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The Shape Bias is Affected by Differing Similarity Among Objects

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Abstract

Previous research has demonstrated that visual properties of objects can affect shape-based categorization in a novel-name extension task; however, we still do not know how a relationship between visual properties of objects affects judgments in a novel-name extension task. We examined effects of increased visual similarity among the target and test objects in a shape bias task in young children and adults. Experiment 1 assessed college students with sets of objects whose similarity between target and test objects was either low or high similarity. Adults preferred shape when the similarity among objects was minimized. Experiment 2 tested 24- month-olds in their use of the shape bias using the Intermodal Preferential Looking Paradigm. Children showed a shape bias only with items whose similarity to each other was low. These findings suggest that the visual properties of objects affect shape bias performance.

Keywords

shape bias; word learning; attentional learning; visual contrast; perceptual similarity; intermodal preferential looking

Early in development, children utilize shape similarity to form categories and learn new words. In a phenomenon known as the ‘shape bias,’ they generalize a novel word to objects that are similar in shape rather than color, size, or texture (Smith, 2000). Recent research has demonstrated that children’s use of the shape bias is affected by the perceptual characteristics of the object stimuli. For example, it has been shown that simple objects facilitate novel name extensions, especially in young word learners (Cimpian & Markman, 2005; Son, Smith, & Goldstone, 2008). Perceptual similarity, which is a measure of relation among objects’ component stimuli, is also likely to affect shape bias (Tversky, 1977). Ideally, shape bias will occur when a test object is similar to a target object only in shape whereas another test object resembles the target only in color. However, in real-life situations where the test objects can have varying degrees of similarity to the target, it is possible that shape bias may diminish. The present study investigates the effect of varying similarity among test items in a shape bias task among both young children and adults.

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In the canonical shape bias paradigm, children are presented with a new object (the target) that is named with a novel noun (e.g.,"This is a *dax*"), and asked which of several newly introduced test objects can be called by the same name (e.g., "Which of these is also a *dax*?"). Children tend to choose the test object that has the same shape as the target, but differs in color or texture, and to ignore the object that is of the same color or texture as the target but differs in shape (Landau, Smith & Jones, 1988). Thus, children (as well as adults) prefer shape over color or size when the objects are labeled. This preference is more pronounced in young children in the presence of names (Smith, 2000). The shape bias develops around two years of age, after children have acquired at least 50 count nouns in their productive vocabularies, and it manifests even more robustly in older children and adults (Jones, Smith & Landau, 1991; Samuelson & Smith, 1999; Tek, Jaffery, Fein & Naigles, 2008).

Smith and her colleagues (Jones, Smith & Landau, 1991; Smith, 1995, 1999; Smith & Jones, 1993) have proposed an attentional learning account of the shape bias, according to which children's experience enables them to learn correlations among perceptual and linguistic units (i.e., objects and words). Shape-based categories first dominate children's early vocabularies because their perceptual systems easily notice solid, rigid objects. Children then acquire the shape bias as a word learning mechanism by learning to associate the most visually salient property of objects (shape) and the syntactic category of nouns (Samuelson & Smith, 1999). At a very young age, children attend to shape properties of objects and can draw inferences about them or learn about the shape-based functions of objects (Graham & Diesendruck, 2010; Ware & Booth, 2010). With development, the shape bias becomes more robust in that children's attention to shape as a guide to organize words becomes more efficient.

Although the shape bias as a word learning mechanism has been well investigated (Imai, 1999; Jones, Smith & Landau, 1991; Landau, Smith & Jones, 1997), research on the influence of different perceptual attributes of objects on the development or manifestation of the shape bias is just beginning. Son et al. (2008) investigated whether children 17.5 months of age would generalize novel nouns better with simple vs. complex objects. They found that a simple object with a smooth shape and a single color promoted good generalization of object name by shape, compared to a complex object with rich detail and more than one color. Moreover, they found that training children with simple objects rather than complex ones facilitated later novel-name extension tasks with complex objects. Son et al. conjectured that the extra details of the complex objects may have distracted such young children during either training or testing, such that attention may not have registered all of the features and/or their memories may not have retained them.

Sera and Millett (2008) have also shown that increased similarity among objects decreases young children's performance in a novel-name extension task, even after providing children with the internal features or functions of those objects. They presented participants with slightly curved and slightly non-parallel target objects. The test objects included a metrically similar object to the target (objects similar to the target in curvature and non-parallelism) and a non-metrically similar object. Seven-year-olds and adults preferred metric choices, and their preference was facilitated by the presence of names. Preschoolers did not prefer metric choices in either a similarity task or a word-learning task even after being provided with the internal features or functions of those objects. Sera and Millett (2008) systematically manipulated test objects in two dimensions: curvature and non-parallelism, which changed by a small degree of curvature and divergence from parallel. Both metrically-similar and metrically-non-similar test objects were visually very similar to each other despite changes in two dimensions. Therefore, it is possible that young children's difficulty in categorizing metrically-similar objects could be due to an overall similarity among objects.

