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Associative learning of pictures and words by low-functioning children with autism

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ABSTRACT This research investigates whether children with autism learn picture, word and object relations as associative pairs or whether they understand such relations as referential. In Experiment 1, children were taught a new word (e.g. 'whisk') repeatedly paired with a novel picture. When given the picture and a previously unseen real whisk and asked to indicate a whisk, children with autism, unlike typically developing peers matched on receptive language, associated the word with the picture rather than the object. Subsequent experiments respectively confirmed that neither a bias for selecting pictures nor perseverative responding accounted for these results. Taken together, these results suggest that children with autism with cognitive difficulties are learning picture–word and picture–object relations via an associative mechanism and have difficulty understanding the symbolic nature of pictures.

KEYWORDS *associative learning; autism; symbolic development*

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Young typically developing infants demonstrate symbolic understanding of both pictures and words by their second birthday (Baldwin, 1991; 1993a; 1993b; Preissler and Carey, 2004; Tomasello, 1998; 2000; Tomasello and Akhtar, 1995). Possessing such symbolic knowledge requires conceptual understanding of symbol–referent relations, specifically, appreciating that pictures or words stand for or represent real items even if the referents are not currently present in space and time. Young children are also adept at monitoring the social world and using the referential intent of adult speakers to ascertain the correct symbolic mappings between pictures or words and their real-world referents. What about a population of children with severe social and linguistic impairment? Children with autism are impaired in both of these domains. This research investigates whether such children, including some individuals who rely upon a pictorial system to communicate,

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are able to form symbolic relationships between pictures, words, and the objects they represent.

Autism is a neurodevelopmental disorder characterized by a triad of impairments in social, behavioral and linguistic domains (Frith, 1989; Kanner, 1943; Volkmar et al., 2000; DSM-IV). One of the most striking deficits across the autistic spectrum is acutely restricted language, with many individuals remaining functionally non-verbal (Lord and Paul, 1997; Tager-Flusberg, 1992; 1996; Volkmar et al., 2000). Augmentative devices based on picture-to-verbal word pairings, such as the Picture Exchange Communication System (PECS), have been successfully implemented as an expressive language tool (Bondy and Frost, 1998; 2002; Lancioni, 1984). The exact process by which low-functioning children with autism learn about pictures has never been closely examined. Specifically, it is unclear whether picture–word and picture–object relationships are established through associative, context-based mappings, or whether children with autism understand the referential, symbolic, relations between the pictures, words, and corresponding real-world objects. 'Low functioning' tends to be a term which conveys different meanings for different researchers; for the present studies I take it to refer to children with impairment in cognitive ability (IQ under 70).

Associative mappings can be created between any two arbitrary stimuli, and are governed by purely statistical regularities in the environment including frequency and temporal contiguity (Rescorla and Wagner, 1972). According to an associative account of word learning, one would have to initially encounter the word or picture in the same context as the real-world entity (Plunkett, 1997). This may make word learning especially difficult as words are generally spoken without their referents in plain sight, and one would expect some associatively based errors. This is precisely what happens in some cases of autism (see Frith and Happé, 1994, p. 98; Kanner, 1946), but such errors do not occur during the course of normal development (Bloom, 2000; Harris et al., 1983).

An alternative account is to possess a symbolic, referential understanding that pictures and words both stand for and represent entities in the world. The relationship between pictures, words, and their referents contains meaning, which is derived from the intention of the symbol's creator (see Bloom and Markson, 1998). Many empirical studies suggest young typically developing children understand the referential capacity of words (Baldwin, 1991; 1993a; 1993b; Tomasello, 1998; Tomasello and Akhtar, 1995).

In Baldwin's (1991) study, upon hearing a new word, infants looked up to consult the speaker for a clue to its referent, and used eye gaze as a predictor of referential content. In contrast, children with autism will instead map a new word to an object in their own line of sight, utterly failing to use eye gaze as a tool for word learning (see Baron-Cohen et al., 1997; Preissler and Carey, 2005). This pattern of results is consistent with associative learning, and other empirical work on the metaphorical use of language by children with autism supports this hypothesis (see Happé, 1995).

