Children's inferences based on *figure* and *ground* thematic roles

Eleanor K. Chestnut (ekc@stanford.edu)
Department of Psychology, 450 Serra Mall
Stanford, CA 94305 USA

Ellen M. Markman (markman@stanford.edu)
Department of Psychology, 450 Serra Mall
Stanford, CA 94305 USA

Abstract

Logically symmetrical predicates are frequently interpreted, by adults, asymmetrically. Adults prefer to say, for example, "My brother met the President," over, "The President met my brother." This is because directional syntax contains *figure* and *ground* thematic roles, requiring the more important or prominent item be placed in the *ground* (second) position. To date, little is known about the development of this asymmetric interpretation. To address this, in Experiments 1 and 2 we asked whether children prefer to relate *figures* to *grounds* when expressing spatial relations (e.g., "The bicycle is next to the building") and similarity (e.g., "A zebra is like a horse"). Children as young as 4 showed emergent preference for this framing. In Experiment 3, we asked whether children ages 4 to 8 infer *grounds* to have higher skill and status in more specific comparisons (e.g., "The blicket cooks as well as the toma"). We also asked whether including the modal *can* (e.g., "The blicket can play soccer like the toma") or the comparative *as well as* (e.g., "The blicket plays soccer as well as the toma") would strengthen this inference. Children ages four through eight tended to associate *grounds* with higher status and skill in comparisons containing the modal *can*, but only the older children seemed affected by the comparative *as well as*. This work has implications for attempts to counter stereotypes: saying that girls do science as well as boys, for example, may imply that boys set the standard.

Keywords: language development; comparison; inference

Introduction

Language is a powerful and indispensable way of transferring knowledge to children. Through verbal descriptions and explanations, adults routinely teach children information that would otherwise not be accessible to them (e.g., Harris & Koenig, 2006). In addition to serving as a vehicle for explicit teaching, however, language can also affect conceptual development, perception, and beliefs in many subtle and implicit ways (e.g., Loftus & Palmer, 1974; Fausey & Boroditsky, 2010; Cimpian & Markman, 2011). The purpose of the present studies was to test whether children are sensitive to implicit information communicated via the linguistic framing of comparisons.

The literature on comparison processing, dating back to Tversky's seminal work in 1977, demonstrates that utterances that are logically equivalent may not be psychologically equivalent. One of Tversky's classic findings is that adults prefer statements such as, "North Korea is similar to China," rather than their reverse—in this case, "China is similar to North Korea" (Tversky, 1977).

A compelling account of this preference is offered by the *cognitive reference point model*. According to this model, asymmetries arise because of an interaction between syntactic thematic roles and the items being compared; sentences with the structure "A [is similar to] B" require that the item that serves as a more natural "reference point" for other category members be placed in the *ground* (B) position, and that the "variant" item be placed in the *figure* (A) position. Adults prefer to say that North Korea is similar to China because China, a more prominent country, serves as a better "reference point" (Rosch, 1975; Talmy, 1975; Bowdle & Medin, 2001). Gleitman et al. (1996) provide support for this interaction by demonstrating that adults make different inferences about non-words based on their syntactic positions. After reading the sentence, "The zum is similar to the gax," for example, adults infer that the *gax* is more important and famous than the *zum*.

Recent research in social psychology has expanded upon the finding that comparison asymmetries have cognitive consequences beyond explicit comparison judgments. Bruckmüller and Abele (2010), for example, found that attribution of status and power varied with the direction of a comparison, even when the comparison was unrelated to status or power. Adults in this study read paragraphs containing sentences such as, "The total number of students enrolled in Law is lower (higher) than the number of students enrolled in Economics." It was found that adults attributed more power and status to the "referent" group (in this case, Economics students) than to the "variant" group.