We extend Sera and Millet's (2008) study by examining the degree to which an increased similarity among test objects affects performance. In defining similarity, we follow Tversky's (1977) contrast model. According to Tversky, similarity between two objects is based on the weighted difference of common vs. distinctive features shared by those objects. Tversky's contrast model of similarity can be represented in the following equation:

$$S(A,B)=\theta f(A\cap B)-\alpha f(A-B)-\beta f(B-A)$$

In the above equation, the similarity of object A to object B, S(A,B), is a function of features shared by A and B, *f*(A∩B), the features found in A but not in B, *f*(A-B), and the features that belong to B but not to A, *f*(B-A). Here, θ, α, β are parameters that can define the relative importance of the common and distinctive attributes. For example, features of object A can be weighted more heavily than the features of object B, depending on the context (e.g., level of attention, saliency of object features, task difficulty. Thus, variations in the weighted similarity between two objects may result in multiple similarity metrics with the same set of objects.

Tversky's model predicts that as the number of common features between two objects increases and the number of distinctive features decreases, they become more similar. In the shape bias paradigm, it is assumed that one of the test objects is similar to the target only in one feature (e.g., shape) and the other is similar to the target only in another feature (e.g., color); the usual choice of shape over color reveals how these features are weighted. However, not all demonstrations of the shape bias have actually adhered to this model (Cimpian & Markman, 2005). Moreover, real-world objects tend to resemble each other on multiple features; therefore, the issue arises as to how the shape bias might manifest itself with objects more like those in the child's natural environment. Consider, for example, a situation in which test object A shares some (but not all) shape properties of the target object T, plus all of its color and decorative properties, while test object B shares all shape properties of T but none of the color or decorative features. In Tversky's model, the overall similarity of A to T are high, because A∩T is high (some shape plus all color properties shared) while A-T and T-A are both low. The overall similarity of B to T is lower because B∩T is likely lower than A∩T, and B-T and T-B are both higher because no color or decorative features are shared. Moreover, even though the weight of the shape does not change, the increased similarity among objects will change the weights in Tversky's model, because the increased similarity will also increase the task difficulty. For example, if one test objects that is supposed to share only the color feature with the target object resembles the target also in shape, the exact-shape match might not always be chosen, assuming that novel noun extensions are based on Tversky's similarity.

Manipulating similarity relationships may also produce differences in performance of adults and children. Smith (1984) has shown that young children classify objects on the basis of overall similarity whereas adults classify objects on the basis of a single attribute such as color or size. For example, children under age five will categorize a red ellipse with an orange circle rather than a red ellipse with a blue ellipse (Smith, 1985). Moreover, for adults shape is a strong indicator of category membership, whereas children may treat shape as an indicator of similarity (Smith, 2003; Son et al., 2008). Therefore, young children may be more susceptible to changes in similarity relationships between objects in a shape bias task.

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The purpose of the present study is to investigate the effect of increased perceptual similarity between target and test items in a novel-name extension task in young children and adults. Our hypothesis is that the increased similarity between the target and the object that matches the target on two dimensions (i.e., color match and a semi-shape match) will lead to a less frequent choice of shape in both adults and children. However, the increased task difficulty introduced by a further similarity between the two test objects may increase the attention demand in young children, and hence, unlike adults, children may be more susceptible to diversion from a shape choice, especially in the presence of novel names (Son et al., 2008).

Our method is somewhat different from that of the conventional shape bias task, in which children are taught each novel word-object pair 1–3 times, using three-dimensional objects or static pictures, and then asked to point to the relevant test object to which the novel label is extended (e.g., Landau et al., 1988; Smith, 1999; Son et al., 2008). Over the past decade, several studies of shape bias using Intermodal Preferential Looking (IPL) have been published. Graham & Poulin-Dubois (1999) found that 18-month-olds could generalize novel words according to shape but not color if shape was emphasized as a contrasting feature during training. More recently, Tek et al. (2008) found that toddlers could demonstrate a shape bias in novel-name extension, even without the extensive training provided by Graham and Poulin-Dubois (1999; Hupp, 2008). Thus, the method seems appropriate for investigating the effects of perceptual differences on 24-month-olds' manifestation of the shape bias.