With regard to understanding pictures, evidence reveals that young typically developing children comprehend the representational role of pictures by 24 months, and can use information in a picture (as when an experimenter points to a chair in a picture of a room) to locate objects in a real-world counterpart (e.g. finding a toy behind a real chair in the world) by 30 months (see DeLoache and Burns, 1993; 1994). In one experiment, a novel word was repeatedly paired with a single novel picture (Preissler and Carey, 2004). When given the choice between the picture and a previously unseen real object that it represented, 18- and 24-month-old children always selected the real object when asked to indicate the item. This result suggests that very young typically developing children understand that pictures refer to real objects. An associative explanation, in contrast, would predict that children select the picture as it was the primary stimulus mapped to the word.

Experiment 1 uses the same paradigm of Preissler and Carey (2004) to assess whether children with autism with limited language skills, including some users of a PECS system, understand the representational nature of pictures and words. In contrast, they may instead learn picture, word and object relations as associative pairs. This research also examines if prior experience with picture–word and picture–object mappings influences the extent of associative learning.

General method

Subjects

Twenty-two children diagnosed with autism by DSM-IV criteria (mean age 7.5 years, range 5.2–9.5 years) were included in the study and tested in their homes. The diagnosis was previously assessed by an educational psychologist or pediatrician, and was confirmed for this study by the Autism Screener Questionnaire (ASQ: Berument et al., 1999). The ASQ is a 40-item questionnaire based on the original Autism Diagnostic Interview–Revised (ADI–R) algorithm used for ICD-10 and DSM-IV diagnosis of autism. A score of 15 or above is indicative of an autism diagnosis. There were 18 males and four females.

The same children were tested in Experiments 1–3, and were given the following assessments in addition to the ASQ (see Table 1): MacArthur CDIs for receptive language (Fenson et al., 1993); Vineland Adaptive Behavior

Scales (Sparrow et al., 1984); and the Leiter–R IQ test (Roid and Miller, 1997), a non-verbal measure (mean = 62; range 37–90). The MacArthur CDIs are parent report forms which measure language and communication in young children; scores are reported in terms of age equivalence. The Vineland Adaptive Behavior Scales measure personal and social skills used for everyday living, including communication. They therefore provide a more 'naturalistic' account of a child's functioning level outside a testing environment. The Leiter–R is a non-verbal measure of IQ which was specifically designed for use with individuals with language disabilities, since it eliminates verbal demands. Both the Vineland and the Leiter–R provide standard scores (average of 100).

Half of the population used the Picture Exchange Communication System (PECS) (average of 2.5 years' experience); these children were matched to non-PECS users on IQ, age and diagnosis (Table 1). There was a difference in language ability as evidenced by the MacArthur CDI (PECS = 19 months; non-PECS = 25 months) and the communication subtest of the Vineland (PECS = 37; non-PECS = 51). This is not surprising as most users of a PECS system are non-verbal children, as in this study. Most non-PECS users in this study had some verbal ability. The language abilities of the participants varied, as is typical with children diagnosed with autism. The non-verbal participants did not have functional communication skills and had few, if any, words. The verbal participants varied as some individuals had a range of words and others used full sentences (although some phrases were scripted or repetitive).

Procedure

Subjects sat at a table next to or across from the experimenter. Items were placed within the children's reach. Children were reinforced throughout each session consistent with their individual reinforcement system (e.g. verbal praise, token system with choice board, edibles, etc.) for attention and behavior. Correct performance was reinforced only during training trials.

Table 1 **Diagnostic measures**

	All Participants with Autism	*PECS Users*	*Non-PECS Users*
N	22	11	11
Age	7.5 years	7.4 years	7.6 years
IQ (Leiter-R)	62	62	62
ASQ	20	21	19
MacArthur CDI	23 months	19 months	25 months
Vineland Communication subtest	43	37	51

Materials The stimuli were small toys and objects, and 2 inch × 2 inch laminated black and white line drawings modeled after Mayer–Johnson stimuli (Mayer–Johnson Co., 1994) (Figure 1).