Surprisingly, no research to date has investigated these asymmetries in children. Considering the power of such directional syntax to shape assumptions in adults, it is important that we determine whether children, who are rapidly building their conceptual knowledge, are similarly influenced by these linguistic subtleties. In many cases, this inferential process is arguably useful for children, as it allows them to learn about the world from minimal linguistic input. Upon hearing that a tangerine is like an orange, for example, a child appropriately may infer that oranges are more typical and common than tangerines. As the research in social psychology suggests, however, this process can have unintended consequences in the social domain, potentially suggesting to children that some social groups are of higher status than others, despite the explicit expression of similarity.

Experiment 1

The purpose of Experiment 1 was to begin measuring children's sensitivity to the way comparisons are framed. Specifically, we were interested in whether children prefer sentences that frame the "referent" as the *ground* and the "variant" as the *figure* when expressing spatial relations (e.g., "The bike is next to the building") and similarity (e.g., "A zebra is like a horse"). From now on, we will refer to these sentence types as "forward statements".

We measured children's sensitivity by presenting them with sentences containing non-words (e.g., "A blicket is like a toma") and then asking them to identify the referents of those non-words in a picture (e.g., a picture of a zebra and a horse). This way, rather than making difficult metalinguistic judgments, children simply had to point to what they thought each non-word meant, and from their responses, we could infer whether they prefer to say, for example, that a horse is like a zebra or that a zebra is like a horse.

We included a Spatial condition in addition to a Similarity condition for two reasons. First, it has been shown that adults have stronger preference for forward statements when expressing spatial relations than when expressing similarity (Gleitman et al., 1996, Experiments 2, 3, 5). This is likely because a spatial relation involves a more literal reference point than does similarity. If children do not show sensitivity to linguistic framing for spatial relations, then it is unlikely that they would show sensitivity to linguistic framing for similarity. Second, if the same underlying *figure* and *ground* roles drive adults' preferences for forward statements for both spatial relations and similarity, then making judgments about spatial relations before making judgments about similarity might prime preference for forward statements when expressing similarity.

Selection of Items

To identify pairs of items that could be used in the Similarity condition of the present study, we asked adults on Mechanical Turk to complete a fill-in-the-blank task that would reflect preferences for forward statements. We wanted to identify items that adults strongly prefer to compare in a particular direction (based on differences in typicality) and that children would also be familiar with.

Methods

Participants. Participants were 31 adults ages 18 – 66 (M = 35, 13 men) who participated on Mechanical Turk for $0.15.

Materials. Twenty-four pairs of words judged by the experimenters to differ in typicality and to be familiar to children (e.g., wolf / dog, helicopter / airplane) were used.

Results

Adults demonstrated strong preferences for the following pairs of words: bush / tree, shorts / pants, juice / water, tent / house, vest / shirt, paws / hands, zebra / horse, tangerine / orange, helicopter / airplane, skirt / dress, moth / butterfly, pie / cake, grey / black, tricycle / bicycle, slipper / shoe, pink / red, crib / bed, and stool / chair. For each of these pairs of words, at least 80% of adults preferred forward statements (M = 87.50%). A subset of these items was used in the present study.

Measuring Children's Sensitivity

Children completed trials measuring their sensitivity to *figure* and *ground* thematic roles in expressions of both spatial relations and similarity.

Methods

Participants. Participants were 45 children (24 boys) ages 5;0 to 6;11 (M = 5;10). An additional 3 children participated but were excluded because they failed to complete the task. A total of 23 children completed the Similarity trials first (M = 5;10, 5;0 – 6;10, 12 boys), and a total of 22 children completed the Spatial trials first (M = 5;10, 5;0 – 6;11, 12 boys). Children were recruited from local nursery schools and a children's museum.

Materials. Pictures used for the Similarity condition contained 6 pairs of images in horizontal alignment that differed with respect to typicality: zebra / horse, stool / chair, bush / tree, slipper / shoe, tent / house, and crib / bed. These pictures were always paired with sentences produced by an alien containing two non-words (e.g., "A blicket is like a toma"). Non-words used for the Similarity condition were *koba* / *rapple*, *blicket* / *toma*, *tibbit* / *zuni*, *modi* / *feppet*, *tamble* / *gazzer*, and *tupa* / *fengle*.