Experiment 1 examined the effect of similarity between the target and test objects on the shape bias performance of adults. We hypothesized that if exact shape matches override all other similarity relations, they should be observed across all similarity conditions. In contrast, under Tversky's model, increased similarity among test objects will result in an increased task difficulty, and the high similarity items should lead to a diminished shape bias. In Experiment 2, we investigated the same phenomenon in 24-month-olds. We hypothesized that when the salience of shape is blurred by an increased similarity among stimuli, young children will have difficulty preferring the object that has a perfect shape similarity to the target object in a novel name extension task. In fact, depending on the level of similarity of the test object to the target on two dimensions, children may even prefer this object over the perfect shape choice when extending a label, possibly due to increased demand on memory and attention skills. We thus presented children with objects belonging either to a high-similarity set or a low-similarity set to reduce memory demands.

Experiment 1

Method

Participants—Thirty nine undergraduates (14 female) participated, recruited from a university psychology department undergraduate participant pool. English was their first and dominant language. Ten additional adults served as participants for the similarity ratings. They included graduate students and research assistants who had no detailed knowledge of the purpose of their ratings.

Materials—The stimuli consisted of five 'quartets' of novel objects (see Figure 1). Each quartet included one target object, made from materials such as toy legos and play dough, and three test objects. One test object matched the target object only and exactly in shape (exact-shape match), one object matched the target only and exactly in color or decorations (color-match), and one matched the target object exactly in color while also sharing some shape features. We called this latter object 'overall match,' since it matched the target on both color/decorations and shape. Because in a classical shape bias paradigm (Smith, 2000) the two dimensions of shape and color are clearly separated and pitted against each other, in this study a shape bias refers to instances in which participants generalize novel names to perfect shape matches. The low-similarity condition consisted of the target, the exact-shape match, and the color-match. The high-similarity condition consisted of the same target and the exact-shape match, but this time the second test object was the overall match. A digital camera was used to take videos of the objects (moving horizontally in space). The stimuli were blocked, such that all color matching objects were presented in one block and all overall matching objects were presented in another block.

The similarity among the test objects and the target objects was not manipulated systematically because in general, it is difficult to manipulate similarity in multiple dimensions, and in particular, no metric for shape similarity exists (Sera & Millett, 2008). Therefore, we used adult judgments to confirm that overall-match objects (i.e., test objects similar to the target on two dimensions: color/decorations and shape) were more similar to the target than the color-match (i.e., test objects similar to the target only in color/decorations). We asked 10 adults to rate the similarity between the color/overall match, the exact shape match, and the targets on a scale from 1 (not similar) to 7 (very similar). The mean similarity rating was 2.48 (SD = .74) for the color-match/target objects in the low-similarity condition and 3.82 (SD = .61) for the overall-match/target objects in the high-similarity condition. Participants rated the overall match significantly more similar to the target than the color-match, $t(9) = 4.70$, $p < .01$). Moreover, the exact shape match was rated as more similar to the target than the color-matching object, M = 3.46, SD = .47; $t(9) = 3.94$, $p < .01$, and the ratings for the exact shape match and the overall-shape match did not differ from each other ($p > .10$).

Procedure—Participants were tested in a quiet room. They were told that they would see a novel object for a short time presented on a laptop followed by two different objects on the screen. Their task was to look at the first object and then choose one of the test objects that matched the instruction given by the experimenter. To control for a practice effect, two blocks of trials were employed such that half of the participants were presented with the high-similarity condition first and the other half were presented with the low-similarity condition first.

Within each block, participants viewed NoName trials followed by Name trials. During NoName trials, participants saw the target object alone on the screen for approximately one second. The two test objects (i.e., the exact-shape and the color-match/overall match objects) were then presented simultaneously, one on the left, and one on the right. The location of presentation was counterbalanced across trials. After presentation of each set of stimuli, the videos were stopped, and the participants were asked to point to the one that looked the same. Responses were recorded manually. The Name trials were similar except that each target object was presented with a novel name (i.e., “This is a *zup*”). A total of five novel names was used (*zup*, *tiz*, *seb*, *dax*, or *pilk*). Then participants saw the test objects simultaneously, and were asked to identify the object having the same label (i.e., “Where is the *zup*?”). The same pattern was repeated with the other four pairs of objects for both high- and low-similarity conditions.

Results

Figure 2 shows the percent of items for which participants chose the shape-match object, by trial and condition type. Participants chose the shape-match significantly more often than chance (50%) for all trials, t (38) = 24.56, $p < .001$. A two-way repeated measures analysis of variance (ANOVA) was performed with similarity (high, low) and trial (NoName, Name) as within-subject factors. The dependent variable was percent of items for which choice was

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the shape match. A significant effect of similarity appeared, F (1, 38) = 15.56, $p < .001$, $\eta^2 = .291$, and a marginally significant effect of trial, F (1, 38) = 2.94, $p = .095$, $\eta^2 = .072$, with no interaction.