Coding Responses were coded as the item(s) children pointed to or gave to the experimenter. Only intentional responses were coded (giving a picture or an object to experimenter, sliding item to experimenter, pointing to item, or picking up and showing to experimenter). If the child played with or explored a picture or an object without clearly indicating a response, this was noted but was not included in the final coding. For instance, if a child indicated that an object was correct (by pointing or giving to experimenter) and then merely played with the picture, this would be coded as a 'real object alone' response. Conversely, if the child indicated the picture (by pointing or giving it to the experimenter) and then merely played with the object, this would be coded 'picture alone' response. Two coders independently coded the videotapes. Agreement on response classification was 94 percent. Disagreements were settled by discussion.

Experiment 1

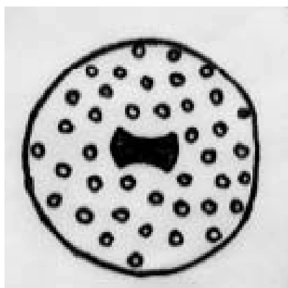
Procedure

Training phase Participants were taught a word, pre-tested as novel, paired with a target picture (either 'whisk' for a picture of a whisk, or a new term 'ziff' for a picture of a garbage disposal crusher, randomly assigned). The stimuli were counterbalanced across participants for Experiments 1 and 2. Children were shown the target picture and told, 'This is a whisk/ziff. Can you touch the whisk/ziff?' The target picture was then presented with a picture determined as familiar (apple), and children were asked to show the experimenter a 'whisk/ziff'. This was repeated until a criterion of three consecutive correct trials was reached. If participants made an error, the training procedure was re-implemented from the initial step (presenting the picture in isolation) until criterion was reached. To ensure that participants had indeed learned the new word, and could discriminate between the target picture and other pictures not used in the teaching procedure, they had to indicate the target picture from an array of five distracter pictures of unfamiliar tools. They were presented in random order in a 3 × 2 sequence.

Mapping test phase Children were presented with the target picture and the previously unseen real object it depicted and were asked to show the experimenter a 'whisk/ziff'. If the participants learned the word through a paired association, without understanding the symbolic role of both words

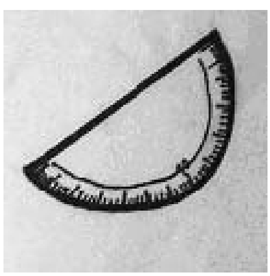
A. Line Drawing (whisk)

B. Real 3-D Object (whisk)

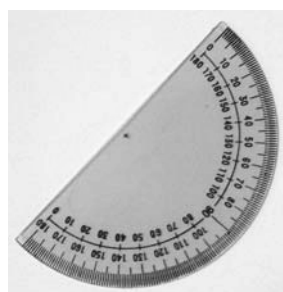


C. Line Drawing (ziff)

D. Real 3-D Object (ziff)



E. Line Drawing (zav)



F. Real 3-D Object (zav)

Figure 1 **Stimuli for mapping test trials, Experiments 1 and 2 (A–D), Experiment 3 (E, F): (A) line drawing (whisk), (B) real 3-D object (whisk), (C) line drawing (ziff), (D) real 3-D object (ziff), (E) line drawing (zav), (F) real 3-D object (zav)**

and pictures, they should choose the picture, since it was the stimulus mapped to the word. According to this view, they could also choose both items due to perceptual similarity between the real whisk and the picture, and still not understand a symbolic relationship between the two. If, however, children understand that both words and pictures refer, they should always include the real object in their choice. A choice of both items could also be consistent with referential understanding, since words do refer to both pictures and objects.

Real item bias control Here, children were presented with 10 trials consisting of one real, familiar object (book, bear, flower, pig, or truck) and one picture of a familiar entity (balloon, cat, apple, crayon, or ball) and were asked to show the experimenter one of the two items ('Show me an X'). This control was performed to ensure that participants could choose an item at the request of the experimenter, and would not simply be drawn to a real, potentially more salient, item. Conversely, children with PECS experience may be biased to select pictures, since they frequently point to pictures in their daily experience. Thus, this control serves to rule out simple object or picture preferences.

Picture choice control Subjects were presented with real items and pictures of those items, e.g. picture of spoon and real spoon, and were instructed to show the experimenter, for example, 'a spoon'. There were four trials of this type (spoon, dog, button, car), randomized for order of administration and side of presentation. The goal of this control was to determine which item (picture, object, or both) children pair with a label for familiar words in their lexicon and to examine if PECS users were more apt to pair words with just pictures, since they have much experience doing so.