Pictures used for the Spatial condition included 6 scenes with two objects that differed with respect to size and mobility, oriented in different ways: a broom and a closet, a cup and a tree, a bench and a river, a cat and a house, a picture and a door, and a bicycle and a building. Again, these pictures were always paired with sentences containing two non-words (e.g., "The doppit is across from the cloopa"). Predicates used were *next to*, *close to*, *far from*, *across from*, *near*, and *attached to*. Non-words used for the Spatial condition were *gaffa* / *nopper*, *doppit* / *cloopa*, *timbu* / *gozi*, *plig* / *fem*, *mido* / *tima*, and *kubi* / *fappo*.

The order of the images in each trial of each condition was counterbalanced across both trials (i.e., the "variant" was on the left side for half of the trials) and children (i.e., half of the children saw the "variant" on the left side).

Procedure. Children completed either the Similarity or the Spatial trials first, and this was counterbalanced across children. Two versions of each condition were constructed, which varied the order in which items were presented. Item order was also counterbalanced across children.

The experimenter began by introducing the child to Blue, a puppet who was described as an alien from a different planet who spoke an alien language. The experimenter told the child that they were going to view a series of pictures, and Blue would tell the child what he saw in each picture using his alien language. The experimenter explained that

she needed the child's help to figure out what Blue's words meant. The experimenter then showed the child the pictures one at a time, and Blue told the child what he saw (e.g., "Look! A blicket is like a toma!" in the Similarity condition, and, "Look! The kubi is next to the fappo!" in the Spatial condition), repeating each sentence twice for each picture. After Blue stated what he saw, the experimenter asked the child what he or she thought the non-words referred to, asking, e.g., "What do you think the blicket is?" If the child did not state his or her response out loud, the experimenter encouraged the child to indicate his or her response by pointing to an image in the picture.

Results

The dependent measure was the proportion of responses that reflected forward statements (e.g., "A zebra is like a horse"; "The bench is near the river"). Chance in this task was 50% for each condition, and we compared performance against chance with two-tailed t-tests. Overall, children preferred forward statements reliably above chance in both the Similarity (M = .61, SE = .03, n = 45, p < .001) and the Spatial condition (M = .68, SE = .04, n = 45, p < .001).

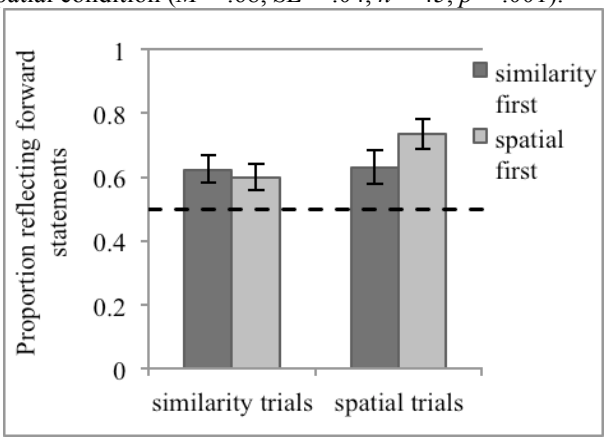

Figure 1: Proportion of children's responses in each condition and task order that reflected forward statements.

Preliminary analyses showed no effect of gender on responses, so gender was not included as a factor in further analyses. A repeated-measures ANOVA with condition as a within-subjects factor and task order and age as between-subjects factors yielded a marginal main effect of condition (F(1, 40) = 3.43, p = .07) on preference for forward statements and marginal interactions between age and condition (F(1, 40) = 3.48, p = .07) and between task order and condition (F(1, 40) = 3.04, p = .09. No other main effects or interactions were significant.

Children displayed marginally stronger preference for forward statements in the Spatial condition than in the Similarity condition, reflecting findings in the adult literature. As discussed, reasoning about similarity is harder and more abstract than reasoning about spatial relations.

