2001; Charman, Baron-Cohen, Swettenham, Cox, Baird, & Drew, 1998; Leekham, et al., 1998; Leekham, et al., 2000; but see Dawson, Meltzoff, Osterling, Rinaldi, & Brown, 1998). Leekham and colleagues (1998) tested if school-aged children with autism (5- to 13-year-olds) were capable of following head turns and eye gaze to locate an object. The children were seated across a small table from the experimenter. Two identical black boxes, each containing a hidden Thomas the Tank Engine toy train, were positioned at equal distances to the left and right of the experimenter. After making eye contact with the children, the experimenter turned her head and looked at one of the two boxes. During training, the toy train would then be revealed. During testing, however, the train was only revealed if the child looked to the correct object (a hidden observer controlled the display). Although there were clear differences between the children with autism and controls, Leekham and colleagues found that more than 50% of the children with autism would spontaneously follow the experimenter's eye gaze and head turn. Interestingly, when the analyses were restricted to children whose mental age was above 48 months, all of the children with autism demonstrated spontaneous gaze following (Leekham, et al., 1998; see also Leekham, Reddy, Lopez, & Stan, 1999).

Nonetheless, not all recent evidence indicates that children with autistic disorder can respond appropriately to social information. Evidence suggests that eye gaze alone may be insufficient to direct the attention of children with autistic disorder (Baron-Cohen, et al., 1997). Eight- to 13-year-olds with autistic disorder were able to learn a name for a novel object *only* if it was the focus of the child's attention (listener's direction of gaze, LDG). When, the speaker looked at and named a different object (speaker's direction of gaze, SDG), the children failed to correctly pair the name with the target object. Children with autistic disorder were correct only 29% of the time in the SDG condition. Thus, while children with autistic disorder may be capable of attending to some types of social information, they cannot rely on eye gaze alone (Baron-Cohen, et al., 1997).

One interesting distinction between these two studies is that while Baron-Cohen and colleagues (1997) required that the children learn a new word, Leekham and colleagues (1998) did not. Thus, two possible interpretations exist. Perhaps children with autism are only capable of responding appropriately to some forms of social information. They may not be able to accurately follow eye gaze, but instead may require a clearer indication of where to look. Under this view, their performance in the Leekham and colleagues (1998) study might have relied more on the head-turn than on the eye gaze. Alternatively, children with autism may be capable of noticing and responding to even subtle forms of social information, such as eye gaze, but may *not* be able to use them to guide word learning. That is, the failure of the children with autism in the Baron-Cohen and colleagues (1997) task may not have been on recognizing the social information, but rather on being able to yoke that information with the novel label to determine which object was being named.

Although the goal of the dissertation may be to determine how well children with autistic disorder can use these types of social information to guide word learning, it was first necessary to ensure that they were capable of responding to them at all. Given the Leekham and Baron-Cohen findings, it was decided that mere eye gaze may be insufficient. As such, in the current experiment, pointing and touching were paired with eye gaze to direct the child’s attention. It was hypothesized that, in the absence of a novel word, children with autistic disorder (and all control children) would be capable of correctly responding to these forms of social information.

Method

Participants. The children described in the general overview of all experiments were the participants for Experiment 1 (see above).

Procedure. At the beginning of Experiment 1, the experimenter placed four objects (wooden blocks, an ice cream scoop, a toy dinosaur, and a stuffed animal) on a tray. The tray was held on the experimenter's lap, at the level of the table, and slightly angled so that the child could easily view the contents of the tray. The tray was out of reach of the child. After gaining the child's attention, the experimenter attempted to direct him/her to a target object through pointing at or touching an object. This was accompanied either by minimal language ("ooh," "aah," or "wow") or with a sentence ("this is neat," or "look at that"). All four possible combinations (pointing with a sentence, pointing with minimal language, touching with a sentence, and touching with minimal language) were used with each child. On all four occasions, the experimenter held the pose (for example, looking at and touching the blocks) for five seconds before handing the target object to the child. Later coding analyzed the child's looking behavior during these five seconds (see below). The child was then permitted to play with the toy for approximately 30 seconds. The total amount of time required for Experiment 1 ranged from 3 to 8 minutes. Counterbalancing controlled for the position of the target object on the tray, which object was indicated by each combination, the order of the objects and the order of the combinations.

Coding. The child's looking responses were coded from the videotapes. Measures of interest included *where* the child first looked (at the target, the experimenter, another object, or somewhere else in the room) and for how *long* the child looked at each during the full five seconds. Twenty-five percent of the tapes were re-coded for intra-judge reliability (mean r = .99; range from .96 to .99). An additional ten percent of the tapes were re-coded by a blind coder for inter-judge reliabilities (mean r = .98, range from .95 to .99).

Results

Data on two children from the AD group were excluded on this task (one for taping difficulties and one for low attention). Two dependent measures were of interest – the average amount of time spent looking at the target object and the total number of correct first looks (i.e., looking at the target object). Preliminary analyses found no effects of gender ($p > .45$) or of how the target was indicated (pointing vs. touching and sentences vs. minimal language; all p's > .65). Data was collapsed across these variables for all remaining analyses.

A Multivariate Analysis of Variance (MANOVA) found group differences in the average amount of time spent looking at the target object, $F(2, 46) = 12.31$, $p < .000$ and in the total number of correct first looks, $F (2, 46) = 8.83$, $p < .001$ (see Table 2). Post-hoc Scheffe tests found the same pattern of results for both measures. For the time looking at the target, the AD group differed from both the LA group ($p < .005$) and the MA group ($p < .001$), but the control groups did not differ from each other ($p > .85$). Both control groups looked longer at the target object (LA mean = 4.10 seconds; MA = 4.42 sec) than did the AD group (2.95 sec; see Figure 3). Similarly, on number of

Table 2: Social attention without word learning: Children's looking responses on Experiment 1

	AD group Mean (SD)	LA group Mean (SD)	MA group Mean (SD)
Total correct first looks (out of 4)	3.07 (1.03)	3.82 (0.39)	3.94 (0.24)
Time looking at (out of 5 sec):			
Indicated object	2.95 (1.29)	4.10 (0.71)	4.42 (0.48)
Experimenter	0.34 (0.38)	0.34 (0.41)	0.27 (0.34)
Other object on tray	0.50 (0.62)	0.27 (0.41)	0.11 (0.22)
Not attending to task	1.21 (0.90)	0.29 (0.32)	0.20 (0.16)

correct first looks the AD group differed from the LA group ($p < .005$) and the MA group ($p < .001$), but the LA and MA groups did not differ ($p > .99$). Again, this was due to the controls (LA mean = 3.82 times out of 4; MA =3.94 times) out-performing the AD group (3.07 times). However tests of proportions did verify that the AD group looked significantly longer at the target ($t(14) = 5.11$, $p < .000$) and more frequently at

the correct object first ($t(14) = 7.75$, $p < .000$) than would be predicted by chance. Thus, although group differences existed, all groups succeeded in locating and attending to the target object.

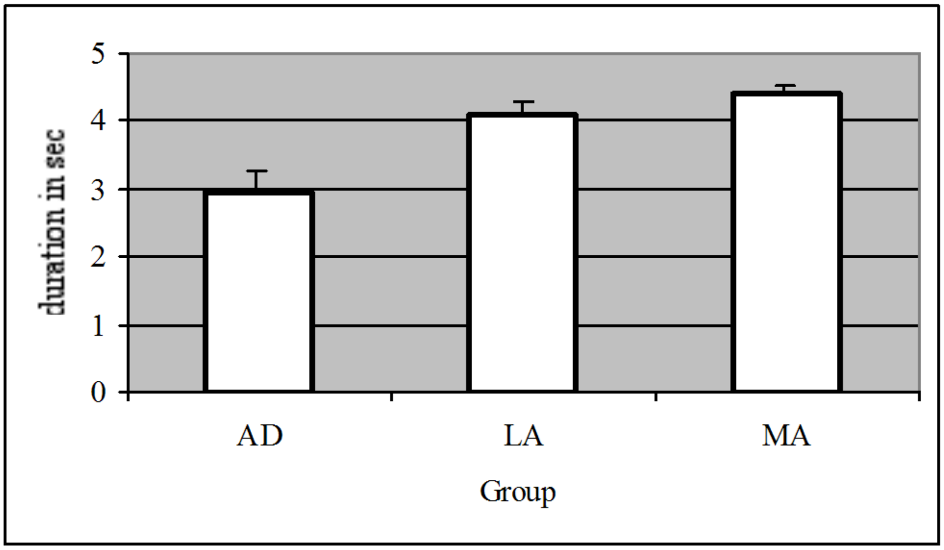

Figure 3: <u>Social attention without word learning.</u> Mean duration of first looks to the target object by group.

Discussion

Overall, all children were capable of responding appropriately to the available social information. Group differences existed: control children looked more directly to the correct object (greater number of correct first looks) and for a longer period of time (longer overall amount of time spent looking at the correct object than did children with autistic disorder. But the AD group performed substantially above chance levels. While they may be slightly different from their typically developing peers, they are still capable of using social information to direct their attention to relevant objects.

This fact alone is important for our understanding of children with autistic disorder. To know that they are not immune to the social environment, that they will respond to the actions of others, is critical to our understanding of the nature of the social impairment in autism (see also Carpenter, et al., 2001; Charman, et al., 1998; Griffin, 2002). But it also raises the question of why the children in the Baron-Cohen and colleagues (1997) study failed to learn a word that was in the *speaker's* focus of attention. Children with autism have a basic ability to respond to some forms of social information, but they may be incapable of using that information to aid them in determining the meaning of a new word. Or, alternatively, the problem may lie in the types of social information provided. Are children with autistic disorder capable of using any forms of social information to guide their word learning? This question was the focus of Experiment 2.

Experiment 2: Social Attention With Word Learning

Baron-Cohen and colleagues (1997) found that school-aged children with autistic disorder could not follow the speaker's eye gaze to determine what object was being labeled. However, it is unclear whether this failure was due to an inability to use any social information to guide word learning, or if children with autism are specifically impaired in their ability to recognize and respond to the eye gaze of others. Substantial research describes their inability to engage in joint attention, a skill that also requires the children to respond to the eye gaze of another (Baron-Cohen, 1989, 1995; Baron-Cohen, et al., 1993; P. Bloom, 2000; Gopnik & Meltzoff, 1994; Klin & Volkmar, 1993; Loveland, 1993; Phillips, et al., 1992; Tomasello, 1999; for a review see Carpenter & Tomasello, 2000).

Research with typically developing children supports the idea that eye gaze alone may be a difficult basis for word learning. As described in Chapter 1, Hollich and colleagues (2000) found that it was not until 19 months of age that children could reliably use the speaker's eye gaze to learn the name for a boring object. 12-month-olds were capable of learning the name for the object of their interest, but they failed to follow the speaker's eye gaze to locate and name the boring object. An interesting parallel exists between the Hollich and colleagues (2000) and the Baron-Cohen and colleagues (1997) findings. Both typically developing 12-month-olds and 8- to 13-year-olds with autistic disorder were able to use the speaker's eye gaze to learn the label for an object that the child found to be interesting. Moreover, both groups of children were incapable of using the same information to learn the name for an object that the child did *not* consider to be as interesting.

Perhaps the solution is the same for both groups: eye gaze alone is not enough. This failure to utilize eye gaze could be related to either *attentional* or *intentional* analyses of the social information. Eye gaze could be too subtle a cue to allow a child access to the speaker's mind – to provide the means of interpreting the speaker's communicative intentions. Or, eye gaze might not be visible enough to heighten the salience of an object, and to therefore make it perceptually interesting.

In the current experiment, the children from Experiment 1 were presented with an interesting and a boring object (consistent with both Baron-Cohen, et al., 1997 and Hollich, et al., 2000). Based on the finding that 8- to 13-year-olds with autistic disorder could not use eye gaze in isolation to learn a novel label, it was assumed that younger children with autism would also be incapable of doing so (Baron-Cohen, et al., 1997). Therefore, while the speaker still began by making eye contact with the child and then looking at the target object, for Experiment 2, she supplemented the eye gaze by either pointing at or touching the object.

These were the same forms of social information that the children had successfully responded to in Experiment 1. Pointing and touching were able to direct the child's attention to an object in the absence of a new word. Therefore, if word learning can occur through purely attentional means, then these cues should be sufficient to enable word learning. If the difficulty in the Baron-Cohen and colleagues (1997) study was in the exclusive use of eye gaze as a cue, then the children diagnosed with autistic disorder should be able to learn a word when provided with additional types of social information. However, if the problem was specific to word learning, that children with autistic disorder cannot use social information to guide word learning, then the children with autism increasing the available types of social information should have no impact on the children's performance and they should fail to learn the words.

Method

Participants. The children described in the general overview of all experiments were the participants for Experiment 2 (see above).

Procedure. Experiment 2 was a modified replication of Hollich and colleagues (2000) third experiment. For the current experiment, a change was made in the response required of the participant. In the original study, the child was asked to merely look at the requested object (while it was displayed on a flip board; see Hollich, et al., 2000). This was necessary due to the limited abilities of young infants. However, the current study tested substantially older children. Thus, rather than asking the children to *look* at the target, they were asked to *pick up* the object. A second change was made to the training phase of the experiment. Based on Baron-Cohen and colleagues' (1997) finding that older children with autistic disorder could not use eye gaze to determine the meaning of a novel word, it was assumed that younger children would also fail on such as task. Therefore, during training, while the experimenter *looked* at the target object, she also pointed to or touched the object.

As a result of using either pointing or touching during the training phase, the current experiment had four possible training conditions: pointing to label the interesting object, pointing to label the boring object, touching to label the interesting object, and touching to label the boring object. In contrast, but using only eye gaze, the original study had only two conditions (labeling the interesting or the boring; see Hollich, et al., 2000). Due to the small sample size available for the current experiment, it was decided to use a within-subjects design and to have each child experience each of the four training conditions. Two further modifications to the original design followed from this decision. First, the total number of objects was doubled, from two pairs of novel objects to four pairs (and from two pairs of familiar objects to four pairs). Second, the experiment was split in half, with each child being tested with two pairs of familiar and novel objects on each day of testing. The decision to divide the task across the two sessions was made in an effort to avoid over-whelming the children. Thus, rather than having to learn four words sequentially in a single task, the children were only required to learn two words (in Experiment 2) on each day. On each day, the total duration of Experiment 2 ranged from 8 to 15 minutes.

Experiment 2 can be split into two major phases, each with at least two sub-phases. Phase I can be called the Familiar phase. During this phase, the experimenter gave the child, sequentially, two familiar toys (for example, a picture book and a rubber duck). The child was allowed to play with each for 30 seconds (exploration sub-phase). After the child explored each toy, the two toys were placed on a tray, the tray was presented to the child, and the child was asked to choose one (e.g., "Pick up the book;" test sub-phase).