Results and discussion

Training phase All children met the word learning criterion (five consecutive correct pairings). There was an average number of 6.8 pairings between the verbal label and the picture, with no difference between PECS (7.5) and non-PECS (6) users ($p = 0.28$, two-tailed, paired t-test). Ten participants (five PECS users and five non-PECS users) required the minimum number (five pairings); three children required six pairings (one PECS user and two non-PECS users), three required seven pairings (one PECS user and two non-PECS users), three required eight pairings (two PECS users and one non-PECS user), and one child required 10 and one child required 19 pairings (both PECS users). Thus, half the children learned to pair the new word with the new picture without error. The other half needed at least one re-implementation of the procedure from the initial step (presenting picture in isolation).

Mapping test phase Five children (22.5%) chose the real item alone, five (22.5%) chose both the real item and the picture, and 12 (55%) chose just the picture alone (Figure 2). These results are significantly different from those obtained from typically developing toddlers, who never selected the picture alone ($\chi^2 = 15.3$, $p < 0.001$, d.f. = 2; see Preissler and Carey, 2004). Seventy-eight percent of the children with autism included the picture in their choice as compared to only 45 percent of the typically developing toddlers, a significant difference ($\chi^2 = 4.6$, $p < 0.03$, d.f. = 1).

PECS versus non-PECS Seventy-three percent of PECS users chose the picture alone, 9 percent selected the real item alone, and 18 percent selected both the picture and the real item (Figure 3). Of the children without PECS experience, 36.4 percent selected the picture alone, 36.4 percent selected real item alone, and 27.2 percent selected both the picture and the real item. The overall difference between the groups was not significant ($\chi^2 = 3.3$, $p = 0.19$, d.f. = 2). However, children in the PECS group were much

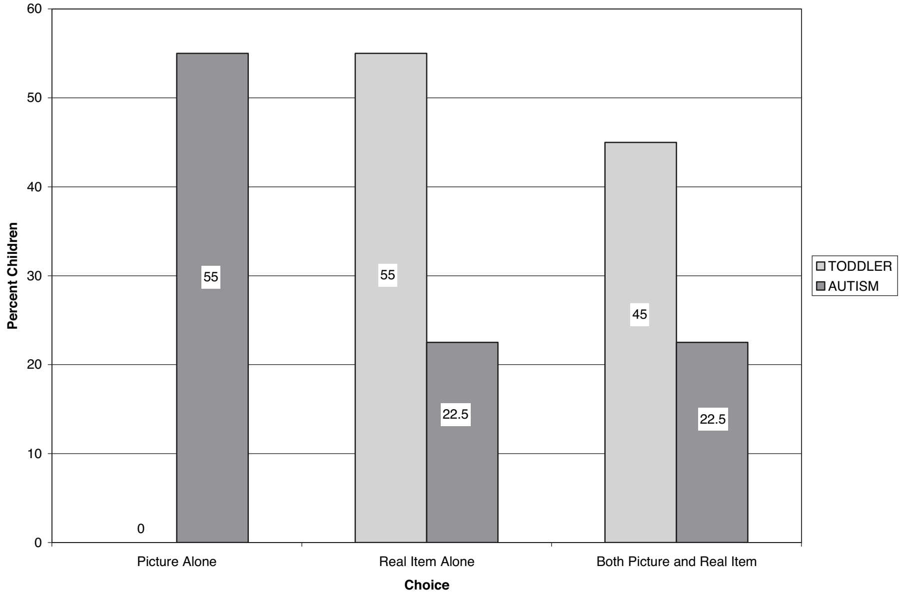


Figure 2 **Results from mapping test phase of Experiment 1 (autism group) and typically developing toddlers (Preissler and Carey, 2004)**

