What constrains children's learning of novel shape terms?

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Abstract

3-year-olds, matched on vocabulary score, were taught three new shape terms by one of three types of linguistic contrast (corrective, semantic or referential). A five-week training paradigm implemented four training and four assessment trials. Corrective contrast ("This is *Concave*. It's not *Square* "; where '*Square*' = child's label for the target) produced more learning than either semantic or referential contrast. Additionally, regardless of group, more was learned about those targets that were classified more variably at pretest. Avoidance of lexical overlap (using more than one term for the same dimension) may make it more difficult for children to learn new dimensional adjectives, and a 'shape bias' might make learning shape terms easier. However, children's expectations about the speaker's communicative intent interacted with the potential benefits of contrast in the semantic condition, and children in that group learnt no more than controls.

Preschoolers' rapid acquisition of new vocabulary is facilitated by their ability to engage in joint attention (e.g. Baldwin, 1991, 1993), their awareness of syntactic forms (e.g. Hall & Graham, 1999), understanding of the speaker's intent (e.g. Akhtar, Carpenter & Tomasello, 1996), and belief that objects have only one name (the assumption of 'mutual exclusivity'; e.g. Markman & Wachtel, 1988). They also believe that new words map onto instances of a novel category for which they do not already know a name ('novel name-nameless category' or N3C principle; Mervis & Bertrand, 1994). By age 2;0 years, children can learn a novel noun after a single exposure by simple naming (e.g. "This is a dax"). However, dimensional adjectives are harder to learn, because the meaning of these words needs to be abstracted from the objects to which they are applied. Rice (1980) took over one thousand trials to teach 3-year-olds three new color terms by telling them, "This is green". The present paper addresses the idea that avoidance of lexical overlap, as described within the mutual exclusivity framework, might make it harder for young children to learn new adjectives for dimensions such as shape, color or texture. This is because extension errors, combined with a belief that terms are mutually exclusive, may prevent a child from determining the referent of a new word within a specific context.

Dimensional adjectives have been taught using linguistic contrast (e.g. Au & Laframboise, 1990; Gottfried & Tonks, 1996), in the form, "this is Y. It's not X", where Y is a new word and X is a word from the same semantic domain as Y, that the child knows. The contrastive context facilitates semantic classification. When hearing, "This is a rhombus. It is not a square" knowing the meaning of 'square' should facilitate semantic classification of the new word 'rhombus' as a shape word. Au and Laframboise (1990) taught 3- to 5-year-olds new color terms with either 'semantic' or 'corrective' linguistic contrast. The former uses one or two terms that are chosen at random from the set the child already knows for the domain, whereas corrective contrast uses the child's own label for a particular referent. Thus, a child would receive semantic contrast when told, "This is ochre. It's not red and it's not green" if 'red' and 'green' were known words but *not* ones the child used to describe the target ochre object at pre-test. If instead the child were told, "This is ochre. It's not yellow" where 'yellow' *was* the term used by the child to label the ochre target, this would be corrective contrast. After a single exposure to the contrastive information children taught by corrective contrast had learned significantly more than a control group taught by simple naming, but another group given semantic contrast learnt no more than controls. Gottfried and Tonks (1996) replicated these findings but varied the test objects on shape as well as color. They found that children interpreted the new terms as shape words when these were introduced in a simple naming context, but as color terms when introduced with corrective contrast. This suggests that children are predisposed to attend to the shape dimension in a word learning context. Au and Markman (1987) also used semantic contrast to teach material and color terms, both with adults and with 3- and 4-year-olds, and found the method effective with adults, but not with children.

Au and Laframboise argued that semantic contrast confuses the child because it introduces an 'unmotivated denial' of terms that the child has not used. An alternative explanation is that the unmotivated denial diverts attention away from the target leads the child to search for the objects named by the speaker, (O'Hanlon & Roberson, 2006). With only one target in view, introducing terms that the child has not used as contrastive information, might conflict with the child's pragmatic expectations. Akhtar (2002) showed that children aged 2- and 3-years are sensitive to pragmatic context. Children in this study were told, "This is a smooth one", or, "This is a round one". When they were subsequently told, "This is a dacky one" in the presence of a novel object of an unusual texture and shape, more children previously exposed to the ‘shape discourse context’ interpreted ‘dacky’ as referring to the shape of the novel object, and more children previously exposed to the ‘texture discourse context’ gave the new term a texture interpretation. Akhtar and Tomasello (1996) proposed that young children actively seek to establish what the speaker wishes to draw the their attention to, and use this information to interpret the meaning of new words. If a child analyses the speaker’s communicative intent within a context of joint attention, they may learn fewer novel shape terms in a context of semantic contrast.

Corrective contrast is more informative because it highlights the relation between the old and the new term. In correcting a child’s extension error, this kind of feedback might help overcome assumptions of mutual exclusivity. This might be particularly relevant for color terms, as young children make more extension errors during early label acquisition in this domain (e.g. Backsheider & Shatz, 1993) than they do in other domains such as shape or material (Au, 1988). A combination of extension errors and an assumption of mutual exclusivity would render the learning of new color terms more effortful, and corrective contrast would be particularly useful under these circumstances. If children are less inclined to over-extend the shape terms they know, then, assumptions of mutual exclusivity should impact less on learning in this domain, and shape terms may be easier to learn. Shape terms might also be relatively easy to learn because children are predisposed to attend to the shape of objects in early word learning (Imai, Gentner, & Uchida, 1994; Landau, Smith, & Jones, 1988). Samuelson & Smith (2000) showed that 3-year-olds use shape as a criterion for word extensions even if they are shown that a particular object’s shape can be altered, before a new name for it is given. Thus a ‘shape bias’ in early word learning (e.g. Landau et al., 1988) might also facilitate the learning of novel shape terms.