Phase II, the Novel phase, followed. Again, the child was given two objects to explore for 30 seconds each, but this time the objects were unfamiliar. For example, the children might be given a small white piece of solid plastic (a safety latch that is used to keep cupboard doors closed) and a wand filled with liquid and sparkling stars and moons that move through the liquid as the wand is moved. The objects were chosen such that one was more perceptually salient than the other. After playing with the objects, the two were placed on a tray, and the child was asked to pick the one they "like better," thereby testing for any preferences that the child may have (salience sub-phase). The object chosen during the salience sub-phase was considered the "interesting" object for the remainder of the novel phase.

The tray was placed on the experimenter's lap – out of reach, but in sight of the child. One object was labeled with a nonce word ("Pick up the modi;" labeling sub-phase). During labeling, the experimenter gained the child's attention, looked at the target object and either pointed to or touched the target object while naming it a total of five times. There were two main conditions: in the coincidental condition, the expreimenter named the interesting object, while in the conflict condition, she named the boring object. Within these two main conditions, though, there were two subconditions; either the object was named by pointing at it or by touching it. Every child experienced all four possible combinations (e.g., pointing at the interesting object; pointing at the boring object; touching the interesting object; touching the boring object). After labeling, the two objects were briefly removed from the tray and held behind the experimenter's back for 5 seconds.[9] Then, the objects were returned to the tray, and the child was asked to find the "modi" (test sub-phase). The child was then asked to find a different nonce word (e.g., "Pick up the glorp;" glorp sub-phase) to assess if he realized that only one word should refer to the object (see Hollich, et al., 2000). Finally, the child was again asked to find the "modi" to ensure that his responses were still influenced by the labeling phase (e.g., "Pick up the modi;" recovery sub-phase).

As described by Hollich and colleagues (2000), the logic of the test trials is as follows. Particularly for the coincidental conditions, if the child selected the correct toy on the test trial, it was unclear if the child had truly learned the label as a word. They may simply have been choosing the object that they preferred to look at or retrieve.

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[9] This is to break the child's focus on the objects and to require the child to remember (briefly) the association between the label and the object.

However, if children used the novel label as a word, then they should have realized that it applied to only one of the objects (for example, the sparkling wand). Thus, when the speaker provided a *new* label (i.e., on the glorp trial), the children should *not* have continued to select the same object. Instead, they should have searched for an alternative novel object to which the new word (i.e., "glorp") might refer. The most likely alternative is the other object on the tray (i.e., the safety latch), however, selecting *any* new object would indicate that the children were using the label as a word.[10] The recovery trial verified that the change in the children's selections was not due simply to boredom. If the children understand that the word "modi" refers to a specific object (i.e., the sparkling wand), then they should choose that object every time that it is requested. Thus, the percentage of trials that the children selected the labeled object should follow a quadratic pattern – or form a "v" when graphed. That is, they should have chosen the labeled object frequently on the test and recovery trials, but only rarely on the intervening glorp trials.

The full sequence (Familiar phase through novel phase) was repeated a second time with new pairs of objects. During each session, the children were therefore tested in the following manner: familiar phase, novel phase, familiar phase, novel phase. Within one testing session, each child was required to learn a name for both an interesting object and a boring object. The order of condition (coincidental or conflict)

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[10] This does not require that the child provide the second object from testing. Although the other object was the most common choice, some children attempted to look around the room for any other object that they did not know a name for, and to provide that object as the "glorp." As this still requires the child to provide an alternative to the just-labeled object (i.e., the "modi"), it still indicates that the child was using the novel label as a word.

was counterbalanced across children. The children were taught via either pointing or touching for session one, with the remaining teaching style utilized for session two (this was also counterbalanced across children). The two counterbalancing factors were randomized with respect to each other.

Coding. The task was coded on-line by marking which object the child selected on each trial. Responses were classified as the child having chosen either (1) the labeled object, (2) the unlabeled object, (3) both objects, or (4) neither object. The object that the child selected first was coded as the choice for the trial. If a child picked up two objects simultaneously, the experimenter requested that the child select "just one." If the child now chose one object, then that was coded as the response. On only one occasion did a child still insist on choosing both objects (and was therefore coded as such). If after four prompts the child had failed to select any object, it was coded as selecting neither object. All tapes were re-coded to verify the accuracy of the markings. Zero discrepancies were found during the verification.

Results

The dependent measure for Experiment 2 was based on the percentage of test trials in which children selected the labeled object. However, the key was the *pattern* of results across the three test trials (test – glorp – recovery). As described in the procedure, a quadratic pattern (or a "v"-shaped pattern) indicated that the children learned the word.

Preliminary analyses again found no effects of gender ($p > .35$) or of testing session (day one vs. day two; $p > .50$). As was true in Experiment 1, there was also no effect of method of labeling (pointing vs. touching; $p > .55$). Data were collapsed across these variables for all remaining analyses. Preliminary analyses *did* identify an effect for which object (interesting vs. boring) was labeled, $t(50) = 3.61$, $p < .001$; therefore all analyses were conducted separately by whether the interesting or the boring object served as the target. Performance on the familiar trials indicated that all children were capable of performing the task (all p's < .001). Across groups, children selected the correct object 3.68 out of the four familiar trials (range from 2 to 4; see Table 3 for group means).

The data for the interesting object as target were analyzed first. A Repeated Measures ANOVA tested for differences between the test, glorp, and recovery trials as well as for group effects. No main effect for group was found, $F(2, 48) = 1.33$, $p > .25$. A planned contrast for trial demonstrated a quadratic pattern, with all groups selecting the labeled object more frequently on the test and recovery trials than on the glorp trial, $F(1, 48) = 90.99$, $p < .001$ (see Figure 4). That is, when the interesting object was

Table 3: Social attention with word learning: Children's performance in Experiment 2 by group

	AD group Mean (SD)	LA group Mean (SD)	MA group Mean (SD)
Familiar trials			
Correct choices (out of 4)	3.41 (0.62)	3.69 (0.60)	3.94 (0.24)
Proportion correct	0.85 (0.15)	0.92 (0.15)	0.99 (0.06)
Coincidental condition (proportion correct)			
Salience trial	1.00 (0)	1.00 (0)	1.00 (0)
Test trial	0.91 (0.26)	0.82 (0.30)	0.88 (0.28)
Glorp trial	0.30 (0.40)	0.11 (0.22)	0.07 (0.26)
Recovery trial	0.89 (0.35)	0.79 (0.36)	0.94 (0.29)
Conflict condition (proportion correct)			
Salience trial	0.00 (0)	0.00 (0)	0.00 (0)
Test trial	0.44 (0.43)	0.68 (0.39)	0.85 (0.29)
Glorp trial	0.29 (0.31)	0.21 (0.31)	0.09 (0.26)
Recovery trial	0.53 (0.38)	0.71 (0.40)	0.85 (0.29)
Overall performance (proportion correct)			
Salience trial	0.50 (0.50)	0.50 (0.50)	0.50 (0.50)
Test trial	0.69 (0.29)	0.75 (0.32)	0.87 (0.19)
Glorp trial	0.30 (0.26)	0.15 (0.20)	0.08 (0.20)
Recovery trial	0.71 (0.27)	0.75 (0.33)	0.90 (0.16)

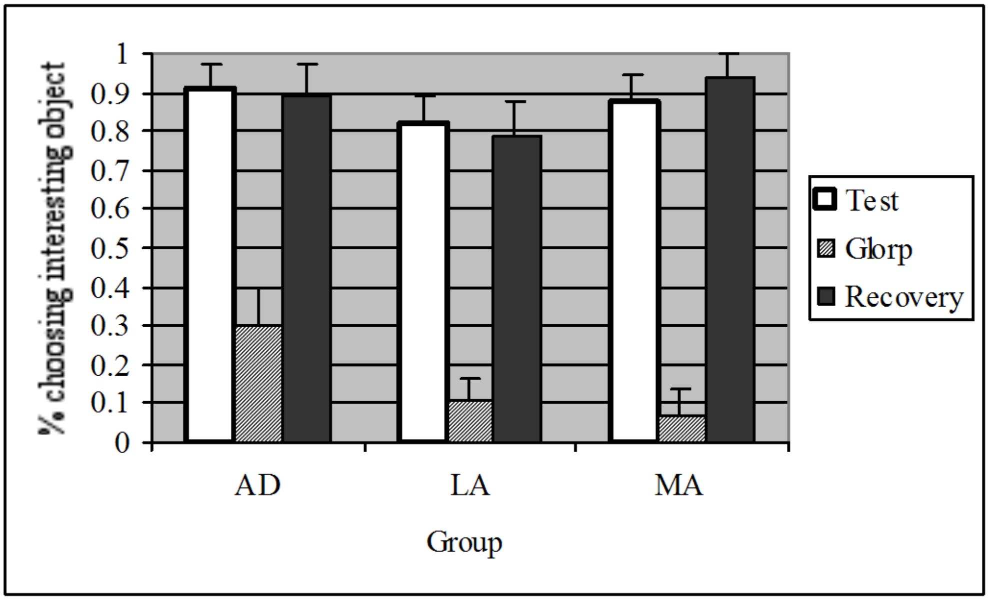

Figure 4: Social attention with word learning: Children's performance in the coincidental condition. Percentage of trials on which children choose the interesting object when it was labeled.

labeled, all children – both typically developing and those diagnosed with autistic disorder – were able to correctly attach the word to the interesting object.

A second Repeated Measures ANOVA tested for differences between the test, glorp, and recovery trials as well as for group effects for the data when the boring object was the target. A main effect for group was found, $F(2,48) = 3.70$, $p < .05$. Due to the main effect for group, planned contrast repeated measures ANOVA's were conducted separately for each group. Both the LA group, $F(1,16) = 11.52$, $p < .005$, and the MA group, $F(1,16) = 34.89$, $p < .001$, demonstrated the "v" pattern. In contrast, while there was a trend toward a quadratic form, the AD group did not reach significance, F(1, 16) = 1.92, p=.185 (see Figure 5).

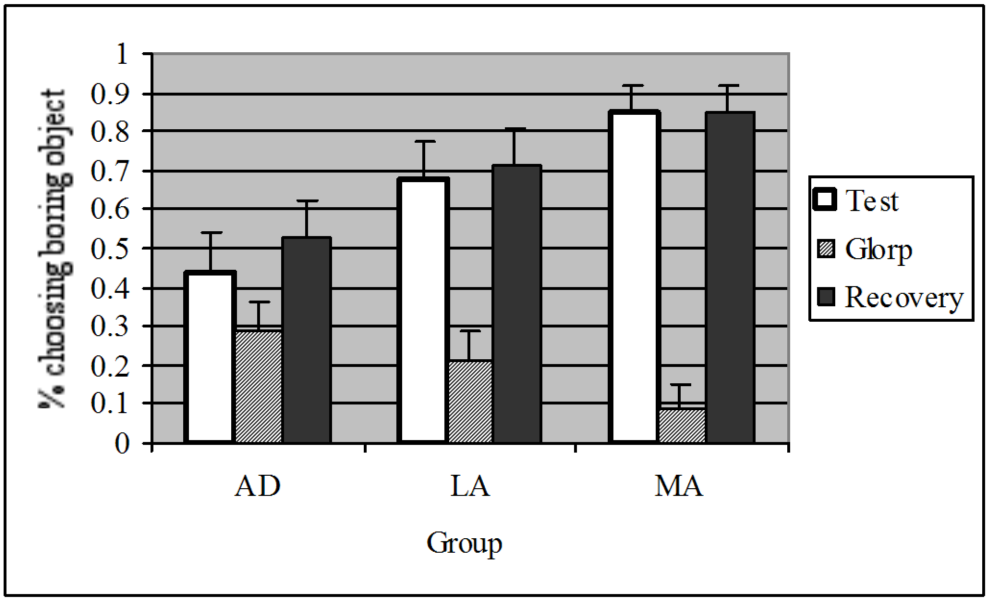

Figure 5: Social attention with word learning: Children's performance in the conflict condition. Percentage of trials on which children choose the boring object when it was labeled.

When the boring object was labeled, the AD group selected it 44% of the time on test trials, 29% of the time on glorp trials, and 53% of the time on recovery trials. Although this pattern failed to reach significance, it does show the "up-down-up" sequence of interest. Moreover, it is important to remember that the boring object was chosen *zero* percent of the time on salience trials. The boring object was defined as the object that the children did not pick during salience. While the test of a quadratic pattern on the test-glorp-recovery trials may have failed to reach significance, the difference between salience and test did, $t(16) = 4.24$, $p < .001$. Thus, while children with autism were not capable of learning the name for a boring object, there is strong evidence that the speaker's actions did succeed in drawing the child's attention to the boring toy.

Discussion

Overall, all children were capable of learning a word in Experiment 2. Typical children easily attached the label to the correct object even when the boring toy was the target. The AD group's performance was comparable to the controls on the familiar trials and when the interesting toy was labeled. However, when the boring object was the target, children with autism experienced greater difficulty, and were unable to demonstrate word learning. They did show the beginnings of a "v" pattern, though, suggesting that children noticed the social information. Further, the difference between salience and test trials demonstrated that the children's attention was influenced by the speaker's actions.

Perhaps even pointing and touching were insufficient for word learning. The children in this experiment were substantially older than the 12-month-olds studied by Hollich and colleagues; moreover, they had more advanced vocabulary levels and mental abilities than would be expected of the younger infants. However, perhaps the 12-month-olds can shed light onto the current findings. Both the prior 12-month-olds and the current AD group demonstrated difficulties in learning the name for a boring object, yet neither group “mis-mapped” the name (i.e., paired the name with the interesting object). Mis-mapping would be indicated by an inverted quadratic pattern, or a “^” pattern. That was not found with either group.

Additional research with typically developing 12-month-olds has found that it is quite difficult to teach them the name for any object that they are not inherently interested in (see Experiments 4, 5, 6, 8, & 11, Hollich, et al., 2000). Even when using objects of equal salience, Hollich and colleagues (2000, Experiments 7 and 9) found it necessary to have the experimenter look at the target object, pick it up, and slowly rotate it while providing the label to find evidence of word learning in 12-month-olds. Only by providing the children with such an extensive amount of social information were they able to find evidence that the infants could learn the name for an object that they did not find inherently interesting (Hollich et al., 2000).

One possibility is that the social information provided in the current study was unable to overcome the lure of the perceptually salient object. While the children had demonstrated an ability to follow these cues to an object (in Experiment 1), pointing and touching may be insufficient for word learning. “…there might be a large gap between detecting social cues, …, and using these cues to assist them in mapping words onto referents (Hollich, et al., 2000, p. 60).” The trend toward a word-learning pattern when the boring object was labeled, paired with the dramatic difference between the salience and test trials, suggests, at minimum, that the children with autism were not immune to the social information.