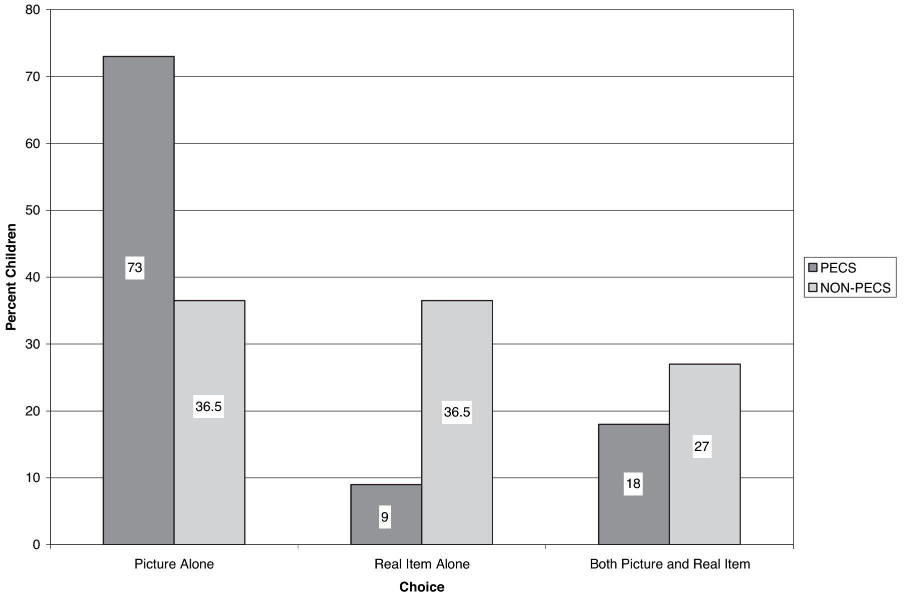


Figure 3 **Results from mapping test phase of Experiment 1: PECS versus non-PECS experience**

more likely than non-PECS users to indicate the picture alone rather than the object alone (odds ratio 8.0; 95% confidence interval 0.66 to 97.3).

Real item bias control Across children, overall accuracy was 89 percent correct, with an average of 86 percent accuracy for trials in which the real item was correct, and 91 percent accuracy for trials in which the picture was correct. There was no significant difference between trial types, and there were no item effects.

Picture choice control In this control, children were presented with four trials consisting of one real, familiar object and one picture denoting the respective object, and were asked, for example, to show the experimenter 'a spoon'. Children selected both the picture and the object on 45.5 percent of the trials, the object alone on 39.7 percent of the trials, and the picture alone on 14.8 percent of the trials (Figure 4). Although children selected the picture on only 14.8 percent of the trials, this effect was largely due to the response of the PECS users (23% picture alone responses versus 6% for non-PECS users).

Discussion Experiment 1 provides evidence that children with autism may not be learning the symbolic nature of words and pictures, but rather are

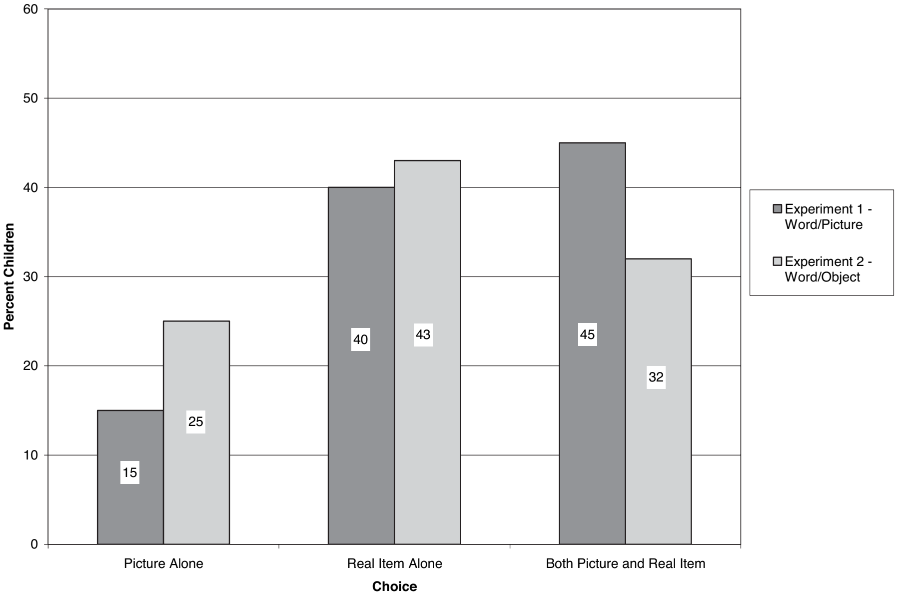


Figure 4 **Results from picture choice control**

learning such stimuli relations as associative pairs. A novel word was paired with a novel picture a minimum of five times; according to an associative account, the central stimulus mapped to the word should be the picture itself. This is precisely the result obtained with this population with autism, but not with typically developing toddlers (Preissler and Carey, 2004).