Thus, participants chose the object that had the same shape as the target significantly more often in the low-similarity than in the high-similarity condition during both NoName and Name trials. Furthermore, they preferred the shape match relatively more often during Name trials than No-Name trials, primarily in the high-similarity condition as they were at ceiling in the low-similarity condition. In sum, presence of the high-similarity objects significantly diminished adults' shape preferences.

Experiment 2

In Experiment 1 we manipulated color-matching and overall-matching test objects in low-similarity and high-similarity conditions while keeping the target and the exact-shape match the same. In Experiment 2, we tested 24-month-olds, using different stimuli in high- and low-similarity sets to minimize memory load. Moreover, we used the Intermodal Preferential Looking Paradigm (IPL) to reduce task demands. An advantage of the IPL paradigm is that the language abilities of children can be tested at early points in development without using a forced- choice task.

Method

Participants—Ten typically developing children (six female) participated. They were recruited from a university database of children. They ranged in age from 23 to 25 months (M = 24.6, SD = 0.61). Ten adults served as participants for the similarity ratings. They included graduate students and research assistants who had no detailed knowledge of the purpose of the ratings; none had participated in Experiment 1.

Materials—Six novel target objects were constructed from simple toys such as wooden blocks and legos; each was 3–5 inches wide and 3–8 inches long. Three of the object sets were designated as low-similarity items, because one of the test objects matched the target only in shape (exact-shape match), whereas the other test object was identical to the target only in color; it shared no other physical similarities (color match). The other three object sets were designated as high-similarity items, because, as with the previous items, one of the test objects matched the target only in shape (exact-shape match); however, this time the other test object was a match to the target not only in color, but also shared some shape properties with the target (overall match) (see Figure 3).

To confirm that the overall matching objects in the high-similarity condition were 'more similar' to the targets than the color matching objects in the low-similarity condition, 10 adults rated the similarity between the overall/color match, the exact-shape match, and their targets on a scale from 1 (not similar) to 7 (very similar). They rated the overall matching objects in the high-similarity condition (M = 2.83, SD = .57) as significantly more similar to their targets than the color matching objects in the low-similarity condition (M = 1.73, SD = .68), t (9) = 4.10, $p < .01$. However, in both conditions, the exact shape matches were rated as more similar to the target than the overall-matching and the color-matching objects (low-similarity condition M = 4.83, SD = .50; high-similarity condition M = 4.00, SD = .49). Moreover, participants rated the exact shape matches as more similar to the target in the low-similarity condition than the exact shape matches in the high similarity condition, t(9) = 4.03, $p < .01$.

Each of the six target objects was video recorded moving back and forth horizontally; 4-second clips were then extracted and arranged in a configuration. The stimuli were presented in two consecutive blocks of trials. The first block constituted the NoName condition, in which no novel names were introduced, and the second block constituted the Name condition, in which the target object was presented with a novel name. Each block was composed of four trials for each set of target and test objects. The first two trials served as familiarization trials, in which the target object appeared first on one side and then on the other side of the screen. Trial 3 presented the test objects; the audio was neutral and non-directing. Trial 4 served as the test trial, in which the test objects were presented again, now with the test audio. The expectation is that children will look longer at the stimulus that matches the audio (Hirsh-Pasek & Golinkoff, 1996). Each trial lasted approximately 4 seconds, with 3 seconds of inter-stimulus interval (when a centering light was presented), for a total of 25 seconds per block and 5 minutes for the entire video. The side of the matching screen was counterbalanced within participants, and alternated in a Right/Left–Left/Right pattern.

Procedure—Children were tested individually in their homes as part of a larger, longitudinal study of language development (Swensen, Kelley, Fein & Naigles, 2007). They were seated either on the floor or on their parents' lap approximately three feet in front a 3.5 x 5 foot screen. The stimuli were projected from an Apple Powerbook onto the screen via an LCD projector. The audio stimuli were presented via a central speaker that was located behind the screen, outside the view of the child. A digital camera located in front of the screen recorded the child's eye movements, which were coded off-line. The MCDI Toddler Form (CDI; Fenson, Dale, Reznick, Thal, Bates, Hartung, Pethick & Reilly, 1991) had been mailed to parents ahead of time and was collected at the end of the session. Only the "Total Words Produced" part of the CDI was tabulated and analyzed for this study.

Coding—Research assistants coded the films after each visit frame-by-frame, recording children's fixations to the right or left videos, to the center, or away. The stimulus audio was not available to the coders. The children's visual fixations were tabulated and analyzed by percent of looking to each video for each trial. On each trial, visual fixations were registered after the child looked at the center lights for more than 0.3 seconds. Trials where a child had not looked at the center lights for at least 0.3 seconds, and/or did not look at the either screen once the videos were presented, were excluded. The empty cells for these trials (comprising 17.5% of trials overall) were replaced by the means for that item.[1] Data from two children were coded by a second person. The average correlation between the two observers was .98, indicating high inter-rater reliability.