The paradigm used here is the same as that with which O'Hanlon & Roberson (2006) taught 3-year-olds new color terms by corrective, semantic and referential linguistic contrast. Referential contrast reflects a naturalistic setting (e.g. "Pass me the concave box; not the square one"), where all the referents named in the input are in view at the time the contrastive information is given (unlike corrective and semantic contrast). O'Hanlon and Roberson found that children receiving corrective contrast learnt significantly more than controls, but those receiving semantic contrast did not, whereas children exposed to referential contrast performed at an intermediate level compared to the other two experimental groups. In addition, irrespective of group, all the children learnt more about the target that they showed less certainty in classifying on a pre-experimental naming task (*beige*) than two other targets, *crimson* and *teal*, consistently classified as 'red' and 'blue', respectively. This pattern would be predicted if children were treating terms as mutually exclusive. A previous study by Carey and Bartlett (1978) using referential contrast reported successful fast mapping among 3-year-olds of a new color term after a single exposure to this learning context, but a replication of this study by Heibeck and Markman (1987) found a similar level of learning when children were told, "Bring me the chromium tray, not the *other* one" Thus the rapid learning in Carey and Bartlett's study might be due to the child's ability to draw correct inferences within the communicative context rather than by the referential contrastive input per se. This interpretation fits a pragmatic view of adjective learning, in which the child avoids lexical overlap by making a successful inference about the speaker's intent (Diesendruck & Markson, 2001). Similarly, children in O'Hanlon and Roberson's referential contrast group may have used pragmatic cues to successfully infer the meaning of the new color terms, while they did not have the advantage of having an extension error corrected, as those in the corrective contrast group did.

The present studies sought to establish the wider applicability of these finding, for children's learning of new adjectives beyond the domain of color. We chose shape terms for comparison, but used the same methodology for two reasons. First, for a domain (shape) to which children appear to orient naturally, linguistic contrast might not facilitate novel term learning any more than simple naming. Second, if there are any potential benefits of using semantic linguistic contrast to teach children new adjectives, these are most likely to emerge in a domain that is relatively easy for them to learn. By making a direct comparison of the effects of corrective, semantic and referential linguistic contrast on novel shape term learning we addressed the question of whether the assumption that two labels are mutual exclusive is the only impediment to young children's learning of new dimensional terms, or whether this interacts with broader aspects of the communicative context.

The experiments used a five-week training paradigm to teach 3-year-olds (matched on vocabulary score) three novel shape terms. Computerized stimuli were used to equate task structure and task demands across conditions, and children interacted with a cartoon character, which introduced the 'games' and gave the children linguistic feedback.

Method

Participants

60 native English-speaking children (38 boys, 22 girls), between 3 years 0 months and 4 years 0 months of age (mean = 3 years 5 months) were recruited from local nursery schools. All had normal language development as assessed by the British Picture Vocabulary Scale (BPVS II; Dunn, Dunn, Whetton, & Burley, 1997). Groups were matched on vocabulary score and all children had vocabulary scores between 3 years 1 month and 3 years 10 months (BPVS II score range 91-111). Among these participants, 12 children were

randomly assigned to one of five groups. The distribution of children across groups is given in Table 1.

(Table 1)

Apparatus and Materials

An Apple Macintosh PowerBook G4 laptop computer was used to generate and present test stimuli. Shape stimuli were presented in cartoon-like video clips (approximately 32 x 20 cm) using SuperCard. Sound recordings were added using Sound Studio and presented via a Sennheiser HD495 headset. A total of 14 stimuli were used in the study, 11 of these were 'basic' shapes, selected among those typically taught in nursery schools either explicitly (i.e. geometrical figures; e.g. circle,) or in contexts such as drawing and story reading (e.g. star, diamond); the other three were the target shapes. The 11 basic shapes chosen were *circle, square, triangle, rectangle, diamond, oval, arrow, star, heart, moon* and *cloud.* The 3 targets were two very low frequency shapes, *chevron* and *concave,* and a novel shape labeled '*pounch'*. These are shown in Figure 1. The target shape words were chosen to ensure that the shape terms were indeed 'novel' for all children and that they were extremely unlikely to encounter these terms outside the experimental environment. Target shapes were selected on the basis of a pilot study, in which an independent sample of 34 three-year-olds attending nursery school were asked to name a variety of low-frequency shapes, selected from the BPVS II (Dunn, Dunn, Whetton, & Burley, 1997), as well as novel shapes, presented individually on sheets of white A4 paper, outlined in black ink. The chevron, concave and 'pounch' stimuli were selected as the targets because children gave enough labels for these (rather than saying, "I don't know"), to enable the experimenter to generate the protocol for the semantic, corrective and referential contrast conditions. 65% of children in the pilot study labeled the chevron shape either 'arrow' or 'kite', 41% labeled the concave shape as either cup, mug or glass, and 77% labeled the pounch stimulus ‘flower’. The full set of labels given by children who participated in the current study, in response to the three target shapes, is summarized in Appendix A. Both the test objects and the cartoon character measured approximately 3.0 x 3.5 cm.