Perhaps the problem was a failure to provide sufficient social cues. If additional types of social information (such as those used with 12-month-olds by Hollich, et al., 2000) were provided, then children with autistic disorder might learn the name for a boring object. Alternatively, maybe children with autism can only acquire words when all sources of information are in alignment, when the social information indicates the same object as perceptual factors do. But, when these cues compete with one another, children with autism may be unable to learn words based solely on social information. That is, no matter how many types of social cues were provided, the children would never be able to overcome the perceptual lure of the interesting toy to learn the name for the boring object.

A third explanation would be that the trouble arises not from a lack of *attentional* social information, but rather from a failure of the children to be able to discern the speaker's communicative *intentions* (P. Bloom, 2000; Tomasello, 1999). Under this perspective, social cues would provide the windows onto intent, the key to unlocking the mysteries of word learning. The problem was not that the AD group could not notice the speaker's actions, but rather that they could not take the speaker's perspective. This ability to take another's point-of-view would form the basis for an understanding of social intentions (P. Bloom, 2000; Tomasello, 1999). Thus, the third and fourth experiments abandoned the focus on attentional social cues and began to investigate the role of social intentions in word learning.

Experiment 3: Social Intention Without Word Learning

Experiments 1 and 2 investigated the abilities of children with autistic disorder to notice and respond to attentional forms of social information. Children with autism were capable to accurately focusing their attention on the object indicated by the adult in Experiment 1, and of using that information to acquire the name for objects that the child found interesting in Experiment 2. However, in parallel with previous research with 12-month-olds, the children with autistic disorder demonstrated difficulties in following the direction of the speaker to learn the name for a boring object – a skill mastered by typically developing 19- to 24-month-olds (Hollich, et al., 2000). One possibility would be that the solution adopted by the older, typically developing toddlers involved at least some analysis of the *intentions* of the speaker.

> The latter [19- and 24-month-olds] take the perspective of the speaker into account in linking a name to a referent; the former [12-month-olds], while sensitive to conflicting cues, only seem to learn words that correspond to their own perspective. (Hollich, et al., 2000, p. 61)

Like the typical 12-month-olds, children with autistic disorder could be unable to adopt the perspective of another person.

As discussed above, psychologists have argued that all social information is not merely attentional. The ability to take another's perspective would be but one example of discerning communicative intent, the *essential* foundation for language learning (Baldwin, 1993, 2000; Baldwin & Baird, 1999; Baldwin & Tomasello, 1998; Carpenter, Akhtar, & Tomasello, 1998; Carpenter & Tomasello, 2000; Tomasello, 1995, 1999). If so, then the difficulties that the children with autism demonstrated in learning the name for a boring object might not have reflected a failure to use attentional social information, but rather may have indicated a difficulty in using the visible social cues to derive the speaker's intent.

In 1995, Meltzoff revolutionized our understanding of typical children with a study of imitation and intention in 18- to 20-month-olds. Using the behavioral re-enactment paradigm, Meltzoff demonstrated that toddlers are capable of inferring the intentions of others. Children watched an adult perform a series of actions. In the intention condition, the adult was seen to attempt a specific action with an object. However, the adult failed to complete the desired action. For example, the adult might attempt to place a string of beads into an upright cylinder. The adult attempted the action a total of three times, but never succeeded in accomplishing the "goal." Each failure was performed slightly differently, so that the children never saw the same action performed more than once (Meltzoff, 1995). In the control condition, the adult attempted the same action as in the intention condition. Again, the precise action varied across the three attempts (e.g., using the right vs. the left hand). However, in this case, the adult succeeded on each of the three trials.

After the third attempt, the objects were presented to the children and they were permitted to simply play. Meltzoff (1995) found that toddlers in both conditions produced the *intended* action (i.e., the action successfully completed in the control condition). In fact, there was no difference between the groups their performance of the intended action! Although the children in the intention condition had never seen the completed action, they inferred what the adult had *meant* to do and modeled their own behavior accordingly. That is, they did not simply re-enact what the adult had actually done, but rather what he had been trying to do.

Bellagamba and Tomasello (1999) tested 12- and 18-month-olds in Meltzoff's paradigm. While they were able to replicate the finding with 18-month-olds, the 12-month-olds in the intention condition rarely produced the intended action. Further, Bellagamba and Tomasello (1999) added an "end state" condition. In this condition, the adult did not model any actions on the objects. Rather, the objects were placed as if the action had been completed, and then this final, "end state" was shown to the children (e.g., with the beads inside the cylinder). Both 12- and 18-month-olds were unlikely to perform the target act when presented with only the end state.

Both Meltzoff (1995) and Bellagamba and Tomasello (1999) interpreted the results as demonstrating that the children had inferred the intentions of the other person. This claim has not, however, gone unchallenged (Carpenter, et al., 2001; Heyes, 2001; Huang, Heyes, & Charman, in press; see also Carpenter & Call, 2002; Charman & Huang, 2002; Want & Harris, 2002; Whiten, 2002). For example, Carpenter, Pennington, and Rogers (2001) found that simply presenting the children with Meltzoff's objects often resulted in the children performing the intending action. This finding was in direct contrast to the failure of children to produce the intended action in Bellagamba and Tomasello's (1999) end-state condition. If Carpenter and colleagues (2001) are correct, then the children's responses might be based on some property of the objects themselves.

> Thus, a critical methodological issue in the use of the behavioral re-enactment paradigm to investigate infants' understanding of intentions is the need to separate the object affordances from consummated and unconsummated intended outcomes, and further to separate body movements from object movements. (Huang, et al., in press, p. 37)

Children with autism have frequently demonstrated impairments in interpreting other's motivations (P. Bloom, 2000; Charman, 2000; Charman, et al., 1998; Griffin, 2002; Rogers & Pennington, 1991; Ruffman, 2000; Tager-Flusberg, 1999, 2001; Tomasello, 1999; for a review see Baron-Cohen, 1995). However, these studies have tested the children's *theory of mind,* the understanding that others may have different thoughts, feelings, and beliefs from your own (Wellman, 1990). While children with autism may never develop a theory of mind (Baron-Cohen, 1995), they might be able to develop more basic skills for analyzing the actions of others. Specifically, recent evidence has found that children with autism may be capable of recognizing intentionality in others' actions.

Carpenter and colleagues (2001) tested two- to five-year-olds with autistic disorder on Meltzoff's (1995) behavioral re-enactment paradigm. Using the same procedures as in the original study, Carpenter and colleagues found that children with autism were just as likely as control children to produce the intended action. However, as noted above, they also found that in a base-line condition, when the children were simply given the objects to explore, the children frequently produced the intended action (Carpenter, et al., 2001). Thus, these findings must be interpreted cautiously. Nevertheless, this study did raise the possibility that children with autism might not exist in a social vacuum – that they may even be attuned to the intentional actions of other people.

Following the logic of Experiments 1 and 2, prior to testing how children with autism use social intentions to guide word learning, it was necessary to first demonstrate that they could even recognize the intentional actions of another. Given the previous research by Meltzoff (1995), Bellagamba and Tomasello (1999), and Carpenter and colleagues (2001), it was decided that the behavioral re-enactment paradigm provided an established means of testing the children's abilities. However, given the challenges to the objects and actions used in the original experiment (Carpenter, et al., 2001; Carpenter & Call, 2002; Charman, et al., 1998; Charman & Huang, 2002; Heyes, 2001; Huang, et al., in press; Want & Harris, 2002; Whiten, 2002), it was decided to change the stimuli for the current experiment. The number of objects available at one time was increased, thereby increasing the number of possible combinations of objects that could exist. Moreover, the actual objects and the actions performed with them were changed so as to form two sets – one in which the actions performed were canonical (e.g., using a mallet to hammer a peg through a peg board) and one with non-canonical actions (e.g., stacking a block on top of a toy tree).

Meltzoff's (1995) results would suggest that both control groups should succeed on this task. The average age of the language-matched control children was 30 months and for the mental-age-matched controls it was 37 months. Both of these are substantially older than the 18- to 20-month-olds involved in the original experiment. Given Carpenter and colleagues (2001) findings, children with autism may well be able to succeed on this task – particularly with the canonical set. However, the abundance of evidence that children with autism have difficulties in understanding the thoughts of others (see Baron-Cohen, 1995) would argue that, to the extent that this task requires the children to discern the thoughts of another, the AD group should fail on this task.

Method

Participants. The children described in the general overview of all experiments were the participants for Experiment 3 (see above).

Procedure. Experiment 3 used the behavioral re-enactment paradigm developed by Meltzoff (1995).[11] There were two sets of four objects used in the current experiment. Both sets consisted of objects that the children were expected to recognize (for example, blocks, trucks, trees). The critical distinction between the sets was in the actions performed on the objects. For the *canonical* set, the actions were those most commonly associated with the objects (see below). In stark contrast, the *non-canonical* set involved performing an unusual action on the objects (see below). In each set, the objects were divided into two pairs; each action was performed on one pair of objects.

The canonical set consisted of several children's toys. A wooden pegboard (with pegs) and a wooden mallet formed one pair of objects. The second pair included the base/post and one plastic ring from an infant's stacking toy (i.e., the type that has

[11] However, it would be unfair to call this study a replication due to the differences in the number of objects, types of objects, and types of actions used in the current study. Rather, it would be more accurate to describe the current study as having been inspired by Meltzoff's (1995) work and to have utilized the same testing paradigm.

five rings of decreasing sizes that are placed over the post to form a pyramidal stack). The actions in this set were those most commonly associated with each pair – using the mallet to "hammer" the pegs through the board and placing the ring onto the base/post. In the canonical set, the actions should be in alignment with the objects' affordances.

The non-canonical set also included familiar objects: a toy pickup truck, a wooden block, a plastic pitcher/watering can, and a plastic palm tree.[12] The truck and the watering can were paired, as were the block and the tree. The actions were to use the watering can to "water" the truck and to stack the block on top of the tree. These actions were chosen to violate the most common pairings of these objects (e.g., "watering" a plant/tree; carrying objects in a pickup truck). In contrast to the canonical set, in this set a deliberate attempt was made to separate the objects' affordances from the actions demonstrated (Huang, et al., in press). While this cannot be perfectly accomplished (at some level, all four objects are toys, and all actions can be broadly classified as "playing with toys"), there should at minimum be a greater distance between the actions and affordances than is found in the canonical set.

Previous research has found that the language used by the adult influences whether or not children interpret an action as intentional (Carpenter, Akhtar, & Tomasello, 1998; Wittek & Behrend, 2002). When an adult said "Whoops," children were less likely to interpret an action as intentional (and more likely to consider it accidental) than when the adult said "There" (Carpenter, Akhtar, & Tomasello, 1998).

[12] A palm tree was chosen as it had a flat top, thereby decreasing the possibility that failure was due to difficulties in balancing the block on top of the tree.

Based on these findings, another modification was made to Meltzoff's (1995) original experiment. To highlight the error, and to hopefully thereby increase the children's awareness that a mistake had occurred, the experimenter said, "Whoops! I missed it" or "Oh no! That's not right" immediately after failing at her attempt. Notice that with this change, it should only make it more likely that the children can read the speaker's intent.

Two further changes were made to the original experiment. First, in previous research, the objects were either given to the children silently, or without any direction (e.g., "now it's your turn"). In an attempt to encourage the children to perform the adult's action (either by mimicking the demonstrated action or by producing the intended action), the experiment gave the toys to the child while saying "can you help me? Can you do it for me?" If the child had discerned what the experimenter was trying to do, then this request should *increase* the likelihood that the child performs the intended action.

A final change was to only use Meltzoff's intention condition (i.e., all children watched the experimenter *fail* to complete an action).[13] As in the original experiment, the experimenter attempted each action a total of three times, but failed on all occasions. Each failure varied from the others. For example, when attempting to hammer the pegs,

[13] The limited number of participants in each group precluded a between-subjects design with half of the children in the intentional condition and half in a control condition (where the adult successfully completed the action). Further, with the addition of a canonical vs. non-canonical distinction, it was decided that attempting to have a within-subjects control design would result in too many tasks for the children to complete.

the experimenter would first miss and hit the board to the right of the peg, then miss and hit to the left of the peg, and then finally miss and hit to the back of the peg.

To begin the task, the experimenter told the child the following. “I have some of my favorite toys here. I’m going to play with them first, to show you how I can play with my toys. Then, you’ll have a turn. OK? So, I’ll play with them first, but I promise that you will get to play with them when I’m done.” This was said both to encourage the child to observe the experimenter’s actions and also to reassure the children that they would be given a turn to play.

The experimenter placed one set of four objects onto a tray (for example, the canonical set). The tray was placed on the experimenter’s lap, out of reach of the child, but in view. Then, the experimenter selected one pair of two objects and attempted to perform an action with them (e.g., attempting to hammer the pegs). However, she failed to complete the intended action. As the mistake occurred, the experimenter expressed her dismay (e.g., “Whoops, I missed it”). She performed two more failed attempts with the same pair of objects. She then replaced them in their original positions on the tray and picked up one object from the remaining pair. Again, she failed the attempted action three times, expressing her dismay each time (e.g., placing the ring onto the post). After the third attempt, the experimenter returned the second pair of objects to their original places on the tray. Then, she said “can you help me, can you do it for me,” and slid the tray toward the child. The child was given an opportunity to play with the objects.

Although only the first action with each pair was coded for the present experiment, to engage the children in the task the children were permitted to play with the objects for up to two minutes. If, after twenty seconds, the child had not yet touched any object, the experimenter provided a prompt for action (e.g., “What can you do with these?”). If, another twenty seconds passed without the child touching any object or after two minutes had passed (if the child was playing with the toys), then the experimenter removed the objects from the tray, and readied the objects for the second set.

The experimenter then told the child, “I have some more toys that I like to play with. Now, first I’ll play with the toys, but then you’ll get a turn.” The four objects from the second set were placed onto the tray, and the tray was returned to the experimenter’s lap. The above sequence was then repeated with the second set of objects. In total, Experiment 3 required between 8 and 10 minutes to complete.

Half of the children in each group (AD, LA, and MA groups) saw the canonical set first, while the remaining children began with the non-canonical set. The order of the pairs/actions within each set varied such that half of the children in each group saw each pair first (e.g., half saw the block/tree then the truck/watering can, while half saw the reverse order). The order of the sets, the order of the pairs within a set, and the location of the objects on the tray were all counterbalanced with respect to one another.

Coding. All coding was done from the videotapes. The child’s first action with each pair of objects was measured. The decision to code only the first action was based on the arguments detailed in Huang and colleagues (in press). Essentially, if the goal is to assess what the children learned from observing the adult, rather than from their own exploration of the objects, then the first act performed by the child should provide a more accurate measure. Actions were classified into one of four categories:

1) A *mimic* response, or performing the exact action demonstrated by the experimenter. For example, if the child attempted to hammer the pegs but missed, it would be coded as a mimic.
2) The *intended* action, or if the child completed the adult's action (for example, hammering the pegs). The definition of "intended action" included one case of failure: when it was clear that the child was attempting to complete the action but failed due to physical constraints (particularly in terms of eye-hand coordination).
3) an unrelated, *novel* action, or when the child performed a specific action, but that action was neither the demonstrated nor the intended action of the adult. For example, if the child attempted to hammer the ring or the post (the other two items in the set of four objects).
4) no response/*uncodable,* or any other action (or lack thereof). The most common usage of this coding was for cases when the children refused to touch any of the toys (i.e., no response). The most common "uncodable" response involved throwing each of the objects to the ground.