Results

The results appear in Figure 4. A two-way repeated measures ANOVA was conducted with similarity (high, low) and trial (NoName, Name) as within-subject factors. A significant similarity by trial interaction appeared, $F(1, 9) = 31.22$, $p < .001$, $\eta^2 = .77$, and no other effects. Planned comparisons revealed that, with the low-similarity items, children preferred the exact-shape match significantly more during the Name trials than the NoName trials, $t(9) = 3.73$, $p < .01$. They preferred the exact-shape match significantly more than the color match during Name trials, $t(9) = 4.50$, $p < .01$, but showed no preference during NoName trials (Figure 4). In contrast, for the high-similarity items, there was a significant preference for the exact-shape match during NoName trials, $t(9) = 3.85$, $p < .01$, which then significantly shifted to the 'overall' match for Name trials, $t(9) = 4.76$, $p < .01$ (Figure 4).

[1]This is a somewhat higher percentage than usually found in IPL studies (~10%), and is likely attributable to the fact that children were tested in their homes, which contain more distracting elements than laboratories.

Children's overall noun and count noun vocabularies, as measured by the CDI, were compared with their shape bias performance, as measured by their preference for the exact-shape match during the NoName trials subtracted from their preference for the exact-shape match during the Name trials across all items; no significant correlations were found.

In sum, children demonstrated a preference for the exact-shape match in the low-similarity condition and a preference for the overall match in the high-similarity condition in the presence of novel names (Name trials). The exact-shape match preferences replicate the usual shape bias effect found with simple objects; the 'overall' match preferences support Tversky's model that an increased similarity among objects will lead to increased task difficulty, which, in turn, will result in a diminished preference for the exact-shape match.

General Discussion

In Experiment 1, we investigated whether adults preferred shape similarity vs. overall similarity in a novel-name extension task; we found that adults were more directed to shape with low-similarity items than with high-similarity items, regardless of the presence of a novel name. In Experiment 2, we examined the same phenomenon, this time with 2-year-olds. Like adults, the children showed a stronger shape bias with low-similarity than high-similarity items; however, for the children this effect held only during Name trials. Experiment 2, however, included different sets of low- and high-similarity items to increase the contrast between the two conditions; hence, similarity between target and exemplars was not systematically manipulated.

What was it about the items in the high-similarity set that caused children's preference for the overall-match in Experiment 2 in the presence of names, and the decline in adults' overall preference for the exact-shape match in Experiment 1? We suggest that the preference for the overall match in the Name trials occurred because the overall matching items in the high-similarity condition were similar to the target in both color and somewhat in shape. The increased similarity between the target and the overall-matching object in color and a less-then-perfect shape dimension reduced the salient quality of the object which had a perfect similarity to the target in shape, resulting in a preference for the overall match during the Name trials. For example, the overall-matching objects for items 2 and 3 in Experiment 1 were in fact very similar to the target objects in shape (see Figure 1), making transferring the name of a novel object to just one same-shape item more difficult. Moreover, in many previous studies, researchers employed simple and smooth target objects with novel shapes and only a single color, such as an inverted U-shape, coin, compact disk, or banana (Smith, 2000; Imai, Gentner, & Uchida, 1994). When similarity is increased among objects, the contrast among them is reduced; therefore, task difficulty increases because the dimensional distinction among objects is blurred. Thus, the shape bias mechanism seems to operate at least partially as a function of the perceptual features of objects, especially in young children.

An interesting result of this study was that adults' performance was different from children's. Children showed a shape bias (looked longer at the shape match during the Name trial compared to the NoName trial) with objects in the low-similarity condition, whereas their preference was for the overall match as opposed to the exact-shape match in the high-similarity condition. Adults, in contrast, did not show such an interaction even though a high similarity among objects hindered their performance in both NoName and Name trials. Little word-driven shape preference was observed in adults, since the preference for shape with the items in the low-similarity condition was at ceiling in both trials (98 %), whereas novel names facilitated the children's preference for shape with low-similarity items.

The difference between adults' and young children's performance suggests differences in changes in the weights of the Tverskian equation (i.e., $S(A, B)=\theta f(A \cap B) - \alpha f(A - B) - \beta f(B - A)$) for adults and young children when the similarity relations between objects are altered. Tversky's contrast model assumes that similarity is a function of the weighted difference of common and distinctive features shared by the object stimuli (Tversky, 1977). In this model, the weights of the objects in a similarity function can change according to context, such as level of attention, saliency of object features, and task difficulty. In a shape bias task, the exact-shape match is weighted more heavily due to the high saliency of the shape feature. However, this relationship can be changed if the second test object is similar to the target not only in color but also in shape. Moreover, the weights can be altered further in favor of the overall-match by increasing task difficulty, thus resulting in a preference for the overall match. Therefore, the preference for the overall match by children in the presence of names, and the adults' overall decreased performance, were both a consequence of this altered relationship in a task that utilized similarity judgments. For example, for the adult participants, the weight for the shape was reduced when pitted against an overall match; however, this reduction was not enough to cause adults to choose the overall match in the novel-name extension task. For children, in contrast, the weights in Tversky's equation changed in favor of the overall match, and, hence, the young children in this study seemed to be more affected by overall similarity than adults.