Simple linear regressions showed that age significantly predicted preference for forward statements in the Spatial condition (F(1, 43) = 5.15, p = .03), but not in the Similarity condition (F(1, 43) = .02, p = .89). Again, a possible explanation is that the Similarity trials are much more difficult than the Spatial trials, even for the oldest children.

Finally, as can be seen in Figure 1, while responses in the two conditions did not differ when the Similarity trials were completed first (t(22) = 0.13, *ns*.), responses in the two conditions *did* differ when the Spatial trials were completed first, in which case children showed stronger preference for forward statements on the Spatial trials, t(21) = 2.37, p = .03. It is possible that completing the subtle and difficult Similarity trials first confused the children, leading to more random responding on the Spatial trials.

Discussion

In Experiment 1, we sought to determine whether children, like adults, prefer to frame "referents" as *grounds* and "variants" as *figures* when expressing spatial relations and similarity. All together, our results suggest that children as young as 5 have an emergent sensitivity to these thematic roles. Contrary to our prediction, however, we found no evidence that reasoning about spatial relations first primed sensitivity to *figure* and *ground* roles on Similarity trials.

Importantly, the present task also served as an indirect measure of the kinds of inferences children make based on *figure-ground* linguistic framing. Since children most often mapped the first non-word in each sentence to the smaller, less mobile objects in the Spatial condition and to the less typical objects in the Similarity condition, they must have been sensitive to the association of these features with the *figure* and *ground* positions in the sentence.

It is worth emphasizing that the difference between, say, "A zebra is like a horse," and, "A horse is like a zebra," or the difference between, "The bench is near the river," and, "The river is near the bench," is extremely subtle. These statements are logically equivalent, they represent the same symmetrical relation, and they differ only in word order. Nevertheless, children seem to pick up on these subtle differences and use *figure* and *ground* roles to constrain the way that they frame relations between concepts.

Experiment 2

Considering that 5- to 6-year-old children have an emerging sensitivity to *figure* and *ground* roles in sentences, we wanted to determine whether even younger preschoolers might show sensitivity to this syntax, and ultimately be able to use this syntax productively to make inferences about concepts. In Experiment 2, we presented 4-year-old children with similar Spatial and Similarity trials.

Methods

Participants. Participants were 40 children ages 3;10 to 4;11 (M = 4;5, 20 boys). An additional 2 children participated but were excluded because of failure to complete the task. A total of 20 children participated in the Spatial condition (M = 4;6, 3;10 – 4;11, 10 boys), and a total of 20 children participated in the Similarity condition (M =

4;4, 3;10 – 4;11, 10 boys). Children were recruited from a university nursery school and a children's museum.

Materials. The items used were identical to those used in Experiment 1, with the addition of two items per condition. The images added to the Similarity condition were vest / shirt and helicopter / airplane, and the non-words were *clomi* / *freeba* and *minku* / *rizza*. The images added to the Spatial condition were shoe / couch and ball / frence, and the non-words were *gerpa* / *bippit* and *harple* / *fova*. The predicates used were *against* and *touching*.

Procedure. The procedure was the same as in Experiment 1, except for two aspects: 1) children participated in only one condition, since we found no evidence of priming in Experiment 1, and 2) the number of trials was increased to 8 to strengthen the sensitivity of the task. Trials were presented in random order.

Results

As in Experiment 1, the dependent measure was the proportion of responses that reflected forward statements. Chance in this task was 50% for each condition, and we compared performance against chance with two-tailed t-tests. Four-year-olds preferred forward statements reliably above chance in both the Similarity (M = .58, SE = .04, p = .04) and the Spatial condition (M = .71, SE = .04, p < .001).

Since preliminary analyses showed no effect of gender on responses, gender was not included as a factor in further analyses. Four-year-olds showed stronger preference for forward statements in the Spatial condition (M = .71) than in the Similarity condition (M = .58), $t(38) = 2.51$, p = .02.