Results from the real item bias control show that children with autism are perfectly capable of ignoring a real, familiar object in favor of a picture of a familiar entity under these circumstances and that PECS users are not simply just pointing to pictures throughout the trials. Thus, even before the test trial was administered, these results provided some evidence that children did not have a simple preference for pictures or were drawn to potential salience of a real object relative to a picture. This supports the interpretation that the mapping test trial results are not due to a simple preference for pictures or the potential salience of the real object relative to a picture. However, children with PECS experience were more likely to indicate a picture alone both in the mapping test trial and for familiar words in the picture choice control. Note in these trials that the picture and the object share perceptual similarity, as compared with the real item bias controls. Perhaps children who are using this system are simply more likely to associate words with pictures when given the choice of a picture and its perceptually similar real referent, regardless of what stimulus was initially mapped to a novel word, since they so often point to pictures in their everyday experience. Experiment 2 explores this possibility.

Experiment 2

Procedure

The same procedure of Experiment 1 was administered with the following exceptions: (1) the training phase involved pairing a novel word ('whisk/ziff' counterbalanced between experiments) with a novel *object*; (2) the real item bias control consisted of different stimuli and was shortened to four trials; (3) the picture choice control consisted of different stimuli and was shortened to two trials. Results of both controls were not statistically different from Experiment 1, and will not be discussed here.

Mapping test phase Children were presented with the target object and a previously unseen picture depicting the same entity, and asked to show the experimenter a 'ziff/whisk' (Figure 1). This phase serves as a comparison for the mapping test phase in Experiment 1. After learning this mapping, it would be appropriate for children to select the real object on the final trial if they have successfully learned the word–object mapping, either as a symbolic relation or as an association. Additionally, a selection of both items would be consistent with either symbolic understanding (after all we can use words to refer to depicted entities in addition to their primary referents) or associative pairings (the picture is perceptually similar to the real object). However, if children, specifically PECS users, select the picture alone, it would imply that they are biased to select a picture when given the choice of a picture and its perceptually similar object, and that the results from the mapping test trial of Experiment 1 might be due to a simple trained propensity to point to pictures when probed verbally to 'point to the *X*'.

Results and discussion

Training phase All participants met the word learning criterion, with an average of 6.7 pairings between the verbal label and the object. There were 6.4 pairings for PECS users and 7.1 pairings for non-PECS users, a non-significant difference ($p = 0.45$, two-tailed, paired t-test).

Mapping test phase One child did not make an intentional response. Of the remaining 21 participants, three chose the picture alone (14.3%), seven (33.3%) chose the real item alone, and 11 (52.4%) chose both items (Figure 5). Children often select the picture and the object in this test trial,