(Figure 1)

Procedure

Each child was tested individually in a quiet corner of the nursery. For computerized tasks children wore headphones and sat facing the screen at a distance that enabled them to touch it (approximately 40 cm). The study took place over a period of 6 weeks for each child. During the first week four pretests were administered, in the following order: (a) a listing task, (b) an assessment of vocabulary age (BPVS II), (c) a naming task (using the full set of fourteen shape stimuli) and (d) a comprehension task (displaying the full set of fourteen shape stimuli but only asking to point to the 11 ‘basic’ shapes). During the successive 5 weeks, four experimental training sessions were run, each followed by an assessment of shape term comprehension. There was a delay of 5 days between training and assessment, and a delay of at least 1 day between assessment and the next training session. The naming, comprehension, and training tasks used computer-generated video-clips in which a (colorless) cartoon character interacted with the child. All instructions, elicitations of responses and appropriate linguistic feedback were delivered by the cartoon character.

Listing task

Children were asked to tell the experimenter all the shape words they knew. Those who failed to list any words were prompted with, “What is your favorite shape?” and then, “Are there any other shapes you can think of?”

Naming task

The cartoon character introduced the game and, on the appearance of the first shape asked, “What shape is this one?” The experimenter recorded the child’s response. The first shape was then replaced by another shape in the same location. The sequence was repeated until all of the 14 shapes were displayed once. If a child failed to respond to the computerized voice, the experimenter prompted him/her saying, “Do you remember this one?” Shapes were presented in random order.

Comprehension task

Fourteen shapes were shown and the child was asked, “Can you show me where my X shape is?” The experimenter recorded the child’s response, and the child was then asked, “Are there any more X ones?” The sequence was repeated for the 11 basic shapes at pretest, and for all the 14 shapes on subsequent assessments.

Experimental training trials

Each training session consisted of three trials, one for each target shape. Three test objects were displayed on each trial. One was the target object; the other two were distractors. Distractors were chosen from the set of 11 ‘basic’ shapes used in the study. The triads were arranged so that each target appeared alongside distractors that children were equally familiar with. The distractors chosen were circle, square, heart and star. On the first two sessions, the test objects were aligned in the center of the top half of the screen, and were white in color; the cartoon character appeared in the center of the bottom half of the screen. On the second trial the test objects were aligned vertically to the right of the screen, and were red in color; the cartoon character appeared to the left of the screen. On the fourth trial the test objects were blue and appeared to the left of the screen, with the character appearing to the right. The test objects and shape sets used are summarized in Appendix B.

Each training trial initially showed three pale grey circles on the screen. The game was explained by the character and then the circles were replaced by the test objects.

In the corrective and semantic linguistic contrast conditions, and the respective control condition (Control 1), the child was asked, for example, “Can you show me where my chevron shape is?” Once the child pointed at the screen, the game proceeded with the character saying, “There it is! I am going to get it!” moving across the screen to the target object, whether the child’s response was correct or not. The two distractors were replaced by pale grey circles, and the appropriate linguistic input was given. Children in the first control group heard, “See this, this is my chevron shape”*;* children in the corrective linguistic contrast group heard, *“*See this, this is my chevron shape, it is not my [child’s own label] shape*”*; in the semantic linguistic contrast group they heard, for example, *“*See this, this is my chevron shape, it is not my star shape, and it is not my circle shape*”*

In the referential linguistic contrast condition, the child was asked, *“*Can you show me where my chevron shape is, not my star shape, and not my circle shape?*”* with the chevron, the star and the circle in view. In the respective control condition (Control 2), the child was asked, “Can you show me where my chevron shape is?” The three shapes remained on display throughout the trial. If the child gave a correct response, the character jumped up, moved across the screen to the target object, pointed to it, and said, “Thank you! I found it! I found my chevron shape!” If the child gave an incorrect response, the character looked left and right (first and second trials), or up and down (third and fourth trials), jumped up and down remaining in the same location, and said, “I’ve looked for my chevron shape! Shall we look for another one?”

In all conditions, the next trial was “played” with a new triad using a different target shape, and a different pair of distractors. At the end of the third trial, the child was thanked for their participation. Targets were presented in random order. The number of times that target words were spoken was equated across trials and groups. Training sessions lasted about 10 min.

2-week follow-up

The naming, comprehension and listing tasks were administered again two weeks after the final training session.

Results

Pretest listing task

Children listed a mean of one shape word at pretest, and two at the 2-week follow-up after completion of the training period (Time 5). The difference was significant by a paired samples t test, t (59) = 7.25, $p < .01$.

Shape knowledge at pretest and Time 4

Table 2 summarizes the percentages of children who knew each of the eleven ‘basic’ shapes at pretest and at the end of the training period (Time 4). Significantly more shape terms were known at Time 4 (9) than were at pretest (8) by a paired samples t test, t (59) = 2.88, $p < .01$.

(Table 2)

Overall learning

All learning scores varied from 0 to 1. Two overall comprehension scores were computed for each child, one for ‘rate of learning’ and one for ‘degree of learning’, over the training period. These scores pooled data across the three target shapes. Rate of learning scores quantified how early on during the experimental timeframe children first successfully identified at least one target at assessment; overall degree of learning scores quantified the proportion of successful responses across the four assessments. Degree of learning scores were also computed for data pooled across targets at Time 1 (assessment 1), Time 4 (assessment 4) and Time 5 (two-week follow up). These scores are summarized in Table 3. A detailed description of how the learning scores were calculated is given in Appendix C.

(Table 3)

Degree of learning was also assessed separately for each one of the three targets at Time 1, Time 4 and Time 5. By comparing accuracy in response to the targets at the beginning and at the end of the training period (Time 1, Time 4), as well as between the first / last assessments and the two-week follow up (i.e. Time 1 vs Time 5; Time 4 vs Time 5), it was possible to capture the changes that took place over time, and whether there was significant learning retention two weeks after training. Learning scores obtained across groups for individual targets are summarized in Table 4.