The 4-year-olds in this experiment were therefore similar to the older children in Experiment 1 in their sensitivity to *figure* and *ground* thematic roles.

Discussion

Like the older children, 4-year-olds displayed sensitivity to directional syntax when expressing both spatial relations and similarity, suggesting that they, too, make inferences about size, mobility, and typicality based on syntax. Their weaker preference for forward statements in the Similarity condition suggests again that sensitivity to *figure* and *ground* thematic roles depends on the predicate used and the abstractness of the relation between the two items.

It is important to note, however, that the phrase *is like* in the Similarity conditions of Experiments 1 and 2 was a general and unconstrained expression of similarity, and arguably not a particularly common one. When we compare two groups or individuals, we tend to specify *how* they are similar, stating, for example, that Sarah *plays soccer as well as* Molly rather than that Sarah is generally *like* Molly. This specification likely makes it easier to identify the appropriate *figure* and *ground*, because the *ground* should be the better exemplar of the skill expressed by the predicate—in this case, soccer-playing. In Experiment 3, we asked whether children show stronger sensitivity to *figure* and *ground* roles in more specific, ecologically valid comparisons such as these.

Experiment 3

To assess children's sensitivity to *figure* and *ground* thematic roles in more specific comparisons, we first identified the kinds of comparisons that children may often hear in everyday conversation. Google searches suggested that comparisons among social groups are often specific (e.g., "Girls are as good at math as boys") rather than general (e.g., "Girls are like boys"). They also suggested that comparisons among groups frequently contain comparatives that presuppose some kind of skill in addition to expressing equivalence (e.g., *as good as*, *as well as*). Finally, they identified the modal *can* as a common part of these comparisons (e.g., "Girls can be scientists, too").

We therefore presented children with comparisons that had these characteristics. In one condition, children heard comparisons containing predicates that specified the dimension of the comparison (e.g., "The blicket plays soccer like the toma"). In a second condition, children heard comparisons that contained the comparative *as well as* (e.g., "The blicket plays soccer as well as the toma"). We predicted that the comparative *as well as* would result in stronger sensitivity to *figure* and *ground* roles because it *explicitly* introduces the notion of skillfulness and suggests that the *ground* is a standard of being skilled. In a third condition, children heard comparisons containing the modal *can* (e.g., "The blicket can play soccer like the toma"). There appears to be a meaningful difference between the phrases "girls play soccer" and "girls *can* play soccer", for example. While the generic phrase "girls play soccer" implies that playing soccer is something that girls routinely do (Gelman, 2004), the phrase "girls can play soccer" seems to suggest that girls have some ability to play soccer without implying that they actually do play. The modal *can*, in short, tempers the relation between the subject and the predicate. So, upon hearing, "Girls can play soccer," one may infer that girls actually *do not* routinely play soccer—if they did, the speaker should have said, "Girls play soccer"—and that there are important reasons for this (e.g., perhaps girls lack the relevant skills; Horn, 2008). In this way, the modal *can* strengthens the asymmetry in skill or status established by *figure-ground* framing.

To measure children's sensitivity to *figure* and *ground* roles in these sentences, we used the same non-word paradigm used in Experiments 1 and 2, except that the pictures contained two people rather than two objects. Both people in the pictures were always dressed in similar attire associated with a specific skill (e.g., in a soccer uniform), but one person was always an adult while the other was always a child. We predicted that in all conditions, the adult should be identified as the *ground* and the child should be identified as the *figure*, because adults are generally more skilled and of higher status than children.

To determine the development of this sensitivity, we tested children ages 4 to 8, and we divided the children into

two groups: younger (ages 4 to 5), who had shown weak sensitivity to *figure* and *ground* roles in the Similarity conditions of Experiments 1 and 2, and older (ages 6 to 8).