A possible reason why adults are more shape oriented than young children either with complex objects or with objects that have high similarities between one another is that adults may treat shape feature as a category, whereas, for young children, shape may simply be a cue for similarity. Therefore, young children may be more susceptible to slight changes in the shared properties of the test objects because they might think they are relevant for similarity (Son et al., 2008). Children detect multiple correspondences among objects by following Tversky's approach; that is, the more overlapping features two objects have, the more similar they are to each other. In adults, on the other hand, because of the importance of shape as a strong indicator of category membership, the weight associated with shape does not decline as dramatically as in young children even after the similarity relationships among objects have been changed. In fact, it has been shown that adults represent shape more abstractly than young children (Smith, 2003), and when young children are trained with abstract shapes that are like caricatures of real-life objects, their performance increases in novel name extension tasks (Son et al., 2008). Other studies have also shown that adults attend to specific object features that may indicate category membership, whereas young children rely on "global similarity" and tend to overemphasize "the way things look" (DeLoache, 1989; Paik & Mix, 2006; Smith, 1984).

That children prefer shape over other dimensions in a shape bias task only with objects whose similarity to each other is kept at minimum may also suggest a processing limitation in novel name extension tasks in young children. Adults' selective attention mechanism is tuned to picking out the most category-relevant information (in this study the shape feature), whereas young children are at a disadvantage because their immature attention mechanisms make them prone to attending to too much information or to the wrong information (Son et al., 2008). Therefore, simpler objects help young children pay attention to the most salient feature (i.e., shape) thereby constraining the number of features that they are attending to.

Previous studies have shown that, in similarity tasks, children perform better with simple objects than with objects that are richly detailed or have many features. These findings may, in fact, indicate constraints in attention and memory skills. For example, Rattermann, Gentner, & DeLoache (1990) tested 3- and 4-year-olds and adults with two sets of objects in a similarity task. One set contained simple objects that differed only in size, and the other set included richly-detailed objects. Compared to adults, children in both groups performed better with simple objects. Similarly, Son et al. (2008) found that 2-year-olds generalize better when presented with objects that contain simpler features or fewer features than objects having many features.

Our results suggest a developmental change in the perception of shape and how context (i.e., similarity relationships between objects) affects shape perception in young children and adults. If 2-year-olds and adults differ in their performance in novel-name extension tasks, a significant question arises as to around what age young children's performance becomes adult like. Although further research is needed in this area, some studies have shown that children under five years of age classify on the basis of overall similarity rather than on a single attribute such as color or size (Smith, 1984). Smith and Evans (1989) gave 2-, 3-, and 4-year-olds three sets of objects and asked them to classify similar or identical objects into two groups. In the first set, all the objects within a group were similar to each other and the between-group dissimilarity was high. In the second set, the objects in one group were identical to each other, and again, the between-group dissimilarity was high. In the third set, one group of objects to be classified included identical objects, but the objects in the other group were also similar to the objects in the first group; thus, between-group dissimilarity was low. Children classified all identical and similar objects together, which, according to Smith and Evans (1989), shows that young children were attempting to classify objects by 'overall similarity' by ignoring the dimensions that separated identical objects from similar ones. Similarly, in our study, the decrease in performance with high-similarity items in young children could be due to an attention bias to overall similarity and ignoring of category specific information (i.e., shape).

The present studies have shown that when similarity among objects in a shape-bias task is increased, both 2-year-olds' and adults' preference for shape decreases. Furthermore, young children seem to be more vulnerable to a change in similarity relations among objects. When objects are named, children's preference for the exact-shape match declines dramatically; instead, they prefer the object that has an overall resemblance to the target object. Our findings indicate that adults may treat shape as a category, which explains why adults still preferred the shape with or without the presence of names, whereas young children are more driven by an overall similarity among objects. Further research is needed to delineate what other object properties can also influence similarity judgments in a novel-name extension task, and how this may changes with development.