(Table 4)

We first considered the rate of learning and the overall degree of learning for the semantic contrast, corrective contrast and control (Control 1) groups, followed by the overall learning for the referential contrast and control (Control 2) groups. Next, we compared performance across all the five groups, at Time 1 (first assessment) and Time 4 (fourth assessment), and then compared performance at Time 1 with the 2-week follow up (Time 5). Direct comparisons of the effects of semantic, corrective and referential linguistic contrast were made possible by having computerized stimuli in which task structure and task demands were equated across all groups, despite subtle differences in the three kinds of learning context.

Rate of learning and overall degree of learning: semantic, corrective and control groups

Between group differences were examined in two (rate of learning, degree of learning) one-factor between subjects ANOVAs with three levels (control, semantic, corrective). The effect of condition on rate of learning was not significant, *F* (2, 33) = 1.21, MSE = .06, $p > .05$, whereas there was a significant effect of condition on overall degree of learning, *F* (2, 33) = 13.70, MSE = .02, $p < .001$. Thus there were between-group differences in the overall amount learned about the three targets over the study period, but not in how early on during the experimental timeframe children begun to correctly identify at least one of the targets on the comprehension task. Post hoc analysis (Tukey HSD) computed on overall degree of learning scores showed that the corrective linguistic contrast group learned more than controls ($p < .001$) and more than children in the semantic linguistic contrast group ($p < .01$), but there were no differences between the control and semantic contrast groups. Even in the shape domain, these results indicate that corrective contrast facilitates learning more than semantic contrast, and that semantic contrast is no more useful than simple naming, at least for young children, when used to guide word learning of new adjectives denoting shape.

Rate of learning and overall degree of learning: referential and control groups

Two separate independent samples t tests were used to analyze between group differences on rate of learning and overall degree of learning scores. Rate of learning scores did not differ significantly between the referential contrast and control groups, *t* (22) = 1.63, $p > .05$, whereas there was a significant difference on overall degree of learning scores, *t* (22) = 2.19, $p < .05$. Thus the referential contrast group learned more overall than the control group, but did not succeed earlier in the training period.

Rate of learning and overall degree of learning: all groups

Independent samples t tests computed on the rate of learning scores and on the overall degree of learning scores for the two control groups showed no differences on either measure of learning, both *t* (22) < 1. Data for these two groups was collapsed for subsequent analyses.

Comparisons between the three experimental groups and the (combined) control groups were examined in two separate (rate of learning, overall degree of learning) one-factor between subjects ANOVAs with four levels (control, corrective, semantic, referential). There was again no effect of condition on rate of learning scores, F (3, 56) = 1.68, MSE = .06, $p > .05$, but a significant effect of condition on overall degree of learning, F (3, 56) = 10.54, MSE = .03, $p < .001$. Post hoc analysis (Tukey HSD) computed on overall degree of learning scores showed better performance among children in the corrective linguistic contrast group compared to those in the semantic contrast group ($p < .01$) and controls ($p < .001$), and better performance among children in the referential contrast group than controls ($p < .05$). However, there were no differences between the referential and the semantic contrast groups, between the corrective and the referential contrast groups, or between the semantic and control groups (all $p > .05$). Overall, children learning by corrective contrast performed better than all the other groups except the referential contrast group, whose performance was intermediate between the corrective and semantic contrast groups.

Degree of learning of individual targets: all groups

If children operated the assumption of mutual exclusivity when learning new words, then, less should be learned of the ‘pounch’ target than of the chevron and particularly of the concave targets, as the latter two were labeled rather inconsistently at pretest (Appendix A), whereas the ‘pounch’ target was very consistently classified as either ‘flower’ or ‘cloud’ by all participants. The learning data for the three individual targets is summarized in Table 4.

These data were analyzed in a 4 (Condition: control, corrective, semantic, referential) x 3 (Target: chevron, concave, pounch) x 2 (Time: degree of learning at Time 1, degree of learning at Time 4) mixed design ANOVA with repeated measures over the second and third factors. Significant main effects were found of Condition, F (3, 56) = 3.34, MSE = .20, $p <$

.05, Target type, F (2, 112) = 3.65, MSE = .15, $p < .05$, and Time of assessment, F (1, 56) = 272.15, MSE = .10, $p < .001$. There was no significant interaction between Target and Condition, F (6, 112) < 1, or between Target and Time, F (2, 112) = 1.99, MSE = .13, $p >$ .05, but the interaction between Time and Condition was significant, F (3, 56) = 9.29, MSE = .10, $p < .001$. There was no three-way interaction, F (6, 112) < 1.

Post-hoc analysis (Tukey HSD) of the main effect of condition showed that the corrective contrast group outperformed the control group ($p < .05$), and post-hoc analysis (Tukey HSD) of the main effect of target showed more overall learning of the concave target compared to the pounch target ($p < .05$). Post-hoc Pairwise comparisons (Tukey HSD) of the interaction between time and condition showed more learning at Time 4 among the corrective contrast group compared to the controls ($p < .01$). There were no other significant differences in this analysis. Overall, the corrective contrast group performed better than the other three groups at Time 4, and more was learned of the concave target than of the chevron or the 'pounch' targets. This pattern is consistent with the proposal that children failed to interpret the new labels as shape terms because they applied the principle of mutual exclusivity of labels and that correcting a child's extension of their own label (ascertained at pretest) facilitated novel shape term learning. In line with this, all of the children given corrective contrast responded successfully to the concave target on the final assessment trial.