Twenty-five percent of the tapes were later re-coded for inter-judge reliability; on two occasions there was a discrepancy between the coders' judgment (mean r = .98, range from 0.75 to 1.00). In both cases, the discrepancy was resolved by having both coders watch the tape simultaneously and then discussing what had happened until both coders agreed upon one coding for the action.

Results

The number of times that children performed the adult's intended action and that the child mimicked the adult's actual action were the measures of interest. There was a maximum of four times that the child could do so for each (two pairs of objects in each of two sets). Preliminary analyses on performance of the intended action found no effect of gender ($p > .85$), so remaining analyses were collapsed across gender.

For the rate at which the children *mimicked* the demonstrated action, no differences were found between sets (canonical vs. non-canonical) for any group (all p's > .55), so tests were conducted on the combined data. An ANOVA found a strong trend toward a group effect, $F(2, 48) = 2.99$, $p = .060$, but post-hoc analyses failed to detect any significant differences (all p's > .15). That is, while when all children were considered there was a suggestion that the groups might differ, when each group was tested individually against the other groups, no significant differences were found. This was likely because the overall rate of mimicking was quite low. Out of 204 possible occasions (4 times each for 51 children), a mimic response was given only 11 times (5.4%). Nine of those eleven times the mimic response was produced by a LA control child; on only one occasion each did an AD or a MA child mimic the experimenter's failed attempt (see Table 4). Interestingly, it was only in the youngest group (i.e., the

Table 4: Social intention without word learning: Rates of mimic and intended responses in Experiment 3 by group

	AD group Mean (SD)	LA group Mean (SD)	MA group Mean (SD)
Canonical set			
Mimic responses			
Number (out of 2)	0.00 (0)	0.12 (0.49)	0.05 (0.24)
Proportion	0.00 (0)	0.06 (0.24)	0.03 (0.12)
Intentional responses			
Number (out of 2)	1.35 (0.79)	1.76 (0.56)	1.94 (0.24)
Proportion	0.68 (0.39)	0.88 (0.28)	0.97 (0.12)
Non-canonical set			
Mimic responses			
Number (out of 2)	0.05 (0.24)	0.41 (0.71)	0.00 (0)
Proportion	0.03 (0.12)	0.21 (0.36)	0.00 (0)
Intentional responses			
Number (out of 2)	0.29 (0.69)	1.00 (0.94)	1.53 (0.80)
Proportion	0.15 (0.34)	0.50 (0.47)	0.77 (0.40)

LA group), that any substantial amounts of mimic responses were found (13% of all trials).

Although no differences by set were found for the rate of mimicking, there was a significant effect of set on performance of the *intended* action, $t(50) = 5.97$, $p < .001$. A MANOVA found group differences within each set; for the canonical set, $F(2, 48) = 4.681$, $p < .05$; for the non-canonical set, $F(2,48) = 9.87$, $p < .001$. Post-hoc Bonferroni tests for the canonical set found that the AD group differed from the MA group ($p < .01$) but not from the LA group ($p > .10$). However, the two control groups did not differ from one another ($p > .99$). These differences arose from higher rates of intended actions for the MA group (1.94 times out of 2) and LA group (1.76 times) than for the AD group (1.35 times). The failure to find a difference between the LA group and either of the other groups is likely because their rate falls between that of the MA group and the AD group. Within the non-canonical set, post-hoc Bonferroni tests found differences between both control groups and the AD group (vs. LA, $p < .05$; vs. MA, $p < .001$). The control groups did not differ ($p > .15$). Again, the MA group (1.53 times out of 2) and the LA group (1.00 times) performed the intended action more frequently than did the AD group (0.29 times). Thus, while there were substantial differences in performance between the two sets, there was also a consistency: for both sets, the MA group demonstrated the highest mean rate of performing the intended actions, with the LA group providing slightly fewer, and the AD group providing the fewest (see Figure 6).

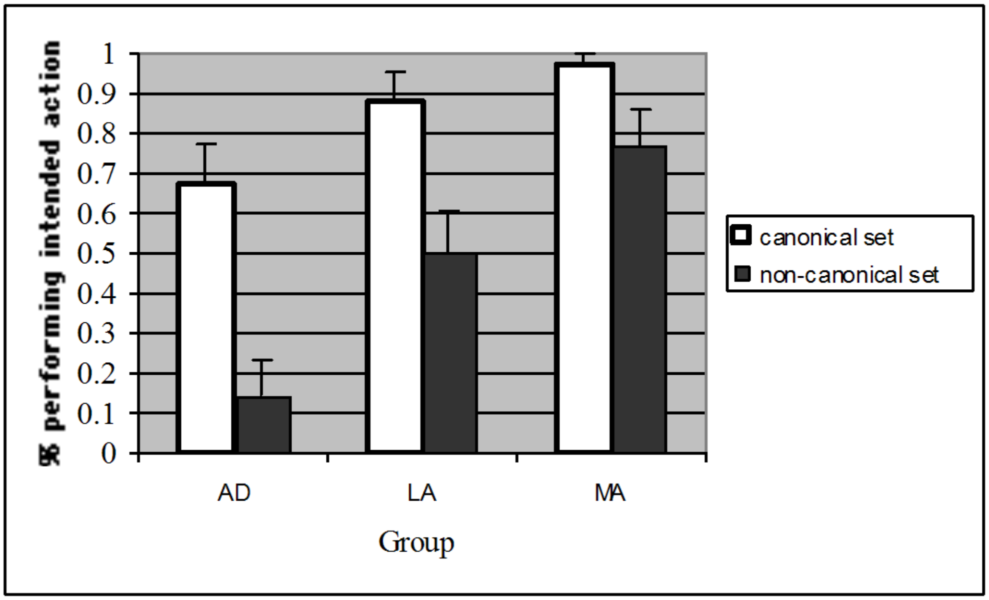

Figure 6: Social intention without word learning. Children's performance of the *intended* action in each set.

Discussion

The typically developing control children had minimal difficulties in identifying and completing the intended action. When the attempted actions matched with the children's previous experience with the objects (the canonical set), they performed the target action between 88% and 97% of the time (LA group and MA group, respectively). These findings raise a question as to whether or not the canonical set actually tested inferential abilities. The children's actions may have used their previous knowledge about how to play with these toys. However, the non-canonical set appears to more certainly draw on the child's interpretation of the experimenter's actions. In the non-canonical set, this task could not be solved based on previous experience but rather required greater attention to the experimenter's actions. While the non-canonical set was more challenging for the children, both control groups still succeeded in discerning and demonstrating the intended action, between 50% and 77% of the time (LA group and MA group, respectively).

Although the children with autistic disorder were not as proficient as the control children, they were nevertheless quite successful at completing the intended action in the canonical set, doing so 68% of the time. The children's knowledge about the objects, coupled with the actions of the experimenter, allowed the children to succeed at this task. In the non-canonical set, however, the children's previous experience could not guide them. The only means of determining the correct action was through watching the experimenter's actions and inferring what she was trying to do. When the autistic group was required to rely solely on their understanding of the adult's intentions, they were unable to solve the task, and performed the intended action a mere 15% of the time.

Why was the non-canonical set so difficult for even the younger, typically developing children? The LA group was substantially older (mean age of 30 months) than the 18- to 20-month-olds previously tested by Meltzoff (1995) and Bellagamba and Tomasello (1999). Thus, they should have already mastered the inferential skills found in the toddlers, yet they only performed the intended action 50% of the time. Several of the changes in the current experiment, such as saying "Whoops" and asking "Can you do it for me," should have increased the likelihood that the children responded with the intended action. Previous experience with the objects in the current task might have played a role, but children rarely (less than 2% of all trials) "un-crossed" the actions – by watering the tree or placing the block into the back of the pickup truck.

Huang and colleagues (in press) offered an alternative explanation for Meltzoff's (1995) results. Rather than assuming that the children were inferring the intentions of the adult, they suggested that the children may instead focus on the affordances of the objects (see also Carpenter & Call, 2002; Charman & Huang, 2002; Heyes, 2001; Heyes & Ray, 2002). This claim would be consistent with the finding that children spontaneously perform the intended action when simply presented with the objects (Carpenter, et al., 2001). The results from the canonical set also support this argument – when the action was in alignment with the objects' affordances, all of the children (even those with autistic disorder) readily performed the target action.

As stated in the methods section, the non-canonical set did not provide a perfect separation between action and affordance. At some level, all of the objects chosen were toys, and all of the actions could be interpreted as "playing" with the toys. However, given the dramatic shift in results between the two sets, it seems possible that the children used different strategies across sets to solve the task. Children with autism are capable of recognizing and responding to the objects' affordances. In the canonical set, when the experimenter's intended action as in alignment with the objects' affordances, the autistic group was able to succeed. But, when the objects did not provide clues as to the correct action, when the only source of information on what they were to do came from the experimenter's intentions, the AD group failed to discern the required action. Consistent with previous research (for reviews, see Baron-Cohen, 1995; Charman, 2000; Charman, et al., 1998; Tager-Flusberg, 1999, 2001; Tomasello, 1999) they could not use the actions of another person to determine that person's intent.

Experiment 3 tested if children with autism could determine the intentions of another person in a task that did not involve word learning. Their failure to do so suggests that they would also be unable to use the speaker's intentions to learn the meaning of a novel word. Therefore, children with autism would provide the perfect test of whether communicative *intention* is necessary for word learning. This was the focus of Experiment 4.

Experiment 4: Social Intention With Word Learning

Psychologists have long debated the role of social information in word learning (Baldwin, 2000; Baldwin & Tomasello, 1998; Carpenter, Akhtar, & Tomasello, 1998; Plunkett, 1995; Samuelson & Smith, 1998; Smith, 1995, 2000). Associationists have argued that "dumb attentional mechanisms" rely on the social environment to direct the child's attention to relevant information (Smith, 1995, 2000). Social cues are but one subset of perceptual information, no more important than bright colors or interesting textures. In stark contrast, social pragmatic theories contend that children must go beyond the surface behaviors of others, to take the perspective of the other persons and to begin to understand their communicative intentions (Tomasello, 1999).

In a series of studies, Tomasello and colleagues (Akhtar, et al., 1996; Akhtar, et al., 1991; Akhtar & Tomasello, 1996, 2000; Baldwin, 1991, 1993, 2000; Baldwin & Tomasello, 1998; Carpenter, Akhtar, & Tomasello, 1998; Tomasello & Barton, 1994;

Tomasello & Farrar, 1986; for a review, see Tomasello, 1999) have demonstrated that 18- to 24-month-olds are sensitive to the speaker's intentions in a word learning situation. Akhtar and Tomasello (1996) tested if children could recognize the speaker's intent to determine the meaning of a word. Children were taught hiding locations for four novel objects. Then, the adult announced that she was going to find a "gazzer," but then was unable to open the toy barn in which the object was hidden. Later, when asked for the gazzer, children consistently chose the object from the barn, *even though the object was never seen after the name was given* (see also Tomasello, et al., 1996).

Moreover, children can also use the speaker's facial expression to determine if an object is the intended target. An adult placed four novel objects into four buckets (Tomasello & Barton, 1994). The experimenter said, "let's find the toma." As she removed each object from it's bucket, she either (a) scowled, replaced the object, and continued searching or (b) smiled and stopped searching. Children assumed that the toma was the object that had caused the adult to smile and stop searching. These studies have led to the current understanding of language as founded upon social intent. By learning to understand adult's actions and motivations, children become enmeshed in their social environment. As language is inherently social, the key to unlocking language must be an understanding of social intent.

These results, though, can also be interpreted as providing evidence for *attentional* interpretations of social information. For example, Samuelson and Smith (1998) provided an alternate interpretation of an earlier study by Akhtar and colleagues (1996). In the original study, children were given a novel toy while their mother was not in the room. When the mother returned, she looked into a box that contained several objects (including the novel toy), and exclaimed, "I see a gazzer!" 20-month-olds assumed that the novel object was the "gazzer." Akhtar and colleagues (1996) contended that children realized that their mother's comment, and therefore the new word, must apply to the object that their mother had never before seen. In contrast, Samuelson and Smith (1998) argued that the children might simply be responding to novelty. Further, they demonstrated that equivalent results could be obtained by increasing the object's novelty through non-social means, such as placing it on a glittering blue tablecloth (Samuelson & Smith, 1998).

This is but one example where the actions of the child may not change, but the *interpretation* of those actions could be used as support for either attentional or intentional theories. Researchers know that children notice attention-getting stimuli, and (at least some) psychologists believe that children are sensitive to the intentions of others. In contrast, children with autistic disorder might provide the natural test case for this debate. As was discussed above children with autism respond to attentional information – be it social or perceptual. However, they do not appear to recognize the intentions of another person. Thus, if they are capable of learning a word, then their success cannot be based on the speaker's communicative intentions. Rather, any success that they demonstrate would be evidence for word learning through purely attentional means.

For Experiment 4, we created a task based on several of Tomasello and colleagues' studies (Akhtar et al., 1996; Akhtar & Tomasello, 1996; Tomasello &

Barton, 1994). A number of objects were contained in one location – a woman's purse. This was done to make the take seem more natural to the children – even young infants have seen their mother searching for items in her purse. The experimenter would tell the child that she was going to get the "parlu" from the purse, but then would be unable to find it. While searching, all but one of the novel objects would be rejected. Could children recognize the adult's intention to locate an object? And, if so, could they use that knowledge to realize that the remaining novel object was the "parlu?" Based on previous work, both groups of typically developing children were expected to be able to find the "parlu" when tested (Akhtar, et al., 1996, Akhtar & Tomasello, 1996; Tomasello & Barton, 1994, for a review see Tomasello, 1999). However, based on the findings of Experiment 3, if this task did require that the children read the intentions of the experimenter, then children with autistic disorder should be unable to find the correct object during testing.

Method

Participants. The children described in the general overview of all experiments were the participants for Experiment 4 (see above).

Procedure. Experiment 4 used two sets of six objects each. In each set, two objects were intended to be familiar to the children; they were chosen from words known to exist in very young children's vocabularies (Fenson, et al., 1994). As a further verification that these objects were familiar to the actual participants, the mothers were asked if their child knew the names for the four objects. In only one case did the parent report that the child did not comprehend all four words (the youngest child in the study – a 15-month-old). In a final effort to ensure that the familiar objects were actually familiar to the children, during the free play session, the experimenter named each of the familiar objects (e.g., "do you want to play with the ball?").