Methods

Participants. Participants were 96 children (48 boys) ages 4;0 to 8;8 (M = 6;1). An additional 3 children participated but were excluded for not completing the task. Children participated in one of the three conditions that differed in sentence type, and 16 children ages 4 to 5, and 16 children ages 6 to 8 participated in each condition (M = 6;1, 4;2 – 8;2, 16 boys in the *Like* condition; M = 6;0, 4;0 – 8;8, 16 boys in the *Can* condition; M = 6;1, 4;4 – 8;7, 16 boys in the *As well as* condition). Children were recruited from a university nursery school and a children's museum.

Materials. Eight pictures were used, each of which contained an adult and a child dressed in similar attire. Child and adult pairs were dressed as soccer players, chefs, cowboys, construction workers, dancers, baseball players, swimmers, or karate students. Children and adults in each pair were always of the same gender. Five pairs were male, and 3 were female. Children and adults in each picture were arranged diagonally from each other, and their positioning was counterbalanced across both trials and participants.

In the *Like* condition, children heard sentences comparing two non-words along specific dimensions (e.g., "The mido cooks like the tima"). Predicates used were *plays soccer*, *cooks*, *rides horses*, *builds things*, *dances*, *plays baseball*, *swims*, and *does karate*. Non-words used were *mido* / *tima*, *gubi* / *fappo*, *wug* / *plom*, *timbu* / *gozi, doppit* / *cloopa*, *gaffa* / *nopper*, *kolva* / *bippit*, and *harple* / *fova*. The *Can* and *As well as* conditions were the same, except that the modal *can* was added to each sentence (e.g., "The mido can play soccer like the tima") and the word *like* in each sentence was replaced with *as well as* (e.g., "The mido plays soccer as well as the tima"), respectively.

Procedure. The procedure was the same as in Experiments 1 and 2, except the experimenter began by stating that Blue was going to say something about the *people* in the pictures. The experimenter then showed the child the first picture, and Blue produced a sentence (e.g., "Hey! The mido cooks like the tima!" in the *Like* condition, "Hey! The mido cooks as well as the tima!" in the *As well as* condition, and, "Hey! The mido can cook like the tima!" in the *Can* condition). Additionally, to ensure that the child understood the task, the experimenter said to the child after this first trial, "So now we need to figure out which one is the [mido] and which one is the [tima]." Blue then repeated his utterance (e.g., "The mido cooks like the tima!"), and the experimenter asked the child what he or she thought the non-words referred to. For the rest of the trials, the experimenter did not continue say, "So now we need to figure out which one is the [mido] and which one is the [tima]." Instead, Blue simply stated each sentence twice for each picture. Trials were presented in random order.

Results

The dependent measure was the proportion of responses that identified the adult as the *ground*. Preliminary analyses showed no effect of gender on responses, so gender was not included as a factor in further analyses. A two-way ANOVA with age group and condition as between-subjects factors yielded a marginal main effect of age group on responses ($F(1, 92) = 3.09$, $p = .08$). Overall, older children (6 to 8) displayed stronger preference for identifying the adult as the *ground* than did younger children (4 to 5). No other main effects or interactions were significant, suggesting that the three conditions did not differ in difficulty, and that older children did not show a selective advantage for any one or two conditions in particular.

Comparisons against chance, however, create a somewhat different picture. Chance in this task was 50% for each condition, and we compared performance against chance with two-tailed t-tests. Overall, children in the *Like* condition were marginally above chance in identifying the adult as the *ground* (M = .58, SE = .05, p = .06), and children in the *Can* and *As well as* conditions were significantly above chance (M = .67, SE = .05, $p < .001$ in the *Can* condition; M = .63, SE = .05, $p < .01$ in the *As well as* condition). When age groups (4 to 5 and 6 to 8) were analyzed separately, both younger and older children were above chance in the *Can* condition (M = .61, SE = .07, p = .06 for younger children; M = .73, SE = .07, p = .001 for older children), but only older children were above chance in the *As well as* condition (M = .70, SE = .07, p = .004).