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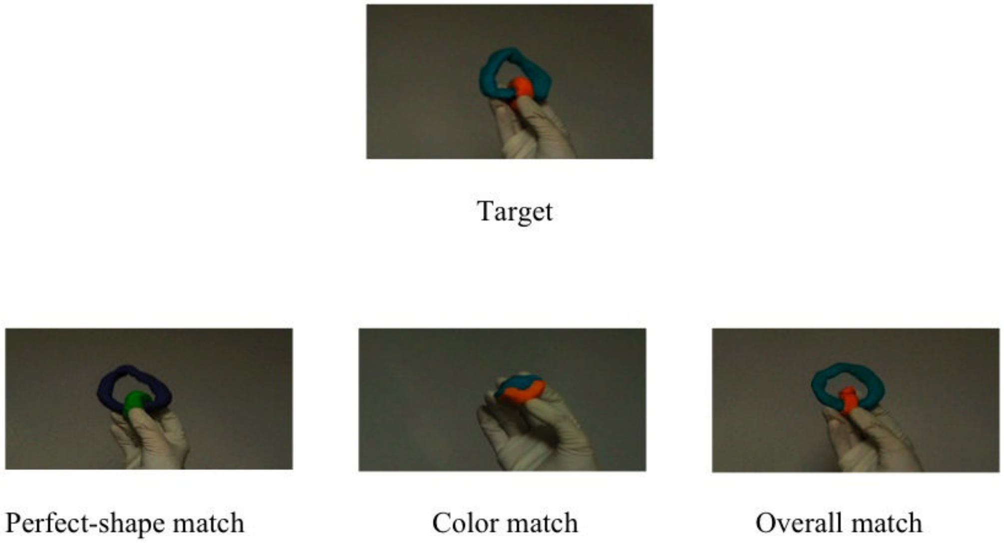

Figure 1.
Example of stimuli used in Experiment 1

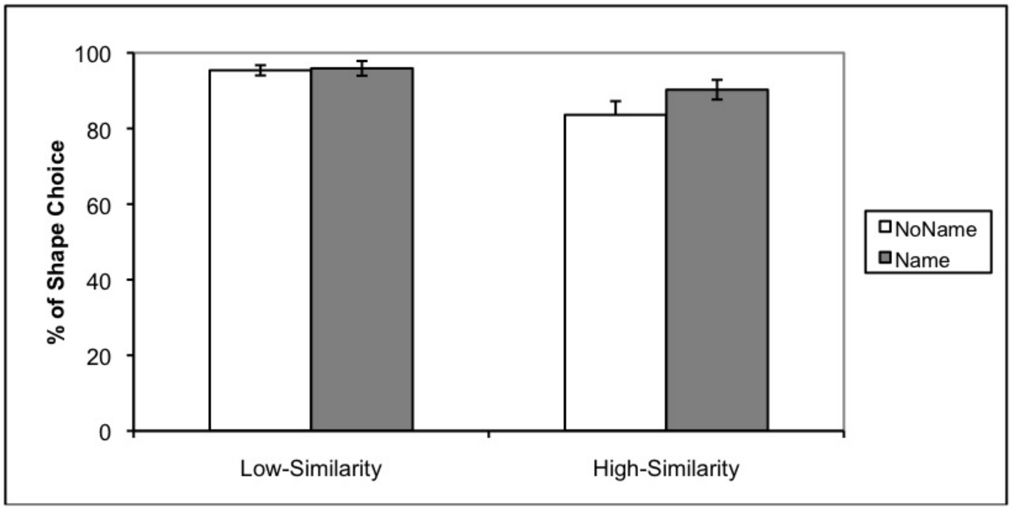

Figure 2.
Percent of shape choices in the low-similarity and high-similarity conditions, Experiment 1