In contrast, the remaining four objects in each set were chosen to be novel for the children. As such, they were *not* commonly found in young children's vocabularies (Fenson, et al., 1994). Again, the parents were asked if the children would recognize the objects, and if so, if the children would know the names for the objects. With the oldest typically developing children, there was one object that several children did recognize (7 children knew what a honey dipper was), although most did not know its name (they referred to it as a "Pooh-toy").[14] There was no difference in performance on Experiment 4 between these seven children and the remaining 27 control children, nor was there any difference in performance with the honey dipper as compared to the other novel objects. For the remaining novel objects, no parent reported that their child would know any name for the object.

Set A contained a ball and a plastic hammer (the familiar objects), and a flat plastic staple remover, a painted wooden honey dipper, a plastic egg separator, and a painted wooden stirrer (i.e., a kitchen utensil). To keep the stirrer comparable in size to the other objects, the handle was removed. Set B included a picture book, a toy frog

[14] Clearly, the children associated the object with Winnie-the-Pooh. Thus, while they recognized the object, they also did not seem to have a specific name for the object, rather they used the general term "toy" and added the information that it was "Pooh's" toy.

(the familiar objects), a square bottle opener, a travel lint remover, a hand-held fruit juicer, and a hexagonal abstract object. All novel objects in set B were plastic.

As with Experiment 2, only half of the task was completed on each testing session. Half of the children in each group did Set A on day one, while the remaining children saw Set B during the first session. The decision to separate the task was made for two reasons. First, this balanced the number of new words that the children were asked to learn in each session (three total – two in Experiment 2, one in this task – per day). Second, splitting the tasks also helped balance the total number of things that the children had to do in each session, making the duration of the sessions more comparable. For each session, Experiment 4 lasted for approximately 5 minutes.

To begin Experiment 4, the experiment brought out a sack purse containing six objects (e.g., set A). The children were allowed to play with each object for approximately 30 seconds. The children were first given the familiar objects, and then the novel objects. The children were only permitted to have one object at a time. After the children played with each toy, the experimenter placed it back in the sack purse. Once the children had a chance to explore all six objects (and once all were returned to the purse), the experimenter said, "let's find the parlu!" She reached into the purse, and retrieved one non-target novel object (e.g., staple remover). As it was displayed, she said, "no, that's not the parlu, I like it, but it's not the parlu." To increase the children's awareness that the object was not what the experimenter was searching for, she shook her head and frowned while saying "that's not the parlu" (see also Akhtar & Tomasello, 1996; Tomasello & Barton, 1994). However, to minimize the chance that the children were responding solely to the speaker's negative affect, she also smiled at each non-target object, and informed the children that she liked it. The object was then returned to the sack. This sequence was repeated two more times, with the experimenter finding, and rejecting, the remaining two non-target novel objects (e.g., the honey dipper and the egg separator).

Rather than removing the fourth object, the experimenter pretended to be unable to find the toma in the sack. After looking through the bag, the experimenter said to the children, "maybe you could find it, can you find the parlu?" She then passed them the purse. While the children searched, she reminded them one more time to look for the parlu. Once the children pulled an object out of the purse (regardless of whether or not they chose the correct object), the experimenter congratulated them, "good job" or "thank you!"

As discussed in the coding session (see below), there was one situation in which the children were permitted to remove more than one object from the purse. A small group of older, typically developing children used a "process of elimination" strategy to find the toma. That is, the child would pull out a novel object, and say "that's not it" or "that's not the parlu" *before* showing the object to the experimenter. In fact, they usually never fully removed the objects from the purse. If this occurred, then the child was allowed to search until the first time that they removed an object from the purse and showed it to the experimenter.

The order of the objects during play and during training was randomized. Which set was used for each session and which object was the target were counterbalanced with respect to one another.

Coding. The task was coded on-line by marking which object the child selected during the test trial. Responses were classified as the child having selected either (1) the target object, (2) a different novel object, (3) a familiar object or (4) no response/uncodable. The object that the child selected first was coded as the choice for the trial. If a child picked a toy, and *before showing it to the experimenter,* said, "this is not the toma" (or an equivalent phrase), and then continued to search, then the first object that the child showed to the experimenter was coded as the child's choice.[15] If a child picked up two objects simultaneously, the experimenter requested that the child select "just one." If the child now chose one object, then that was coded as the response. If after four prompts the child had failed to select any object, it was coded as selecting neither object. All tapes were re-coded to verify the accuracy of the markings. Zero discrepancies were found during the verification.

Results

The frequency with which the children selected the correct object was the dependent measure. At test, there were four novel objects and two familiar objects

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[15] Among the control children there was a tendency to select the objects before looking in the bag. Then they would say if the object was or was not the toma. As this strategy resulted in the children clearly specifying which object they felt was the toma ("this is the toma" or "is this one the toma"), it was decided to code the child's indicated choice as their selection.

present. For statistical tests, chance rates were based on all six objects (0.17) rather than just the four novel items (0.25). This was decided for two main reasons. First, all six objects were present and available as choices; children in each group occasionally selected the familiar object during test. Second, the familiars were included specifically to increase the number of objects available at test that had *not* been seen during training to limit the possibility that children were simply choosing the object to which they had had the least exposure.

No effects of gender or testing session (day one vs. day two) were found (p's > .75) in preliminary tests, so data were collapsed for all further analyses. A Chi-square analysis found group differences in performance, $\chi^2 = 2.89$, $p < .05$. The AD group most frequently failed to find the correct object. Ten out of the 17 children selected the wrong object on both sets; only six children in the MA group had a score of zero on this task (see Table 5). In contrast six of the MA children, but only two of the AD children, selected the correct object both times.

Tests of proportions assessed if the groups' performance exceeded chance levels (i.e., one out of six, or 0.17). Based on the Chi-square analysis, the tests were conducted separately for each group. The MA group performed above chance levels, $t(16) = 3.17$, $p < .005$, selecting the target object 50% of the time. The LA group also exceeded chance levels, $t(16) = 2.50$, $p < .05$, correctly finding the target 41% of the

Table 5: Social intention with word learning: Frequency with which children chose the target object in Experiment 4 by group

	AD group	LA group	MA group
Correct selections			
0	10	7	6
1	5	6	5
2	2	4	6

time. In contrast, the AD group did not surpass chance levels, t(16) = 1.13, p > .25, choosing the target object only 26% of the time.[16] Thus, while both control groups demonstrated word learning on this task, the children with autistic disorder did not (see Figure 7).

Discussion

This was clearly a challenging task – even the typically developing children were correct only 40-50% of the time. In Experiment 4, the children must first realize that the experimenter was searching for a specific object, and that it's name is "parlu." Then, they needed to pay attention to her actions and to recognize that she did *not* succeed in her search. Therefore, none of the three objects shown during the failed

[16] Using the more conservative estimate of chance (0.25, or one out of four novel objects) did not affect results for the MA or AD groups. For the LA group, the results change to only showing a strong trend for word learning, t(16) = 1.65, p = .059.

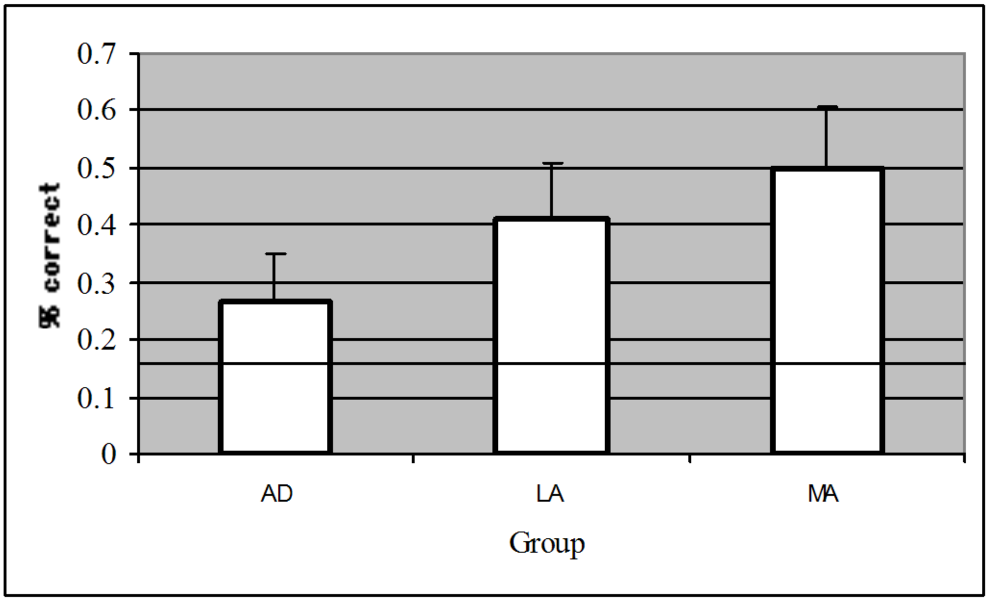

Figure 7: <u>Social intention with word learning.</u> Percentage of trials on which children selected the correct object in Experiment 4. The line indicates chance performance (0.17).

search could be the parlu. Finally, the children were required realize that the parlu must be a different object and that they should look in the purse for a fourth novel object. This may seem an impossible task for such young children. However, these same task demands were made of much younger children (i.e., 18- to 24-month-olds) in similar studies (Akhtar, & Tomasello, 1996; Tomasello & Barton, 1994). And, in the present study, the MA and LA groups demonstrated that they were able to discern the meaning of the word.

In contrast, the children with autism could not learn the word. What prevented the AD group from succeeding? General cognitive processes, such as memory, should not have caused the group differences. In Experiment 2, the AD group had demonstrated that they were able to rapidly learn and remember words. Additionally, the MA group was specifically matched on nonverbal mental abilities so as to account for the effects of general cognitive processing skills. Furthermore, the LA group, who learned the words, had less developed cognitive skills (as demonstrated by their lower nonverbal mental abilities levels). All children, including the AD group, were attentive during the training process, watching as each object was removed from the bag. Therefore the problem must lie in the children's understanding of the experimenter's actions. Either the children did not realize that the adult had failed to find the desired object, or the children could not use that information to guide their word learning.

It is possible that the failure occurred at the point of word learning – i.e., that the children were able to recognize the experimenter's failed intention, but unable to use that information to determine which object was the parlu. However, it is more likely that the difficulty was in recognizing the experimenter's intention. In Experiment 3, when the children were not required to learn a new word, they were unable to discern the intentions of the experimenter. And, in extensive previous research, children with autism have been consistently unable to go beyond another's actions to infer the other's intentions (Baron-Cohen, 1989; Baron-Cohen, et al., 1992; Baron-Cohen, et al., 1997; Baron-Cohen, et al., 1993; Hobson, 1993; Kanner, 1943, 1946; Kasari, et al., 1990; Klin & Volkmar, 1993; Leekham, et al., 2000; Lewy & Dawson, 1992; Long, 1994; Loveland & Landry, 1986; Tager-Flusberg, 1999, 2001; but see Carpenter, et al., 2001). In the current experiment, it is impossible to know whether the children with autistic disorder were unable to infer the experimenter's intention, or if their difficulty was in using that information to guide their word learning. In either case, the end result was the same – they could not use the speaker's actions and intentions to learn the meaning of the novel word.

CHAPTER 3: GENERAL DISCUSSION

How do children learn the meanings of new words? One question that has polarized research in this field has been the role of the social environment. On the one hand, associationist theories have argued that children rely on “dumb attentional mechanisms” (Smith, 1995, 1999, 2000; Smith, et al., 1996). That is, the same associative processes that drive all forms of learning are also responsible for word learning. Adults and their intentions are no more important than any other part of the environment. While the adult may direct the child’s attention to a specific object, bright colors, interesting textures, and moving components can do so as well (Samuelson & Smith, 1998). The critical component is the statistical regularities that exist between objects and words (Smith, 1995, 1999, 2000).

In direct opposition, social-pragmatic explanations have focused on the role of the social environment (Baldwin, 2000; P. Bloom, 2000; Nelson, 1996; Tomasello, 1995, 1999). They have claimed that until children understand that adults are attempting to communicate, no word learning can occur (Baldwin, 2000; P. Bloom, 2000; Tomasello, 1999). From birth, infants are immersed in their social environment, noticing and responding to the adults around them (Adamson, 1995; Tomasello, 1999; Vandenberg, 1999). These basic skills develop, providing a child with a means to enter the adult’s mind so that they can use the speaker’s perspective to determine the meanings of words (P. Bloom, 2000; Tomasello, 1999).

Recently, a few theories, such as the Emergentist Coalition Model (ECM), have suggested that both processes may occur (Hirsh-Pasek, et al., 2000; Hollich, et al., 2000). That is, children would begin the word learning process with only associational learning to guide them, slowly amassing a set of individual words. During this process, the children could become more attuned to their social environment – recognizing that adults frequently indicate what objects, actions, and events they are discussing. Children would come to depend more heavily on the information provided by the social environment until eventually they would be able to use the speaker's actions and intentions to acquire words.

Unfortunately, previous research with typically developing children has been unable to resolve this debate. Theorists interpreted the same research findings as support for each of the theories (Akhtar, et al., 1996; Hoff & Naigles, 2002; Samuelson & Smith, 1998). The clues to understanding the speaker's intent would be precisely the same behaviors (looking, pointing, touching, handling) that serve to draw the child's attention to that object. Further, the child's action – learning a word – would also be identical. The only distinction would come in the *interpretation* of the procedures and results, and each side has provided dramatically different explanations for what occurred, and why it did.

This dissertation disentangles the role of *attention* to social cues from the use of these cues to determine social *intentions*. Children with autistic disorder provide the natural test case for the role of social intentions. Extensive research has demonstrated that these children are unable to recognize the intentions of others (for a review, see Baron-Cohen, 1995; Charman, et al., 2000; Tager-Flusberg, 1999, 2001). Thus, the possibility that the children's word learning was due to intentional understanding was eliminated. By studying a group whose word learning strategies were limited it was possible to determine how far word learning could progress through purely attentional means. Further, by learning the extent to which attentional strategies contribute to word learning, it was possible to determine when social intentions become a *necessary* component of lexical development.

To that end, Experiment 1 tested if the AD children were even attending to the people around them. If an adult pointed to an object and said, “Look at that,” would the children do so? All of the children were able to follow the adult’s actions and to locate the target object. This indicated that children with autistic disorder were *not* oblivious to the people around them – rather, they allowed the experimenter’s actions to direct their own behaviors.

Since the children responded to the actions in isolation, we next tested if they could use these actions to guide their word learning. All three groups could follow the speaker’s actions to determine the referent for a novel word, but the AD group could only do so when the word labeled an object that they liked. That is, if the speaker followed in on the child’s interest, and thus placed into alignment social and perceptual cues, all children were able to attach the word to the correct object. When the speaker attempted to label the boring object, the child’s personal interest was pitted against the adult’s actions. A conflict existed between social and perceptual factors. In this case, the children with autistic disorder could not override their own preferences and use the *speaker’s* perspective to determine the meaning of the word.