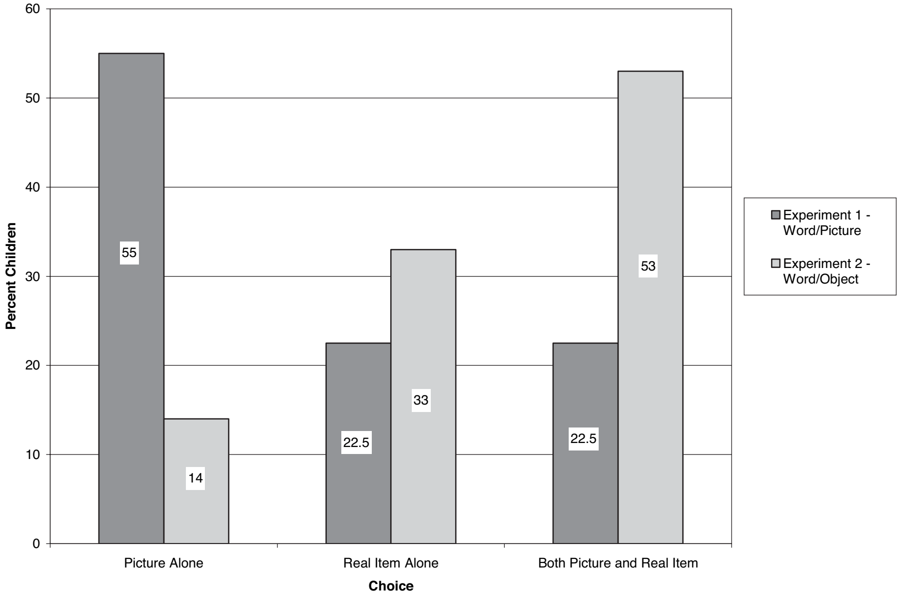


Figure 5 **Results from mapping test trial of Experiments 1 and 2**

which could support an associative or a symbolic hypothesis. Hence these results by themselves do not provide evidence for either account; however, they bear upon the interpretation of Experiment 1. Children are not simply selecting the novel picture alone on the test trial, which differs significantly from the performance in the mapping test trial of Experiment 1 ($\chi^2 = 7.96$, $p < 0.02$, d.f. = 2). This finding rules out a picture preference hypothesis, as we would expect children to select the picture alone in the same proportion as Experiment 1 (55%) if a simple preference for pictures is what determined their response.

PECS versus non-PECS Nine percent of PECS users chose the picture alone, 45.5 percent selected the real item alone, and 45.5 percent selected both the picture and the real item. Of the children without PECS experience, 20 percent selected the picture alone, 20 percent selected the real item alone, and 60 percent selected both the picture and the real item. This is not a significant difference between groups ($\chi^2 = 3.3$, $p = 0.19$, d.f. = 2). The children who selected the picture alone comprised one PECS user and two non-PECS users, and therefore this response choice is not influenced by prior PECS training.

Discussion Results from Experiment 2 support the hypothesis that children with autism are learning picture, word and object relations associatively, and that a history of reinforcement for indicating pictures for the users of a PECS system does not account for the results obtained in Experiment 1. A further possibility may, however, account for the data. Children with autism have notable impairments in frontal lobe function, including perseveration (Ozonoff, 1997; Rapin and Katzman, 1998; Shu et al., 2001), the inability to disengage from a previous action, especially when reinforced, in response to shifting stimuli. During the training trials of Experiment 1 and 2, children are reinforced for correct responding. Perhaps the results of the mapping test trial of Experiment 1, namely children robustly selecting just the picture, are due to perseverative responding and the inability to shift from the previously reinforced response, rather than reflecting associative learning. Experiment 3 explores this possibility.

Experiment 3

Procedure

This experiment was identical to Experiment 1 with the following exceptions: (1) the training phase involved teaching a new word ('zav') mapped to a novel line drawing (a protractor); (2) there were no real item bias control and picture choice control phases; (3) a perseveration trial was introduced, followed by a mapping test trial, both of which are described below.

Perseveration trial Participants were presented with the protractor picture (the response which had been reinforced at least five times) and a picture of an apple. They were asked to show the experimenter an *apple*. If the children have difficulty disambiguating from a previously reinforced response, they should perseverate on the protractor picture and continue to point to it or hand it to the experimenter. If, however, children are paying attention to the experimenter's instruction and are able to disengage from a previous response, they should correctly indicate the apple picture.

Mapping test trial As in Experiment 1, participants were presented with a newly learned picture ('zav') and the real object the picture depicts (a protractor: see Figure 1) and were instructed, 'Can you show me a zav?' This trial is an internal replication of the mapping test trial of Experiment 1.

Results and discussion

Training phase All participants except one met word learning criterion. There was an average number of 6.4 pairings between the verbal label and picture, with 7.2 pairings for PECS users and 5.5 pairings for non-PECS users, a non-significant difference ($p = 0.19$, two-tailed, paired t-test).

Perseveration trial In the perseveration trial, one child did not make an intentional response. Of the remaining 20 participants, 18 correctly chose the apple picture alone (90%), which is statistically different from a chance level of 50 percent ($p < 0.02$, two-tailed t-test). The two remaining participants, both PECS users, indicated the picture of the protractor (10%). Overall, children with autism are able to disengage from the previously reinforced response and indicate a new stimulus at the request of the experimenter. Here, only 10 percent of children selected the previously reinforced response in comparison with Experiment 1 (55%), a statistically significant difference ($\chi^2 = 10.1$, $p < 0.001$, d.f. = 1).