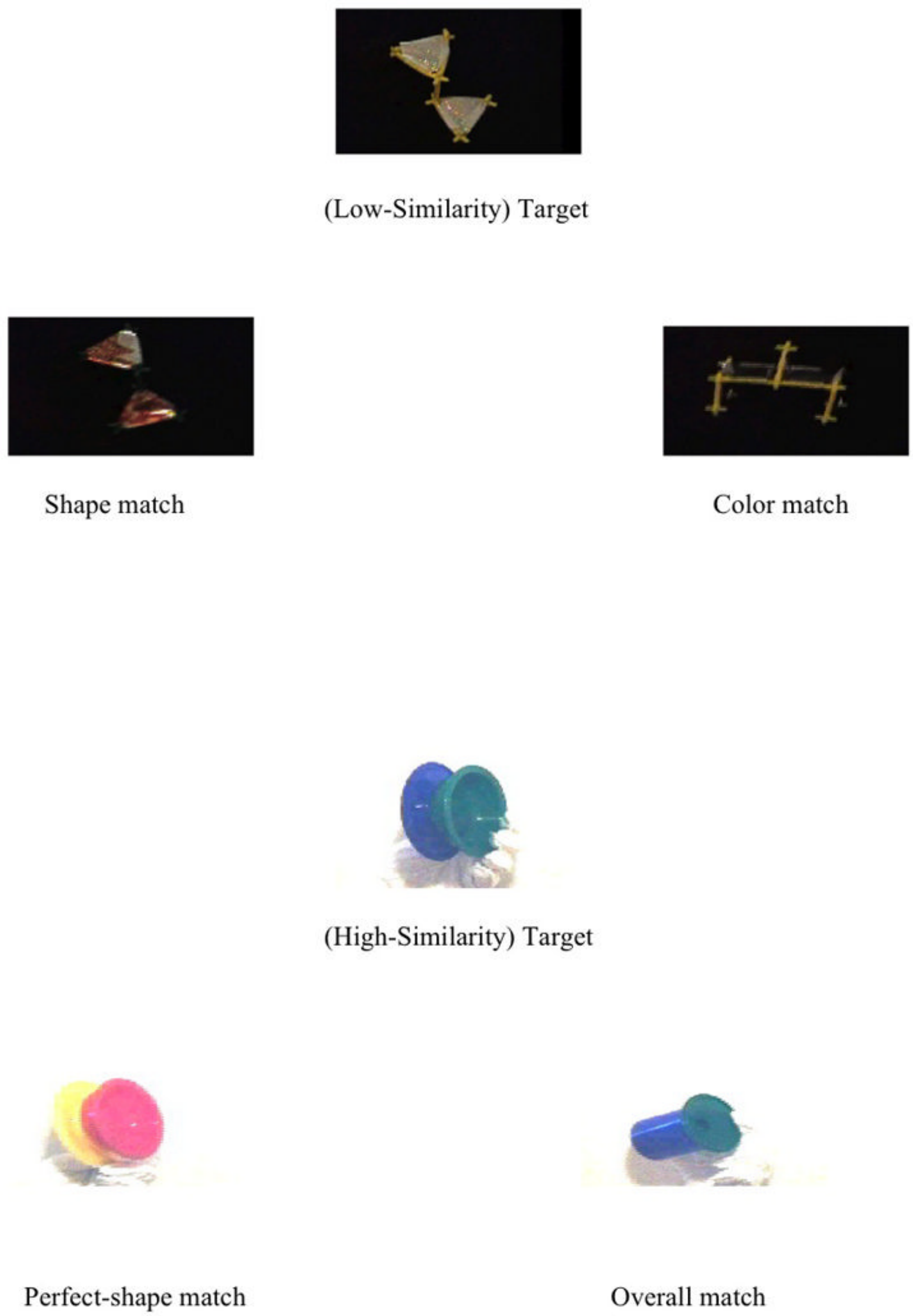

Figure 3.
Example of stimuli used in Experiment 2

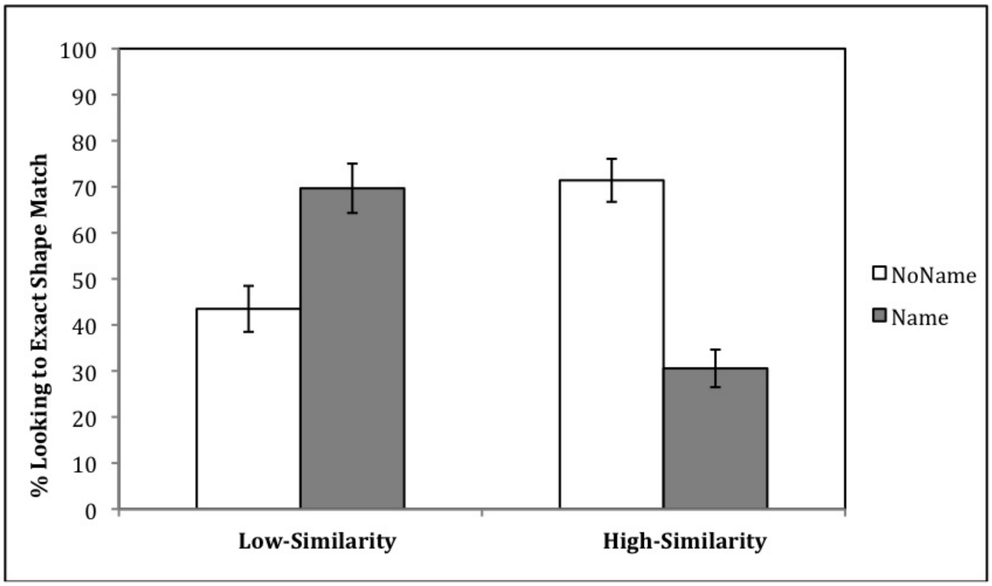

Figure 4.
Percent of looking to the shape match in the low-similarity and high-similarity conditions, Experiment 2