While Experiments 1 and 2 focused on how children utilize *attentional* forms of social information, Experiments 3 and 4 required that the children use the adult's actions to infer the adult's *intentions*. Could children use an adult's *failed* action to determine what she had intended to do? When the attempted actions matched with the children's previous experience with the objects (the canonical set), all three groups succeeded in performing the target action. While the non-canonical set was more challenging for all children, the control groups still succeeded in discerning the adult's intention, performing the action at least 50% of the time. In contrast, children with autistic disorder appeared unable to identify and complete the intended action, doing so only 15% of the time.

These findings suggest that recent evidence that children with autism could imitate intentional actions should be cautiously interpreted (Aldridge, et al., 2000; Carpenter, et al., 2001). Experiment 3 could not determine whether or not the children with autistic disorder were able to recognize intentions in other people. However, it did demonstrate that they were only capable of completing the actions when the adult's intentions over-lapped with their own knowledge about the objects' affordances (see also Huang, et al., in press). Therefore, before assuming that completion of the target action indicates that children with autism are capable of inferring intentions, researchers must first ascertain if the objects may have provided the key to the children's success.

Given that the autistic group was unable to rely exclusively on the adult's behavior to determine the intended action, they should provide the natural test case for the importance of social intentions for word learning. If AD children can succeed in a short-term, laboratory word-learning task, then it *cannot* be due to a reliance on the speaker's intentions. Experiment 4 required that children learn the meaning of a new word. However, to do so, the children needed to move beyond a focus on the adult's actions to understand her intentions. The typically developing children understood the speaker's intention and relied on that information to find the correct object. As expected, however, the children with autistic disorder were unable to use the adult's intentions to determine which object was named "parlu."

This series of experiments was designed to assess the influence of attentional and intentional social information on children's actions and on their ability to learn novel words. For the first two tasks, merely watching the adult's actions would have given the children sufficient information to locate the correct object. While moving beyond the actions, and taking the adult's perspective, might have been beneficial in these tasks, it was not necessary. In contrast, taking the adult's perspective, and detecting her intended actions, was essential for the remaining tests. Success on Experiment 1 was crucial – children must demonstrate that they are aware of the other person's presence before they could possibly use that person's actions either to learn new words or to derive intentions. Experiment 3 provided the means of interpreting the children's actions on the word learning tasks. If the children could not recognize intentional actions in isolation, then they should likewise be unable to depend on social intentions to guide their word learning.

Typically developing children succeeded on all four tasks. They were able to follow the actions of an adult, and to utilize those actions to determine the meaning of new words. Moreover, they could take the adult's perspective. They used the other person's actions to determine what she was attempting to do – why she was acting in that manner. Reading the adult's intentions was not a simple task. The control children were more accurate if the person's actions were clear (in Experiment 2) or if the objects provided clues as to what the child should do (the canonical set in Experiment 3). However, when necessary, the typically developing groups *could* rely exclusively on the experimenter's actions to discern her intentions (to determine the proper action for the non-canonical set in Experiment 3 or to find the correct object in Experiment 4).

The children with autistic disorder presented a more varied profile. They succeeded on Experiment 1; thus, they were capable of attending to the experimenter. Further, when the social cues coincided with the child's own interests, they were able to use the speaker's actions to guide their word learning (i.e., when the interesting object was name in Experiment 2). Similarly, when the children's previous experience and the objects' affordances matched with the experimenter's actions, the AD group was able to complete the intended action (the canonical set for Experiment 3). However, for the autistic group, this overlap was critical. They could not rely solely on *either* attentional or intentional social information to learn new words (or to identify the intended action). Without confirmation from the children's own preferences or experiences, they could not depend on the adult's actions for guidance.

Implications for Children With Autistic Disorder

This dissertation not only aimed to clarify our understanding of word learning strategies, but also attempted to gain a better understanding of how children with autistic disorder respond to their social environment. Historically, psychologists considered these children to be asocial – unaware of the other people that surround them (Kanner, 1943, 1946). That perception changed to a notion that the children noticed other people, but that they relegated others to the same category as trees, chairs, and toys (Klin & Volkmar, 1993; Mundy, 1995; for a review, see Hobson, 1993). Only recently has evidence surfaced that suggests that children with autistic disorder recognize and *respond* to the actions of other people (Aldridge, et al., 2000; Charman, 2000; Charman, et al., 2001; Leekham, et al., 1998; Leekham, et al., 2000; Meltzoff, 2000). In fact, two studies have suggested that children with autism may be able to infer another's intentions (Aldridge, et al., 2000; Carpenter, et al., 2001; but see Charman, et al., 2001, Huang, et al., in press). Therefore, while the primary focus of this research was to better understand word learning in general, a secondary goal was to clarify how children with autism relate to their social worlds.

The current investigation was restricted to children with verified diagnoses of autistic disorder (APA, 1994). Other related syndromes, that compose the category of autistic *spectrum* disorders, were not included (for example, Asperger's syndrome, Rett's disorder, pervasive developmental disorder – not otherwise specified). Therefore, future research would need to determine if these findings apply to these related syndromes. However, the current study was not limited to high-functioning children – rather, an effort was made to include a range of functioning levels. That this goal was achieved was demonstrated by the variability in performance on the standardized measures (see the general methods section above for detailed information on the children's performance on these tests).

Although the autistic group could use attentional social information to aid their word learning (in Experiment 2), they were unable to use that ability to succeed in Experiment 4. This would indicate that at least some words could not be learned through purely attentional means. However, how relevant is this laboratory task to the children's real lives? That is, in the real world, would the children ever *need* to use word-learning strategies that rely on social intentions? The children's existing vocabularies indicated a substantial effect of not developing an understanding of social intentions. The autistic group's average chronological age was just over 5 years, and their average nonverbal mental age was just under that of a 4-year-old. In contrast, their average vocabulary level was that of a typical 21-month-old. Thus, this inability to utilize the speaker's intention has had dramatic consequences on the children's language development.

Nonetheless, two findings in the current research should provide a source of hope for children with autistic disorder. First, the children *were* able to learn new words! When the adult *followed in* on the children's attention, and provided a name for the object that *they* found most interesting, the children learned the word 91% of the time. Research with typically developing infants has also found that following in on the child's actions (at least during early stages of language development) leads to children acquiring a larger vocabulary (Akhtar, et al., 1991; Carpenter, Nagell, & Tomasello, 1998; Dunham, et al., 1993; Tomasello & Farrar, 1986). A simple suggestion would seem evident from these findings – whenever possible, adults should attempt to teach the children names for the objects, actions, and events that the *child* prefers.

Second, the current pattern of results formed an intriguing parallel to previous research with typically developing infants (Hollich, et al., 2000). In previous research using the same objects as in Experiment 2, 12-month-olds also were able to readily learn the name for an interesting object. Moreover, the younger infants demonstrated the same difficulty in using the speaker's perspective to attach the label to the boring object. Both groups demonstrated that the speaker's actions during training influenced the children's actions during testing and neither group mis-mapped the label (i.e., mistakenly assumed that the label referred to the interesting object) (Hollich, et al., 2000). However, while the children with autistic disorder have only been assessed with the training style of Experiment 2, extensive research has further explored what types of social information *do* enable a 12-month-old to learn the name for a boring object (Hollich, et al., 2000). The similarity between the two groups would suggest that future research should investigate if the abilities of 12-month-olds may not hold the key to unlock at least one of the mysteries of autism.

For children with autism, the great divide is *not* between being social or asocial, but rather it is between being able to make use of attentional versus intentional forms of social information. In typically developing children, these early intentional abilities are precursors to later theory of mind skills (Bartsch & Wellman, 1995; P. Bloom, 2000;

Charman, Baron-Cohen, Swettenham, Baird, Cox, & Drew, 2000; Ruffman, 2000; Tomasello, 1999; Wellman, 1990). Extensive research has documented the failure of children with autistic disorder to achieve theory of mind (Baron-Cohen, 1995; Baron-Cohen, et al., 1993; Bruner & Feldman, 1993; Charman, et al., 2001; Ruffman, 2000; Tager-Flusberg, 1999, 2001). The current research demonstrated that the problem arises much earlier, with a failure to acquire the ability to take another's perspective or even to recognize the intent that underlies another person's action. This early inability to recognize intentional actions may lead to later difficulties in developing a theory of mind.

> It thus may be that the difficulties of children with autism in understanding other persons as intentional agents leads to deficits in their symbolic skills, which then may create difficulties in representing situations perspectivally. (Tomasello, 1999, p. 133)

Implications for Theories of Word Learning

Do children need to recognize a speaker's intentions to learn new words? Or, can mere attention to the adult's actions in word learning contexts lead to full language development? The results of these experiments showed that children could learn some words solely through noting social cues that draw attention to the named objects. Children with autistic disorder, who could not infer the speaker's intentions, were able to learn words, but only when the speaker named objects that the children found interesting. While this finding indicates that there is a means of teaching children with autistic disorder new vocabulary words, it also indicated that attentional social information can only get children part-way through language development. If intention can be discerned, then children are able to infer what the speaker meant to label. Missing this piece, AD children are forced to rely on "dumb attentional mechanisms" and brute association for word learning. For normal language development to occur, children must go past what they can see, realize why the other person acted in that manner, and become able to take the speaker's perspective.

Communicative intentions may not be *necessary* for word learning, but they are clearly important. To date, we cannot quantify how far relying exclusively on attentional information can get a child, but we know that it must be very limited. The substantial gap between the vocabulary level of the autistic group and their chronological and mental ages showed how this restriction had affected their language development.

Finding that attentional cues are sufficient for some word learning, but that an intentional understanding is necessary for later vocabulary growth would argue for a developmental explanation of language acquisition. The Emergentist Coalition Model (ECM) has provided such an account (Golinkoff, et al., 1999; Hirsh-Pasek, et al., 2000; Hirsh-Pasek, et al., in press; Hollich, et al., 2000). Children would begin the word-learning process with a focus on perceptual features of the environment and attentional forms of social information. Initial word learning would be slow and laborious, as the child slowly amassed enough experience to form associations between words and objects (or actions, properties, events, et cetera). However, over time, this would change. The statistical abilities that contribute to the children's associations would begin to detect a new regularity – that mom frequently indicates what she is talking about. Adults don't simply talk to children, they also look at, or point to, or hold up the objects that they are discussing (L. Bloom, 1993, 2000; Bloom & Tinker, 2001; P. Bloom, 2000; Nelson, 1996; Tomasello, 1999).

This recognition of the consistency between the adults' language and their actions would result in the children paying more attention to the social environment (Hollich, et al., 2000). A shift would begin, from the initial reliance on more perceptual cues, to an ever-increasing reliance on subtle social cues such as intent. At first, children may focus on *attentional* forms of social information. However, over time, the children would begin to adopt the speaker's perspective, and eventually to infer the speaker's intentions. Evidence with typically developing children has demonstrated this shift (Hennon, et al., 2001; Hollich, et al., 2000). Ten-month-olds do not yet rely on even attentional social information to determine the meaning of a novel word (Hennon, et al., 2001). By 12 months of age, children have already begun to switch. At this age, infants only learn a word when attentional social cues overlapped with perceptual cues (Hollich, et al., 2000). In sharp contrast, 19- and 24-month-olds had already changed their learning to now rely upon the speaker's perspective to determine the meanings of words (Hollich, et al., 2000).

The current findings dovetailed with the previous research. The children with autistic disorder were capable of recognizing attentional social cues, and used that information to guide their word learning. However, as was the case with the 12-month-olds, they were only able to do so reliably when the social and perceptual information both indicated the same object (i.e., when the adult named the object that the children thought was more interesting). The ECM focused on the need, in early word learning, for multiple, overlapping cues – precisely what children with autistic disorder required. However, according to the ECM, for typical language development to occur, the children must eventually rely more exclusively on social information (Golinkoff, et al., 1999; Hirsh-Pasek, et al., in press; Hirsh-Pasek, et al., 2000; Hollich, et al., 2000).

The ECM has yet to explain *how* this shift occurs or even what types of social information the children would begin to focus on. Is the change due to the formation of a "social crane," much like Smith's (1995, 2000) shape bias? Or, do children develop new skills in perspective taking, and then use these new abilities to begin to detect social intentions? Hollich and colleagues (2000) have developed one means of testing the extent to which children rely on social information. When the speaker attempts to name a boring object, a conflict exists between social and perceptual cues. If children are capable of learning the name for a boring object, then they must also be able to rely on the social cues. In contrast, if children are unable to attach the label to the boring object, then they cannot yet let social information dominate over the competing perceptual cues. However, future research must explore further *when* and *how* this shift occurs.

At its essence, language is communication, and communication depends on being able to actively share the "contents of individuals minds" (Bloom, 1993, p. 14). Recognizing another's perspective may provide children with the first means of accessing another's thoughts. This, in turn, would enable the children to determine what the person meant to do, what the speaker's intention was. Only then would children be able to use language as described by Bloom (2000),

> Language exists in a society to embody and make known our intentional states – the goals and plans, the beliefs and desires, and the feelings we have that are, themselves, unobservable … Children learn language for acts of expression, in the effort to make known to others what their own thoughts and feelings are about, and for acts of interpretation, in the effort to share the thoughts and feelings of another person. (p. 22)

Conclusions

Historically, a sharp divide has been maintained between theories of typical and atypical populations (such as autistic disorder). This separation must end. Research with specific groups should increase our understanding of that population. But, it can also illuminate the processes that drive *typical* development (Bloom & Lahey, 1978). For example, the current experiments provided a glimpse of how children with autistic disorder view their social worlds. But, at the same time, they highlighted the importance of using the speaker's perspective, and of detecting another's intentions, for word learning in general. Only by recognizing that typical and atypical populations share the same general processes of development will psychologists come to truly describe language (Hennon, 2000).

The power of this integration can be seen in the current dissertation. Learning how children with autistic disorder relate to their social worlds has deepened our understanding of this special population. They are attending to other people, and use another's actions to direct their own behavior. This is remarkable considering the degree to which the AD children's functioning levels varied. The overall group was moderate- to low-functioning, yet they were capable of using the speaker's action to learn new words! Their word learning abilities, though, were highly dependent upon multiple, overlapping cues. Without at least two sources of information (for example, the speaker's actions and the child's own perceptual preferences) indicating the same object, they were unable to determine the meanings of novel labels. Redundant cues seem to assist both young word learners and children with autistic disorder (Hollich, et al., 2000).

By studying children with autistic disorder, we not only learned more about a specific group, but also gained insight into how *all* children learn words. Attentional social cues are sufficient to learn words – particularly when the social cues are in alignment with other sources of information (e.g., perceptual cues, linguistic cues). Using social information exclusively to direct attention, however, is not enough for normal lexical acquisition. At some point, children must look beyond the adult's actions and recognize the speaker's intentions. Communicative intentions (and the speaker's perspective) become an *essential* piece of the language-learning puzzle. The challenge for researchers in word learning, and for those interested in treatment programs for individuals with autistic disorder, is to find out **how** typical children shift from using attentional cues to intentional cues. Only when we know more about how this process unfolds will we become able to develop therapies geared toward teaching more proficient word learning strategies to children with autism. Finally, only through investigating how all children make this change will psychologists understand how typical children learn to use language as a true means of communication, as a way to share their thoughts and feelings with another person.