2-week follow-up (Time 5): all groups

Learning retention of the three targets following the training period was examined by comparing the degree of learning scores at the first assessment to those at the 2-week follow-up (Table 3) using a 4 (Condition: control, corrective, semantic, referential) x 3 (Target: chevron, concave, pounch) x 2 (Time: degree of learning at Time 1, degree of learning at Time 5) mixed design ANOVA with repeated measures over the second and third factors.

The main effect of Condition was not significant, *F* (3, 56) < 1, but there were significant main effects of Target type, *F* (2, 112) = 5.29, MSE = .18, *p* < .01, and Time of assessment, *F* (1, 56) = 93.68, MSE = .10, *p* < .001. The interaction between Target and Condition was not significant, *F* (6, 112) < 1 and the interaction between Time and Condition was not significant, *F* (3, 56) = 1.64, MSE = .10, *p* > .05, but there was a significant interaction between Target and Time, *F* (2, 112) = 4.75, MSE = .12, *p* < .05. There was no three-way interaction, *F* (6, 112) < 1.

Post hoc pairwise comparisons (Tukey HSD) of the main effect of Target type found more learning across groups of the concave target compared to both the pounch and the chevron targets (both *p* < .05). Post hoc analysis (Tukey HSD) of the interaction between Target and Time showed better performance at the 2-week follow-up with the concave target compared to both the chevron and pounch targets (both *p* < .01). This suggests that children found the concave target easier to learn, consistent with the idea that an assumption of mutual exclusivity might have hindered learning of the chevron and 'pounch' targets to a greater extent than the concave target, because children were less certain how to categorize this stimulus in the pretest naming task ("What shape is this one?").

Further analyses: comparison between shape and color term learning

The training paradigm used in the current study was identical to that used by O'Hanlon and Roberson (2006) to teach color terms, and the samples were matched on both chronological age and vocabulary score. We were thus able to directly compare learning between the two domains. Control data within each set of studies was collapsed, as there were no significant differences between Control group 1 and Control group 2 in either study. We compared the overall degree of learning scores using a 2(Target type: shapes, colors) x 4(Condition: control, semantic, corrective, referential) fully between subjects ANOVA. .

Results showed a significant main effect of Target type, F (1, 88) = 61.804, MSE = .02, $p <$ .001, and a significant main effect of Condition, F (3, 88) = 14.985, MSE = .02, $p < .001$, but no interaction. Pairwise comparisons (Tukey HSD) of the main effect of Condition showed that all four groups learning novel shape terms significantly outperformed the equivalent groups learning novel color terms (all $p < .05$). Thus shapes were easier to learn than colors, but corrective contrast was consistently better than other forms of contrast or simple naming in teaching novel dimensional adjectives. The results of the two studies are summarized in Figure 2.

(Figure 2)

Discussion

The present study used corrective, semantic and referential linguistic contrast to teach 3-year-olds new shape terms, and showed that corrective and referential contrast facilitated more learning than simple naming, whereas semantic contrast did not. Additionally, the data showed that all children, regardless of group, learned more about the concave target than they did about the chevron and ‘pounch’ targets. The concave target was the shape that children gave more variable labels to at pretest (Appendix A), suggesting less certainty about the classification of this object. However, the data also showed no differences across groups in the rate of learning, measured by the earliest assessment trial on which children gave at least one correct response to any target. We consider the usefulness of corrective, semantic and referential contrast on the degree of learning first, and then address the possible reasons why, regardless of the kind of feedback received, all children’s rate of learning scores were similar.

Correcting a child’s own label with a new shape term in a contrastive manner, might facilitate learning because it overtly rectifies the child’s extension error. When learning new count nouns, even one-year olds take advantage of corrective contrast (Chapman, Leonard, &

Mervis, 1986). When children are learning new adjectives, corrective feedback is particularly useful because this class of words applies to many different objects that might be otherwise semantically unrelated. The correction draws the child's attention to the appropriate dimension as well as enabling an assessment of the relation between the child's classification (e.g. 'cup-shaped' for the 'concave' target) and the adult classification ('concave'). Word learning is facilitated when multiple sources of information 'converge on a common hypothesis' (Woodward & Markman, 1998). Additionally, if a child holds a strong belief about the semantic classification of a particular referent, corrective contrast should help overcome assumptions of mutual exclusivity. Bowerman and Choi (2003) suggest that the stronger the existing organization of the perceived world is, the greater the resistance that has to be overcome to restructure it. Our data support this view since all children, regardless of the feedback received, found it easier to map the new word 'concave' than they did to map 'chevron' or 'pounch', and there was considerably less certainty about the classification of this target at pretest. 47% of the children gave names for the concave target that differed from one another, compared to 18% in response to the chevron target, and only 3% in response to the 'pounch' target.

Even with the shape domain, that appears relatively easy to learn, semantic contrast did not facilitate learning. Semantic contrast provides some additional information about the meaning of new adjectives, by contrasting them with familiar words from the same semantic domain as the to-be-learned word. Yet 3-year-olds (unlike adults) appear to be unable to use this information to guide word interpretations. This may be because, when learning new adjectives, children at this age still rely heavily on pragmatic cues, such as the objects that are the locus of attention for both the word learner and the speaker at the time new words are introduced, or the objects that the speaker intends the child to direct attention to in the conversation (e.g. Akhtar and Tomasello, 1996). The ‘unmotivated denial’ (Au and Laframboise, 1990) in semantic contrast might divert the child’s attention away from the intended target in a search of the alternatives named by the adult.