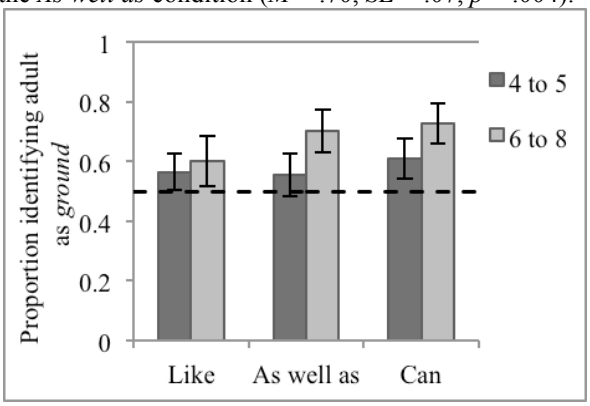

Figure 2: Proportion of children's responses in each age group and condition identifying the adult as the *ground*.

Discussion

While children ages 6 to 8 were reliably above chance in identifying the adult as the *ground* in both the *Can* and *As well as* conditions, children ages 4 to 5 benefited only from the modal *can*. Thus, modals such as *can* and comparatives that presuppose skill such as *as well as* may play an important role in biasing children towards associating the *ground* with higher skill and status.

One reason why we did not see stronger sensitivity to *figure* and *ground* roles in younger children could be that

the task was too difficult for them. The task required children to process sentences that were more complex than those used in Experiments 1 and 2, and this increased complexity likely made an already difficult task involving inference and word-referent mappings even harder.

Older children might not have identified the adult as the *ground* in the *Like* condition because the predicates used were still somewhat vague with respect to skill and status. Stating that Sarah plays soccer like Molly, for example, does not entail that Molly is *good* at soccer; rather, it could be that Sarah and Molly simply play in some eccentric way.

General Discussion

The results of these studies suggest that children are becoming sensitive to *figure* and *ground* roles in sentences during the preschool years. In Experiments 1 and 2, we found that children ages 4 to 6 prefer to relate *figures* to *grounds* when expressing both spatial relations and similarity. While preference for this linguistic framing was robust for spatial relations, it was weak for similarity, suggesting that sensitivity to *figure* and *ground* roles may take longer to develop for more abstract relations. Our results also suggested that children make inferences about size, mobility, and typicality of referents based on syntactic position: children identified the larger, less mobile objects as the *grounds* in the Spatial conditions and the more typical objects as the *grounds* in the Similarity conditions. In Experiment 3, we found that using comparisons that contained more specific predicates along with the comparative *as well as* (e.g., "The blicket cooks as well as the toma") and the modal *can* (e.g., "The blicket can cook as well as the toma") revealed strong sensitivity to *figure* and *ground* thematic roles in children aged 6 to 8, but not younger children, suggesting that at least by early elementary school, these linguistic elements strengthen the association of the *ground* with higher skill and status.

Considering children's emerging sensitivity to *figure* and *ground* roles in sentences, it may be important for adults to carefully consider how they frame comparisons, particularly when trying to express equivalence among social groups. Statements such as, "Girls can do science as well as boys," for example, may backfire on a number of levels, despite being well-intentioned and egalitarian on the surface.

Importantly, not only might directional comparisons like these perpetuate stereotypes and social rankings, but such comparisons might also themselves *introduce* contrasts between category members. Critically, as previously mentioned, children are in the process of constructing their knowledge of the world. If children do not already know how two category members differ on a particular dimension, then, directional comparisons may, in fact, plant the idea in the child's mind that differences exist. Although this process of associating certain features with items framed as either *figures* or *grounds* is useful to the extent that it allows children to learn characteristics of category members without the speaker having to state them explicitly—saying that a helicopter is like an airplane, for example, could signal to the child that airplanes are more common and typical than helicopters—it may also result in the differential attribution of status and ability to social groups and lead to social biases. Attempts to counter stereotypes by saying, "Girls can do science as well as boys," in short, may actually suggest to the child that boys set the standard.

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