REFERENCES CITED

Adamson, L. B. (1995). *Communication during infancy.* Madison, WI: Brown & Benchmark.

Akhtar, N., Carpenter, M., & Tomasello, M. (1996). The role of discourse novelty in early word learning. *Child Development*, *67,* 635-645.

Akhtar, N., Dunham, F., & Dunham, P. (1991). Directive interactions and early vocabulary development: The role of joint attentional focus. *Journal of Child Language*, *18*, 41-50.

Akhtar, N., & Tomasello, M. (1996). Twenty-four month old children learn words for absent objects and actions. *British Journal of Developmental Psychology, 14,* 79-93.

Akhtar, N., & Tomasello, M. (2000). The social nature of words and word learning. In R. M. Golinkoff, K. Hirsh-Pasek, L. Bloom, L. B. Smith, A. L. Woodward, N. Akhtar, M. Tomasello, & G. Hollich (Eds.), *Becoming a word-learner: A debate on lexical acquisition* (pp. 115-135). New York: Oxford University Press.

Aldridge, M. A., Stone, K. R., Sweeney, M. H., & Bower, T. G. R. (2000). Preverbal children with autism understand the intentions of others. *Developmental Science, 3*, 294-301.

American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders* (4^{th} ed.). Washington, DC: Author.

Argyle, M., & Cook, M. (1976). *Gaze and mutual gaze.* Cambridge, England: Cambridge University Press.

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

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

Baldwin, D. A. (2000). Interpersonal understanding fuels knowledge acquisition. *Current Directions in Psychological Science, 9,* 40-45.

Baldwin, D. A., & Baird, J. A. (1999). Action analysis: A gateway to intentional inference. In P. Rochat (Ed.), *Early social cognition: Understanding others in the first months of life* (pp. 215-240). Mahwah, NJ: Erlbaum.

Baldwin, D. A., Markman, E. M., Bill, B., Desjardins, N., Irwin, J. M., & Tidball, G. (1996). Infants' reliance on a social criterion for establishing word-object relations. *Child Development, 67,* 3135-3153.

Baldwin, D. A., & Tomasello, M. (1998). Word learning: A window on early pragmatic understanding. In E. Clark (Ed.), *Proceedings of the Twenty-Ninth Annual Child Language Research Forum, 29* (pp. 3-23). Cambridge, UK: Cambridge University Press.

Baron-Cohen, S. (1989). Perceptual role-taking and proto-declarative pointing in autism. *British Journal of Developmental Psychology, 7,* 113-127.

Baron-Cohen, S. (1993). From attention-goal psychology to belief-desire psychology: The development of a theory of mind and its dysfunction. In S. Baron-Cohen, H. Tager-Flusberg, & D. J. Cohen (Eds.), *Understanding other minds: Perspectives from autism* (pp. 59-82). New York: Oxford University Press.

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

Baron-Cohen, S., Allen, J., & Gillberg, C. (1992). Can autism be detected at 18 months? The needle, the haystack, and the CHAT. *British Journal of Psychiatry, 161,* 839-843.

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

Baron-Cohen, S., Tager-Flusberg, H., & Cohen, D. J. (1993). *Understanding other minds: Perspectives from autism.* New York: Oxford University Press.

Bartsch, K., & Wellman, H. (1995). *Children talk about the mind.* New York: Oxford University Press.

Bates, E., Camaioni, L., & Volterra, V. (1975). The acquisition of performatives prior to speech. Merrill-Palmer Quarterly, 21, 205-226.

Bellagamba, F., & Tomasello, M. (1999). Re-enacting intended acts: Comparing 12- and 18-month-olds. *Infant Behavior and Development, 22,* 277-282.

Bloom, L. (1973). *One word at a time: The use of single word utterances before syntax.* The Hague: Mouton.

Bloom, L. (1993). *The transition from infancy to language: Acquiring the power of expression.* New York: Cambridge University Press.

Bloom, L. (1998). Language acquisition in its developmental context. In W. Damon (Ed.) *Handbook of child psychology, Vol. 2; Cognition, perception, and language* (pp. 309-370). New York: Wiley.

Bloom, L. (2000). The intentionality model of word learning: How to learn a word, any word. In R. M. Golinkoff, K. Hirsh-Pasek, L. Bloom, L. B. Smith, A. L. Woodward, N. Akhtar, M. Tomasello, & G. Hollich (Eds.), *Becoming a word-learner: A debate on lexical acquisition* (pp. 19-50). New York: Oxford University Press.

Bloom, L., & Lahey, M. (1978). *Language development and language disorders.* New York: Wiley.

Bloom, L., & Tinker, E. (2001). The intentionality model and language acquisition. *Monographs of the Society for Research in Child Development, 66* (4, Serial No. 267).

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

Brazelton, T. B., Koslowski, B., & Main, M. (1974). The origins of reciprocity: The early mother-infant interaction. In M. Lewis & L. Rosenblum (Eds.), Parent-infant interaction (pp. 137-154). Amsterdam: ASP CIBA Foundation.

Brown, J., & Prelock, P. A. (1995). Brief report: The impact of regression on language development in autism. *Journal of Autism and Developmental Disorders, 25,* 305-309.

Brown, R., Hobson, R. P., Lee, A., & Stevenson, J. (1997). Are there “autistic-like” symptoms in congenitally blind children? *Journal of Child Psychology and Psychiatry and Allied Disciplines, 38,* 693-703.

Bruner, J. (1983). *Child’s talk: Learning to use language.* Oxford: Oxford University Press.

Bruner, J., & Feldman, C. (1993). Theories of mind and the problem of autism. In S. Baron-Cohen, H. Tager-Flusberg, & D. Cohen (Eds.), *Understanding other minds: Perspectives from autism* (pp. 267-291). New York: Oxford University Press.

Butterworth, G. E., & Grover, L. (1990). Joint visual attention, manual pointing, and preverbal communication in human infancy. In M. Jeannerod (Es.), *Attention and performance 13: Motor representation and control* (pp. 605-624). Hillsdale, NJ: Erlbaum.

Carpenter, M., Akhtar, N., & Tomasello, M. (1998). Fourteen- through 18-month-old infants differentially imitate intentional and accidental actions. *Infant Behavior and Development, 21,* 315-330.

Carpenter, M., & Call, J. (2002). The chemistry of social learning. *Developmental Science, 5*, 22-24.

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* (4, Serial No. 255).

Carpenter, M., Pennington, B. F., & Rogers, S. J. (2001). Understanding of others' intentions in children with autism. *Journal of Autism and Developmental Disorders, 31,* 589-599.

Carpenter, M., & Tomasello, M. (2000). Joint attention, cultural learning, and language acquisition: Implications for children with autism. In A. M. Wetherby & B. M. Prizant (Eds.), *Autism spectrum disorders: A transactional developmental perspective* (pp. 31-54). XXX;XXX.

Charman, T. (2000). Theory of mind and the early diagnosis of autism. In S. Baron-Cohen, H. Tager-Flusberg, & D. Cohen (Eds.), *Understanding other minds: Perspectives from developmental cognitive neuroscience* (pp. 422-441). New York: Oxford University Press.

Charman, T., Baron-Cohen, S., Swettenham, J., Baird, G., Cox, A., & Drew, A. (2000). Testing joint attention, imitation, and play as infancy precursors to language and theory of mind. *Cognitive Development, 15,* 481-498.

Charman, T., Baron-Cohen, S., Swettenham, J., Cox, A., Baird, G., & Drew, A. (1998). An experimental investigation of social-cognitive abilities in infants with autism: Clinical implications. *Infant Mental Health Journal, 19,* 260-275.

Charman, T., & Huang, C. T. (2002). Delineating the role of stimulus enhancement and emulation learning in the behavioral re-enactment paradigm. *Developmental Science, 5,* 25-27.

Corkum, V., & Moore, C. (1995). Development of joint visual attention in infants. In C. Moore & P. Dunham (Eds.), *Joint attention: Its origins and role in development* (pp. 61-83). Hillsdale, NJ: Erlbaum.

Dawson, G., Meltzoff, A. N., Osterling, J., Rinaldi, J., & Brown, E. (1998). Children with autism fail to orient to naturally occurring social stimuli. *Journal of Autism and Developmental Disorders*, *28,* 479-485.

Dunham, P., Dunham, F., & Curwin, A. (1993). Joint attentional states and lexical acquisition at 18 months. *Developmental Psychology*, *29*, 827-831.

Dunn, L., & Dunn, L. (1997). *Peabody Picture Vocabulary Test – 3rd edition.* Circle Pines, MN: American Guidance Service.

Elliott, C.D. (1990). The nature and structure of children's abilities: Evidence from the Differential Abilities Scales. *Journal of Psychoeducational Assessment, 8,* 376-390.

Fenson, L., Dale, P. S., Reznick, J. S., Bates, E., Thal, D. J., & Pethick, S. J. (1994). Variability in early communicative development. *Monographs of the Society for Research in Child Development, 59* (5, Serial No. 242).

Gergely, G., Csibra, G., Bíró, S., & Koós, O. (1994, June). *The comprehension of intentional action in infancy.* Paper presented at the meeting of the International Conference on Infant Studies. Paris.

Gergely, G., Nádasdy, Z., Csibra, G., & Bíró, S. (1995). Taking intentional stance at 12 months of age. *Cognition*, *56,* 165-193.

Golinkoff, R. M., Hirsh-Pasek, K., Bloom, L., Smith, L. B., Woodward, A. L., Akhtar, N., Tomasello, M., & Hollich, G. (2000). *Becoming a word-learner: A debate on lexical acquisition.* New York: Oxford University Press.

Golinkoff, R. M., Hirsh-Pasek, K., & Hollich, G. (1999). Emerging cues for early word learning. In B. MacWhinney (Ed.), *The emergence of language* (pp. 305-331). Mahwah, NJ: Erlbaum.

Golinkoff, R. M., Mervis, C. B., & Hirsh-Pasek, K. (1994). Early object labels: The case for a developmental lexical principles framework. *Journal of Child Language*, *21*, 125-155.

Gopnik, A., & Meltzoff, A. N. (1994). Minds, bodies, and persons: Young children's understanding of the self and others as reflected in imitation and theory of mind research. In S. T. Parker & R. W. Mitchell (Eds.), *Self-awareness in animals and humans: Developmental perspectives* (pp. 166-186). New York: Cambridge University Press.

Griffin, R. (2002). Social learning in the non-social: Imitation, intentions, and autism. *Developmental Science, 5,* 30-32.

Hennon, E. A. (2000). Integrating the field of language development: How middle-ground theories are embracing both typical and atypical development. Unpublished manuscript.

Hennon, E. A., Slutzky, C. B., Sootsman, J., Hirsh-Pasek, K., & Golinkoff, R. M. (2001, April). *Reconciling competing theories of word learning: Developmental changes from 10 to 24 months.* Poster presented at the biennial meeting of the Society for Research in Child Development, Albuquerque, NM.

Hertzig, M. E., & Shapiro, T. (1990). Autism and pervasive developmental disorders. In M. Lewis & S. M. Miller (Eds.), *Handbook of developmental psychopathology* (pp. 385-395). New York: Plenum

Heyes, C. M. (2001). Causes and consequences of imitation. *Trends in Cognitive Science, 5,* 253-261.

Heyes, C. M., & Ray, E. D. (2002). Distinguishing intention-sensitive from outcome-sensitive information. *Developmental Science, 5,* 34-36.

Hirsh-Pasek, K., Golinkoff, R. M., Hennon, E. A., & Maguire, M. (in press). Hybrid theories at the frontier of developmental psychology: The Emergentist coalition model of word learning as a case in point. In G. Hall & S. Waxman (Eds.), *Weaving a lexicon*. Cambridge, MA: MIT Press.

Hirsh-Pasek, K., Golinkoff, R. M., & Hollich, G. (2000). An emergentist coalition model for word learning: Mapping words to objects is a product of the interaction of multiple cues. In R. M. Golinkoff, K. Hirsh-Pasek, L. Bloom, L. B. Smith, A. L. Woodward, N. Akhtar, M. Tomasello, & G. Hollich (Eds.), *Becoming a word-learner: A debate on lexical acquisition* (pp. 136-164). New York: Oxford University Press.

Hobson, R. P. (1993). *Autism and the development of mind.* Hillsdale, NJ: Erlbaum.

Hoff, E., & Naigles, L. (2002). How children use input to acquire a lexicon. *Child Development, 73,* 418-433.

Hollich, G. J., Hirsh-Pasek, K., & Golinkoff, R. M. (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).

Howlin, P., & Yule, W. (1990). Taxonomy of major disorders in childhood. In M. Lewis & S. M. Miller (Eds.), *Handbook of developmental psychopathology* (pp. 371-383).

Huang, C. T., Heyes, C., & Charman, T. (in press). Infants' behavioral re-enactment of "failed attempts": Exploring the roles of emulation learning, stimulus enhancement, and understanding of intentions. *Developmental Psychology*.

Imai, M., Gentner, D., & Uchida, N. (1994). Children's theories of word meaning: The role of shape similarity in early acquisition. *Cognitive Development, 9,* 45-76.

Jaffe, J., Beebe, B., Feldstein, S., Crown, C. L., & Jasnow, M. D. (2001). Rhythms of dialogue in infancy. *Monographs of the Society for Research in Child Development, 66* (2, Serial No. 265).

Jones, S., & Smith, L. B. (1998). How children name objects with shoes. *Cognitive Development, 13,* 323-334.

Kanner, L. (1943). Autistic disturbances of affective contact. *The Nervous Child, 2,* 217-250.

Kanner, L. (1946). Irrelevant and metaphorical language in early infantile autism. *American Journal of Psychiatry, 103,* 242-246.

Kasari, C., Mundy, P., & Sigman, M. (1990). Affect sharing in the context of joint attention interactions of normal, autistic, and mentally retarded children. *Journal of Autism and Developmental Disorders, 20,* 87-100.

Keil, F. (1994). Explanation, association, and the acquisition of word meaning. In L. B. Gleitman & B. Landau (Eds.), *Lexical acquisition* (pp. 169-197). Cambridge, MA: MIT Press.

Klin, A., & Volkmar, F. (1993). The development of individuals with autism: Implications for the theory of mind hypothesis. In S. Baron-Cohen, H. Tager-Flusberg, & D. J. Cohen (Eds.), *Understanding other minds: Perspectives from autism* (pp. 317-331). New York: Oxford University Press.

Landau, B., Smith, L. B., & Jones, S. S. (1988). The importance of shape in early lexical learning. *Cognitive Development, 3,* 299-321.

Landau, B., Smith, L. B., & Jones, S. S. (1992). Syntactic context and the shape bias in children's and adult's lexical learning. *Journal of Memory and Language, 31,* 807-825.