Children receiving referential contrast learned an intermediate amount between those given corrective contrast and those given semantic contrast. The context offered by referential contrast should facilitate learning since the negated alternatives (e.g. star and circle) can be seen at the time the novel term is introduced. The information available to the child within context leads to a single hypothesis about the meaning of the new word. However, with referential contrast, children had to exclude the irrelevant objects in order to focus on the target. Dividing attention may have made learning harder. In addition to these attentional demands, the slight difference in the amount of learning promoted by referential and corrective contrast might also have been due by the latter enabling children to overcome assumptions of mutual exclusivity. A similar pattern of results was found in children learning mappings between new color terms and new colors by O’Hanlon and Roberson (2006).

The consistent pattern of results across two different dimensional domains suggests a common strategy underpinning the learning of new adjectives by 3-year-olds. Children come to the word-learning context predisposed to avoid lexical overlap. At the same time, they take account of the relationship between the objects in view and the information conveyed by the speaker. However, constraints on word learning such as assumptions of mutual exclusivity and an assessment of the speaker’s intent can operate in parallel. Our data suggest that, even with a domain such as shape, which children are predisposed to attend to, treating terms as mutually exclusive may hinder novel term learning and, at the same time, a context in which pragmatic cues are confusing also hinders learning. So semantic contrast attempts to direct the child’s attention to the dimension of shape by contrasting a novel term with familiar shape terms, but the child's expectation that the speaker will name only objects that are the focus of joint attention overrides that information and this kind of learning context does not support learning at 3 years of age.

The idea of a 'shape bias' early in word learning has recently been challenged (e.g. Cimpian & Markman, 2005; Diesendruck & Bloom, 2003). However, our data support the existence of a predisposition to attend to the shape of objects in a word learning context, because (unlike for colors) there were no differences in the *rate* of learning across groups and children in all groups (even controls) learned more about the novel shape terms than children taught novel color terms in an identical training regime. Our data support the proposal of Gottfried and Tonk's (1996; see also Au, 1988; Dockrell, 1981) that, at the very least, children notice the shape of an object before they notice other dimensions, and this tendency supports the learning of novel shape terms.

Retention of these terms 2-weeks after training was poor however, compared to the single trial learning reported for count nouns (Carey & Bartlett, 1978; Markson & Bloom, 1997). This suggests that despite a predisposition to attend to the shape of objects, dimensional terms are harder to learn as a class than count nouns. The mapping between a shape term and its referent needs reinforcement over time just as does the mapping between say, a new color term and its referent (e.g. O'Hanlon & Roberson, 2006). One reason for this could be that the pragmatics of the learning context require more inferences to be made when an adult names features or dimensions of an object rather than labeling the whole object. To abstract the information that a novel term like 'round' applies to the shape of an object, a child must hear it used repeatedly across a range of different objects, remember the shape of previously labeled instances, and appreciate the relation between the different referents. They also need to appreciate that, for dimensional adjectives, one label can have multiple referents.

Gentner (2003, p. 228) reviews evidence that experience with interchanges of language (conversations with adults) is crucial to the development of cognition, improves memory ability and amplifies “the human capacity for structural alignment and mapping”. The present experiments demonstrate that some dimensional terms are easier to learn than others, but also that the structure of the linguistic input, and the context within which it is presented significantly impacts on the ease with which novel adjectives are learned.

Appendix A

Children’s labels for the three target shapes at pretest, in Experiment 1 (N=60)*

Chevron		Concave		Pounch	
Arrow (27)	45%	Cup/mug/glass (11)	18.3%	Flower (28)	46.7%
Kite (9)	15%	Table (9)	15%	Cloud (23)	38.3%
Diamond (3)	5%	Bone (4)	6.7%	Tree (6)	10%
Other (11)**	18.3%	Other (28) **	46.7%	Star (2)	3.3%
Don’t know (10)	16.7%	Don’t know (8)	13.3%	Don’t know (1)	1.7%

*The number of children is given in brackets

** Labels that were produced only once among the group were classified ‘Other’

Appendix B

Objects and shape sets used on training trials in Experiment 1

	Target: Chevron	Target: Concave	Target: Pounch
White	chevron, star, circle	concave, heart, square	pounch, heart, square
Red or blue	chevron, heart, circle	concave, star, square	pounch, star, square

Appendix C

Computation of rate of learning and degree of learning scores

Rate of learning scores - These scores varied from 0 to 1, and were computed using a linear equation accounting for the fact that (i) four assessments took place (once following each training session), and (ii) on each occasion the within-session performance could vary from 0 (no correct responses given) to 3 (all three targets correctly pointed to). Each child had a single rate of learning score; the less training required to learn, the higher the score obtained. The Equation derived was: *Rate of Learning = (Assessment Trial + (Correct targets/Targets))/k*, where *Assessment Trial* corresponds to the 'Time' at which one or more correct responses were given; values varied from 3-0 (one score for each of the four assessments). A score of 3 applied when one or more correct responses were given at first assessment (i.e. following the first training session); a score of 0 applied when one or more correct responses were given on the fourth, and final, assessment (following the fourth/final training session). *Correct targets* quantifies the number of targets pointed to correctly within-session (0-3), and *Targets* refers to number of available correct responses (targets) on each session (3). The constant *k* was set to a value of 4. Hence, a child who labeled *one* target correctly at *first* assessment obtained a single rate of learning score of 3+(1/3))/4 = 0.833. A child who correctly labeled *two* targets at *second* assessment obtained a single rate of learning score of 2+(2/3))/4 = 0.667. A child who correctly labeled *three* targets at *fourth* assessment obtained a single rate of learning score of 0+(3/3))/4 = 0.250. The score for failing to give correct responses on all assessments was given by (0+(0/3))/4 = 0.