Mapping test phase This trial is identical to the mapping test trial of Experiment 1. Four participants (22.2%) chose the real item alone, eight (44.4%) chose both the real item and the picture, and six (33.3%) chose just the picture alone. These results are significantly different from those obtained from typically developing toddlers, who never selected the picture alone ($\chi^2 = 9.2$, $p < 0.01$, d.f. = 2; Preissler and Carey, 2004) and are not statistically different from the test trial of Experiment 1 ($\chi^2 = 2.4$, $p = 0.3$, d.f. = 2).

PECS versus non-PECS Fifty-six percent of PECS users chose the picture alone, 11 percent selected the real item alone, and 33 percent selected both the picture and the real item. Of the children without PECS experience, 11 percent selected the picture alone, 33 percent selected the real item alone, and 56 percent selected both the picture and the real item. Although there is a trend for children with PECS experience to be more likely to indicate the picture alone than non-PECS users, this is not a significant difference ($\chi^2 = 4.2$, $p = 0.12$, d.f. = 2).

Discussion These results indicate that the children with autism are not simply perseverating on the last previously reinforced response or, in this case, perseverating on a response (picture of a 'zav') that had been reinforced for at least five consecutive trials. Rather, they can inhibit a potentially prepotent response and correctly indicate a newly requested item. Therefore, the results from the mapping test trial of Experiment 1 cannot be explained by perseverative responding. In addition, the mapping test trial of Experiment 3 supports the results of Experiment 1: after learning a word–picture pairing, children with autism are likely to associate the word only with the picture, and not with the object the picture depicts.

General discussion

These results indicate that children with autism with limited language skills are learning picture, word and object relations as associative pairs. In contrast, typically developing 18- and 24-month-old toddlers instead understand the symbolic relation between pictures, words and their referent objects in the world (see Preissler and Carey, 2004). In Experiment 1, children were given repeated experience pairing a new word with a new line drawing. When presented with the newly learned line drawing and its real, previously unseen, referent, children with autism indicated the picture alone over half the time when asked to show the experimenter the referent of the word. In addition, children with autism who had experience using a pictorial system of communication, and therefore a great deal of experience pointing to pictures for expressive and receptive needs, exhibited a higher proportion of 'associative' (picture) responses. It is important to emphasize that even non-PECS users with autism were more likely than typically developing children to indicate the picture alone.

Experiments 2 and 3 ruled out alternative explanations for these data, respectively a simple preference for pictures and perseveration of a last previously reinforced response. Of course, the results could be an effect of limited cognitive function rather than autism *per se*, and examining a group of mentally retarded children without an autism diagnosis would alleviate this confound. Nonetheless, it is clear that this population of children is learning by a different process from typically developing toddlers, and that an associative mechanism may underlie how children with autism learn language.

The hypothesis put forward here is that children with autism are not generalizing a learned label from a picture to a referent object, and this is because they do not know that the main function of pictures is representational. When a picture is labeled for a typically developing child or adult, we adeptly apply the new word to its real-world referent or at least formulate a conceptual representation of a corresponding real referent. We do this because we are equipped with the knowledge that the purpose of a picture is to refer, and therefore when a picture is labeled, somewhere in the world there exists a corresponding referent. Lower-functioning children with autism may lack this knowledge and instead respond in accordance with the principles of associative learning.

This research has implications for the costs and benefits of a pictorial system of communication such as PECS, and for how such systems are taught and implemented. On the one hand, children with limited language abilities greatly benefit from PECS or other visual communicative aids as they can provide a means for children without prior spontaneous functional speech or gestural communication to get their basic needs met, reduce frustration, etc. It is hard to tell (and certainly not from these data) whether the PECS system plays to existing strengths or actually in a sense teaches children to behave more associatively. The kinds of children who rely on PECS most likely have a general associative style, which is why behavioral therapy works so well for such a population. Future research is needed to determine the interaction between an associative style of learning, pictorial communication, and the symbolic development in autism.

Overall, this research indicates that children with autism are learning picture, word and object mappings as associative pairs, rather than as referential relations. Prior experience with a PECS type system or low language level (specifically non-verbal status) influences the likelihood of learning associatively.

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