Landau, B., Smith, L. B., & Jones, S. S. (1998). Object shape, object function, and object name. *Journal of Memory and Language, 38,* 1-27.

Landry, S. H., & Loveland, K. A. (1988). Communication behaviours in autism and developmental language delay. *Journal of Child Psychology and Psychiatry, 29,* 621-634.

Leekham, S., Baron-Cohen, S., Perret, D., Milders, M., & Brown, S. (1997). Eye direction detection: A dissociation between geometric and joint attention skills in autism. *British Journal of Developmental Psychology, 15,* 77-95.

Leekham, S. R., Hunnisett, E., & Moore, C. (1998). Targets and cues: Gaze-following in children with autism. *Journal of Child Psychology and Psychiatry, 39,* 951-962.

Leekham, S. R., Lopez, B., & Moore, C. (2000). Attention and joint attention in preschool children with autism. *Developmental Psychology, 36,* 261-273.

Leekham, S., Reddy, V., Lopez, B., & Stan, P. (1999, April). *Gaze-following and declarative joint attention in children with autism.* Poster presented at the biennial meeting of the Society for Research in Child Development, Albuquerque, NM.

Lewy, A., & Dawson, A. (1992). Social stimulation and joint attention in young autistic children. *Journal of Abnormal Child Psychology, 20,* 555-566.

Long, S. (1994). Language and children with autism. In V. Reed (Ed.), *An introduction to language disorders* (2nd ed.). New York: Merrill.

Loveland, K. (1993). Autism, affordances, and the self. In U. Neisser (Ed.), *The perceived self* (pp. 237-253). Cambridge, UK: Cambridge University Press.

Loveland, K., & Landry, S. (1986). Joint attention and language in autism and developmental language delay. *Journal of Autism and Developmental Disorders, 16,* 335-348.

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

Meltzoff, A. N. (1995). Understanding the intentions of others: Re-enactment of intended acts by 19-month-old children. *Developmental Psychology, 31,* 838-850.

Meltzoff, A. N. (2000). Infants' understanding of people and things. Keynote address at the International Conference on Infant Studies, Brighton, UK.

Messer, D. J. (1994). *The development of communication: From social interaction to language.* New York: Wiley.

Moore, C., Angelopoulos, M., & Bennett, P. (1999). Word learning in the context of referential and salience cues. *Developmental Psychology, 35,* 60-68.

Moore, C., & Duham, P. (Eds.). (1995). *Joint attention: Its origins and role in development.* Hillside, NJ: Erlbaum.

Mundy, P. (1995). Joint attention and social-emotional approach behavior in children with autism. *Development and Psychopathology, 7,* 63-82.

Mundy, P., Sigman, M., & Kasari, C. (1994). Joint attention, developmental level, and symptom presentation in autism. *Development and Psychopathology, 6,* 389-401.

Mundy, P., Sigman, M., Ungerer, J., & Sherman, T. (1996). Defining the social deficits of autism: The contributions of nonverbal communication measures. *Journal of Child Psychology and Psychiatry, 27,* 657-699.

Nelson, K. (1985). *Making sense: The acquisition of shared meaning.* New York: Academic.

Nelson, K. (1996). *Language in cognitive development.* New York: Cambridge University Press.

Owens, R. E. (1982). *Program for the acquisition of language with the severely impaired (PALS).* Columbus, OH: Merrill.

Owens, R. E. (1992). *Language development: An introduction.* New York: Merrill.

Phillips, W., Baron-Cohen, S., & Rutter, M. (1992). Understanding intention in normal development and in autism. *British Journal of Developmental Psychology, 16,* 337-348.

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

Prizant, B. M., Wetherby, A. M., & Roberts, J. E. (2000). Communication problems. In C. H. Zeanah (Ed.), Handbook of infant mental health (2nd ed.) (pp. 282-297). New York: Guilford.

Quine, W. V. O. (1960). *Word and object*. Cambridge, MA: Harvard University Press.

Rogers, S. J., & Pennington, B. F. (1991). A theoretical approach to the deficits in infantile autism. *Development and Psychopathology, 3,* 806-850.

Ruffman, T. (2000). Nonverbal theory of mind: Is it important, is it implicit, is it simulation, is it relevant to autism? In J. W. Astington (Ed.), *Minds in the making: Essays in honor of David R. Olson* (pp. 250-266). Malden, ME: Blackwell.

Rutter, M., & Schopler, E. (1987). Autism and pervasive developmental disorders: Consepts and diagnostic issues. *Journal of Autism and Developmental Disorders, 17*, 159-186.

Samuelson, L. K., & Smith, L. B. (1998). Memory and attention make smart word learning: An alternative account of Akhtar, Carpenter, and Tomasello. *Child Development, 69,* 94-104.

Samuelson, L., & Smith, L. B. (1999). Statistical regularities among count/mass syntax, solidity, and category structure in early noun vocabularies. *Cognition, 73,* 1-33.

Scaife, M., & Bruner, J. (1975). The capacity for joint visual attention in the infant. *Nature, 253,* 265-266.

Schafer, G., & Plunkett, K. (1998). Rapid word learning by fifteen-month-olds under tightly controlled conditions. *Child Development, 69,* 309-320.

Schaffer, H. R. (1984). *The child's entry into a social world.* London: Academic Press.

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* (No. 1, Serial No. 256).

Simmons, J., & Tymchuk, A. (1973). Learning deficits in childhood psychosis. *Pediatric Clinics of North America, 20,* 665-679.

Smith, L. B. (1995). Self-organizing processes in learning to learn words: Development is not induction. In C. A. Nelson (Ed.), *Basic and applied perspectives on learning, cognition, and development* (pp. 1-32). XXX:XXX

Smith, L. B. (1999). Children's noun learning: How general learning processes make specialized learning mechanisms. In B. MacWhinney (Ed.), *The emergence of language* (pp. 277-303). XXX:XXX.

Smith, L. B. (2000). Learning how to learn words: An associative crane. In R. M. Golinkoff, K. Hirsh-Pasek, L. Bloom, L. B. Smith, A. L. Woodward, N. Akhtar, M. Tomasello, & G. Hollich (Eds.), *Becoming a word-learner: A debate on lexical acquisition* (pp. 51-80). New York: Oxford University Press.

Smith, L. B., Jones, S. S., & Landau, B. (1996). Naming in young children: A dumb attentional mechanism? *Cognition, 60,* 143-171.

Smith, L. B., Jones, S. S., Landau, B., Gershkoff-Stowe, L., & Samuelson, L. (2002). Object name learning provides on-the-job training for attention. *Psychological Science, 13,* 13-19.

Stern, D. (1985). *The interpersonal world of the infant.* New York: Basic Books.

Tager-Flusberg, H. (1986). Constraints on the representation of word meaning: Evidence from autistic and mentally retarded children. In S. Kuczaj & M. Barrett (Eds.), The development of word meaning (pp. 139-166). New York: Springer-Verlag.

Tager-Flusberg, H. (1997). Language acquisition and theory of mind: Contributions from the study of autism. In L. B. Adamson and M. A. Romski (Eds.), *Communication and language acquisition: Discoveries from atypical development* (pp. 135-160). Baltimore: Brookes.

Tager-Flusberg, H. (1999). A psychological approach to understanding the social and language impairments in autism. *International Review of Psychiatry, 11,* 325-334.

Tager-Flusberg, H. (2001). Understanding the language and communicative impairments in autism. In L. M. Glidden (Ed.), *International review of research in mental retardation: Autism* (pp. 185-205). San Diego, CA: Academic.

Tomasello, M. (1988). The role of joint-attentional processes in early language acquisition. *Language Sciences, 10,* 69-88.

Tomasello, M. (1995). Joint attention as social cognition. In C. Moore & P. Dunham (Eds.), *Joint attention: Its origins and role in development* (pp. 103-130). Hillsdale, NJ: Erlbaum.

Tomasello, M. (1999). *The cultural origins of human cognition*. Cambridge, MA: Harvard University Press.

Tomasello, M., & Barton, M. (1994). Learning words in non-ostensive contexts. *Developmental Psychology, 30,* 639-650.

Tomasello, M., & Farrar, M. J. (1986). Joint attention and early language. *Child Development, 57,* 1454-1463.

Tomasello, M., Strosberg, R., & Akhtar, N. (1996). Eighteen-month-old children learn words in non-ostensive contexts. *Journal of Child Language, 22,* 1-20.

Trevarthan, C. (1979). Communication and cooperation in early infancy: A description of primary intersubjectivity. In M. Bullowa (Ed.), *Before speech: The beginning of interpersonal communication* (pp. 321-347). Cambridge, England: Cambridge University Press.

Trevarthan, C. (1993). The self born in intersubjectivity: The psychology of an infant communicating. In U. Neisser (Ed.), *The perceived self: Ecological and interpersonal sources of self-knowledge* (pp. 121-173). New York: Cambridge University Press.

Vandenberg, B. (1999). Infant communication. *North American Journal of Psychology, 1,* 29-34.

Want, S. C., & Harris, P. L. (2002). How do children ape? Applying concepts from the study of non-human primates to the developmental study of "imitation" in children. *Developmental Science, 5,* 1-13.

Wellman, H. (1990). *The child's theory of mind.* Cambridge, MA: MIT Press.

Whiten, A. (2002). Primatology and developmental science: Who's aping whom? *Developmental Science, 5,* 36-38.

Wittek, A., & Dehrend, D. (2002, April). *Children use novel verbs to determine an actors' intention: Evidence from the behavioral reenactment task.* Paper presented at the International Conference on Infant Studies, Toronto, Canada.

Wittgenstein, L. (1953). *Philosophical investigations*. New York: Macmillan.

Woodward, A. L. (2000). Constraining the problem space in early word learning. In R. M. Golinkoff, K. Hirsh-Pasek, L. Bloom, L. B. Smith, A. L. Woodward, N. Akhtar, M. Tomasello, & G. Hollich (Eds.), *Becoming a word-learner: A debate on lexical acquisition* (pp. 81-114). New York: Oxford University Press.

Woodward, A. L., & Hoyne, K. L. (1999). Infants' learning about words and sounds in relation to objects. *Child Development, 70,* 65-72.

Woodward, A. L., Markman, E. M., & Fitzsimmons, C. M. (1994). Rapid word learning in 13-18-month-olds. *Developmental Psychology, 30,* 553-566.

APPENDIX A

SUBTESTS OF THE DIFFERENTIAL ABILITY SCALES

Block Building. The block building task uses eight wooden blocks. The first test is for the child to stack as many blocks as possible. For the remaining twelve questions, the experimenter uses four blocks and gives the child the other four blocks. The child is asked to use his/her blocks to build the same thing as the experimenter builds.

Verbal Comprehension. This task tests a variety of identification and direction-following skills. The easiest questions include showing the child a picture of a teddy bear and asking him/her to "show me teddy's eyes" or "show me teddy's ears." Questions progress through more challenging identification tasks (given a set of toys, "give me the car" or "give me all the things that have hair," {a cat, a dog, and a horse}). More challenging sections require the child to follow directions as well as understand prepositions ("put the car under the bridge") and conjunctions ("give me all the chips that are neither red nor square").

Picture Similarities. Children are shown a page with four line drawings across the top. They are given a single card, and asked "which does this go with?" Although the first two items involve exact matches (hexagon with hexagon; smallest circle with smallest circle), the remaining items involve pictures that are similar or related, but never identical (example, a world map and a globe). Perceptual and conceptual similarities are assessed (color, shape and size or an envelope with a stamp).

Naming Vocabulary. Children are shown colored line drawings and asked to provide a name for the picture ("what's this?"). The 26 question progress rapidly from fairly simple items (e.g., chair, key, fish) to more difficult items (e.g., volcano, paper clip, easel).

Pattern Construction. Children are given flat rubber squares that are solid yellow one side and solid black on the other. First, the experimenter places two squares side-by-side, one showing the black side, the other showing yellow. Children are asked to make theirs match the experimenters. Once children can make a matching rectangle, the experimenter shows them pictures in a book that they can also make the squares match. The pictures begin with items requiring two squares, but quickly require four, and then six squares. Children are scored for their accuracy in forming the required design (both for position of squares and for having the correct color showing) as well as speed of formation.

Early Number Concepts. As its name implies, this task assesses emerging number and mathematical skills. The first task is to count to ten. Later items progress from requiring simple counting, to basic addition (e.g., "if he has two balloons and she has three balloons, how many balloons if they put them all together), to more advanced addition (e.g., counting in multiples of ten). Some questions test an understanding of ordinal numbers ("who is fifth in line"); others assess abilities to recognize matching quantities of dissimilar objects (e.g., six snails and six bottles).

Copying. The final subtest administered asked the child to copy simple shapes. First, the experimenter drew a straight line and asked the children to do likewise. Next, she drew a circle and again asked the children to do so. The remaining items required the child to copy line drawings from a book. Early items included a capital T, L and X. Medium difficulty items asked the child to draw a series of lower-case letters (e.g., odo or dbd). More challenging questions presented the child with complicated abstract shapes. Partial credit is given for shapes that approach correct shapes, but that are not ideally formed.

APPENDIX B

SAMPLE ITEMS FROM THE PEABODY PICTURE VOCABULARY TEST

For the Peabody Picture Vocabulary Test – 3rd edition (PPVT; Dunn & Dunn, 1997), children are shown a page with four blank-and-white line drawings, numbered one through four. They are asked to find one picture (e.g., "Where's climbing?"). Children can indicate their response by pointing to the picture or by saying the number for the picture. This appendix provides only a portion of the items contained in the PPVT. It is intended to provide examples of the types of questions asked of the children, not a comprehensive list of every word tested.

Prompt	Pictures in set
Bus	(1) broom, (2) bell, (3) elephant, (4) bus
Climbing	(1) child climbing a ladder, (2) desk, (3) bed, (4) stool
Helicopter	(1) hot air balloon, (2) helicopter, (3) glider, (4) jet
Digging	(1) pulling, (2) digging, (3) climbing, (4) bathing
Feather	(1) feather, (2) fish's tail, (3) antlers, (4) paw
Elbow	(1) hand, (2) neck, (3) wrist, (4) elbow
Arrow	(1) hook, (2) arrow, (3) bow, (4) yo-yo
Nest	(1) spider web, (2) bird in cage, (3) nest, (4) caterpillar
Harp	(1) harp, (2) lute, (3) banjo, (4) guitar
Envelope	(1) calendar, (2) envelope, (3) newspaper, (4) magazine
Rectangle	(1) rectangle, (2) pentagon, (3) polygon, (4) trapezoid
Towing	(1) truck towing a car, (2) car driving on road, (3) wrecked car, (4) car on mechanic's lift
Squash	(1) celery, (2) lettuce, (3) peas, (4) squash
Nostril	(1) ear, (2) lips, (3) eye, (4), nostril
Wrench	(1) pliers, (2) file, (3) bevel, (4) wrench