Degree of learning scores – These scores varied from 0 to 1. Overall degree of learning scores were computed for responses given to the three targets overall (i.e. not separately for each target type). These were obtained by summing the total number of correct responses given during the study period, and dividing the outcome by the total number of available correct responses (i.e. 12; three for each of the four assessments). For example, ceiling performance with one of the targets (e.g. correctly pointing to the teal target on assessments 1 through 4) produced an overall degree of learning score of 4/12 = .333. Degree of learning was also assessed separately in response to each target at Time 1 (assessment 1, following the first training trial), Time 4 (assessment 4, following the fourth / final training trial), and Time 5 (two-week follow up). These graded measures of learning also varied from 0 to 1. Children scored 1 for giving a correct response and 0 for giving an incorrect response. As these scores were computed separately for each of the three targets, and children within each group scored 1 for giving a correct response and 0 for giving an incorrect response, the within-group scores for graded measures of learning correspond to the proportion of children who responded correctly at each assessment stage (e.g. if 7 / 12 children in the control group responded correctly to the teal target at Time 4, the degree of learning at Time 4 (in response to ‘teal’) for the control group would be 7/12 = .58).

References

Akhtar, N. (2002). Relevance and early word learning. *Journal of Child Language, 29*, 677-686.

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

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.

Au, T. K. (1988). Children's use of information in word learning. *Papers and Reports in Child Language Development, 27*, 15-22.

Au, T. K., & Laframboise, D. E. (1990). Acquiring color names via linguistic contrast: The influence of contrasting terms. *Child Development, 61*, 1808-1823.

Backsheider, A. G., & Shatz, M. (1993). *Children's acquisition of lexical domains*. Paper presented at the Conference Namel. Retrieved Access Datel. from URLl.

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 meaning. *Journal of Child Language, 20*, 395-418.

Bowerman, M., & Choi, S. (2003). Space under construction: Language specific spatial categorization in first language acquisition. In D. Gentner & S. Goldin-Meadow (Eds.), *Language in Mind: Advances in the study of Language and Cognition* (pp. 387-428). Cambridge: MIT Press.

Carey, S., & Bartlett, E. (1978). Acquiring a single new word. *Papers and Reports in Child Language Development, 15*, 17-29.

Chapman, K. L., Leonard, L. B., & Mervis, C. B. (1986). The effect of feedback on young children's inappropriate word usage. *Journal of Child Language, 13*, 101-117.

Cimpian, A., & Markman, E. M. (2005). The absence of a shape bias in children's word learning. *Developmental Psychology, 41*(6), 1003-1019.

Diesendruck, G., & Bloom, P. (2003). How specific is the shape bias? *Child Development, 74*(1), 168-178.

Diesendruck, G., & Markson, L. (2001). Children's Avoidance of Lexical Overlap: A Pragmatic Account. *Developmental Psychology, 37*(5), 630-641.

Dunn, L. M., Dunn, L. M., Whetton, C., & Burley, J. (1997). The British Picture Vocabulary Scale (second Ed.) (BPVS II). The NFER-NELSON Publishing Company Ltd, Berkshire, UK.

Gentner, D. (2003). Why we're so smart. In D. Gentner & S. Goldin-Meadow (Eds.), *Language in Mind: Advances in the study of Language and Thought* (pp. 195-236). Cambridge: MIT Press.

Gottfried, G. M., & Tonks, J. M. (1996). Specifying the relation between novel and known: Input affects the acquisition of novel color terms. *Child Development, 67*, 850-866.

Hall, D. G., & Graham, S. A. (1999). Lexical Form Class Information Guides Word-to-Object Mapping in Preschoolers. *Child Development, 70*(1), 78-91.

Heibeck, T. H., & Markman, E. M. (1987). Word learning in children: An examination of fast mapping. *Child Development, 58*, 1021-1034.

Imai, M., Gentner, D., & Uchida, N. (1994). Children's theories of word meaning: The role of shape similarity in early acquisition. *Cognitive Development, 9*, 45-75.

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

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

Mervis, C. B., & Bertrand, J. (1994). Acquisition of the novel name-nameless category (N3C) principle. *Child Development, 65*, 1646-1663.

O'Hanlon, C. G., & Roberson, D. (2006). Learning in context: Linguistic and attentional constraints on children's color term learning. *Journal of Experimental Child Psychology, 94*, 274-300.

Rice, M. (1980). *Cognition to language categories: Word, meaning and training*. Baltimore: University Press.

Samuelson, L. K., & Smith, L. B. (2000). Children's Attention to Rigid and Deformable Shape in Naming and Non-Naming Tasks. *Child Development, 71*, 1555-1570.

Woodward, A. L., & Markman, E. M. (1998). Early word learning. In D. Kuhn & R. S. Siegel (Eds.), *Handbook of child psychology: Vol.2. Cognition, perception, and language* (pp. 371-420). New York: John Wiley & Sons.

Table 1

Distribution of children according to chronological age, vocabulary age and number of shape terms known at pretest across the two experiments (means and standard errors)

	Chronological Age[a]	Vocabulary Age[a]	Number of shape terms
Experiment 1			
Control 1	3;6 (.10)	3;6 (.06)	9 (.38)
Control 2	3;5 (.09)	3;3 (.04)	8 (.42)
Corrective	3;4 (.06)	3;4 (.06)	8 (.46)
Semantic	3;5 (.09)	3;5 (.06)	8 (.39)
Referential	3;5 (.10)	3;4 (.08)	8 (.41)

Note. Standard errors are in parentheses

[a] Ages are expressed in years and months (years;months)

Table 2

Percentages of children who passed the criterion for knowing the 11 basic shapes (naming and comprehension) at pretest and fourth assessment (Time 4) in Experiment 1

Shape	Experiment 1 (*n* = 60)										
	Circle	Square	Triangle	Rectangle	Diamond	Oval	Arrow	Heart	Star	Moon	Cloud
Pretest	100	98	80	43	43	27	57	100	100	93	97
Time 4	100	97	83	53	50	25	55	98	100	98	100

Table 3

Comprehension scores for rate of learning, overall degree of learning, and degree of learning at first assessment (Time 1), fourth assessment (Time 4) and the 2-week follow-up (Time 5) across groups of Experiment 1 (means and standard errors)

	Control 1	Control 2	Corrective	Semantic	Referential
Rate of Learning	.49 (.09)	.45 (.09)	.63 (.04)	.51 (.07)	.61 (.04)
Degree of Learning (overall)	.25 (.05)	.26 (.05)	.55 (.03)	.33 (.04)	.41 (.04)
Degree of Learning (Time 1)	.08 (.04)	.08 (.04)	.06 (.04)	.08 (.06)	.06 (.04)
Degree of Learning (Time 4)	.42 (.08)	.44 (.09)	.86 (.05)	.58 (.08)	.67 (.09)
Degree of Learning (Time 5)	.28 (.08)	.36 (.08)	.39 (.08)	.50 (.07)	.44 (.09)

Note. Data are pooled across targets. Scores range from 0 to 1. Standard errors are in parentheses

Table 4

Degree of learning of the chevron, concave, and ‘pounch’ targets at first and fourth assessment (Time 1 and Time 4) and 2-week follow-up (Time 5) across groups of Experiment 1 (means and standard errors)

	Control (combined)	Corrective	Semantic	Referential
Chevron				
Degree of Learning (Time 1)	.04 (.04)	.08 (.08)	.08 (.08)	.08 (.08)
Degree of Learning (Time 4)	.42 (.10)	.83 (.11)	.58 (.15)	.50 (.15)
Degree of Learning (Time 5)	.25 (.09)	.25 (.13)	.42 (.15)	.33 (.14)
Concave				
Degree of Learning (Time 1)	.13 (.07)	.08 (.08)	.08 (.08)	.08 (.08)
Degree of Learning (Time 4)	.58 (.10)	1.00 (0)	.58 (.15)	.92 (.08)
Degree of Learning (Time 5)	.50 (.10)	.50 (.15)	.67 (.14)	.75 (.13)
Pounch				
Degree of Learning (Time 1)	.08 (.06)	0	.08 (.08)	0
Degree of Learning (Time 4)	.29 (.09)	.75 (.13)	.58 (.15)	.58 (.15)
Degree of Learning (Time 5)	.21 (.08)	.42 (.15)	.42 (.15)	.25 (.13)

Note. Scores range from 0 to 1. Standard errors are in parentheses

Figure captions

Figure 1. The three target shapes

Figure 2. Mean overall degree of learning scores (0-1) of shapes (current study) and colors (O’Hanlon & Roberson, 2006)

Figure 1

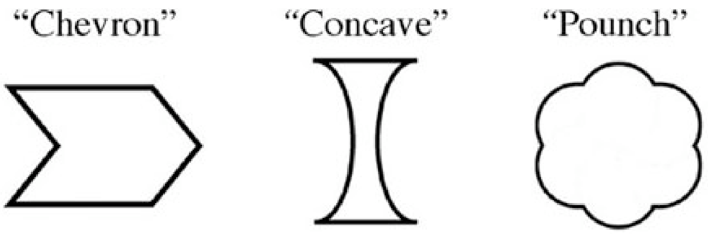
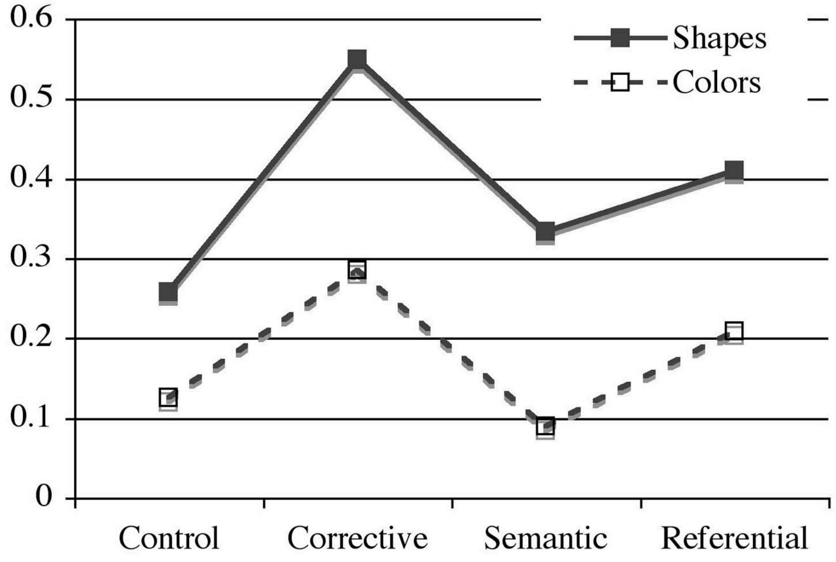


Figure 2


0.6
0.5
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Shapes
Colors
Control
Corrective
Semantic
Referential