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# Are Horses Like Zebras, or Vice Versa? Children's Sensitivity to the Asymmetries of Directional Comparisons

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Adults exhibit strong preferences when framing symmetrical relations. Adults prefer, for example, "A zebra is like a horse" to "A horse is like a zebra," and "The bicycle is near the building" to "The building is near the bicycle." This is because directional syntax requires more typical or prominent items (i.e., reference points) to be placed in the complement position. Three experiments with children ages 4–8 ($N$ = 181) explored whether children share this sensitivity to directional syntax. Children of this age showed an incipient preference for framing reference points as complements. Stating, "Girls do math as well as boys," which frames boys as the reference point for girls, may therefore actually teach children that boys set the standard.

Language is a powerful and indispensable way of transferring knowledge to children. While it can be used explicitly to teach, it can also affect perception, beliefs, and conceptual development in many more subtle and implicit ways (e.g., Cimpian & Markman, 2011; Fausey & Boroditsky, 2010; Gelman, Taylor, & Nguyen, 2004; Loftus & Palmer, 1974). The ways in which language implicitly conveys information are important to understand because adults may unintentionally shape children's conceptual development by communicating information that effectively counteracts the message they are explicitly trying to express.

One notable example of explicit and implicit information in language counteracting each other can be found in the way we express comparisons involving symmetrical predicates. Take the symmetrical predicate *is like*, for example. The phrase "A is like B" clearly implies that B is also like A. Contrast this with an asymmetrical predicate, say *kill.* The phrase "A killed B" does not at all imply that B also killed A. So, if "A is like B" implies that B is like A, one might think that the order in which A and B are mentioned would not change the meaning of the sentence. But, in fact, it does. Adults strongly prefer to say, for example, "A zebra is like a horse" rather than "A horse is like a zebra." Or to take some other symmetrical predicates, adults prefer to say, "My brother met the president" rather than "The president met my brother," and "The bicycle is next to the building" rather than "The building is next to the bicycle" (Bowdle & Medin, 2001; Gleitman, Gleitman, Miller, & Ostrin, 1996; Rosch, 1975; Tversky, 1977; Tversky & Gati, 1978). Such directional statements (i.e., statements with items in the subject and complement positions), though explicitly expressing symmetrical relations, actually imply differences between the items referenced. These implications can be seen even in sentences involving novel items. For example, upon hearing that A is like B, adults tend to infer that B is more typical or prominent than A; upon hearing that A *met* B, adults tend to infer that B is more important and famous than A; and upon hearing that A is *next to* B, adults tend to infer that B is larger and less mobile than A (Bruckmüller & Abele, 2010; Bruckmüller, Hegarty, & Abele, 2012; Gleitman et al., 1996).

These findings date back to a series of seminal studies conducted by Tversky (1977), who showed that adults are sensitive to the linguistic framing of similarity. In these groundbreaking studies, Tversky found that adults overwhelmingly preferred to say, for example, "North Korea is similar to China" rather than its reverse, "China is similar to North Korea." Tversky accounted for this preference with his feature contrast model. This model makes two main assumptions: (a) similarity between two items increases as the number of their common features

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increases and decreases as the number of their unique features increases, and (b) the subject of the comparison receives "focus," causing its unique features to be weighted more heavily than the complement's (Tversky, 1977; Tversky & Gati, 1978). In the case of North Korea and China, because North Korea is less prominent and has fewer unique features than does China, North Korea is perceived to be more similar to China than China is to North Korea. As a result, "North Korea is similar to China" sounds better to adults than "China is similar to North Korea." Based on these findings, Tversky argued that although similarity may seem to be a symmetrical concept, it is actually often *a*symmetrical. According to his model, similarity would become truly symmetrical only if the two items compared were of equal prominence (e.g., "China is similar to Japan"), or if the comparison were *nondirectional*. Nondirectional comparisons are those in which both items are placed in the subject position, such as "North Korea and China are similar to each other." Here, both countries receive focus, so their unique features are given equal weight and the order in which the countries are mentioned in the comparison does not influence judgments of similarity.

Several researchers—including us—however, have since disagreed with Tversky's (1977) description of *similarity* per se as asymmetrical, arguing that such asymmetries in comparisons can be created by other linguistic factors. Bowdle and Gentner (1997), for example, propose that asymmetries are driven by differences in informativeness. By their account, framing preferences do not have to result from differences in perceived similarity; rather, one direction of a comparison is simply more informative than the other, and adults prefer statements that are maximally informative (Grice, 1975). Here, the authors define informativeness as the amount of information that can be projected from the complement of the comparison to the subject. If we know more about China than North Korea, for example, then the statement, "North Korea is similar to China," would generate more new inferences about North Korea than the statement, "China is similar to North Korea," would generate about China.

Another proposal, the cognitive reference point model, is that comparison asymmetries arise as a result of grammatical principles that require more typical or prominent items ("reference points") to serve as complements and less typical or prominent items ("variants") to serve as subjects (Bowdle & Medin, 2001; Gleitman et al., 1996; Rosch, 1975). Adults prefer to state, for example, "The bicycle is next to the building" rather than "The building is next to the bicycle," not because the predicate *is next to* is inherently asymmetrical, but because buildings typically serve as reference points, or landmarks, for bicycles rather than vice versa. Similarly, adults prefer to say that 996 is essentially 1,000 rather than the reverse not because *is essentially* is asymmetrical, but because we usually use 1,000, and not 996, as a conceptual "anchoring point" for other numbers (Rosch, 1975). Thus, adults prefer to state, "North Korea is similar to China" rather than "China is similar to North Korea," because "North Korea is similar to China" expresses a more standard variant–reference point relation between China and North Korea. In other words, it is the asymmetry of the subject and complement positions of the sentence, rather than the predicate, that results in framing preferences (cf. Talmy, 1978).

According to this proposal, the standard variant–reference point relation between the items does not always have to be preferable if the context makes it clear that the opposite framing would be more appropriate. Also, adults may alter their interpretations of items so that they are compatible with their respective positions in the sentence. Gleitman et al. (1996) provide some evidence for this: After asking their participants, "Can you think of any occasion in which you might prefer to say, 'The building is next to the bicycle?'" they found that adults could readily come up with such contexts. One adult, for example, stated that this framing would make sense "if you had this humungous bicycle statue in the town square and a tiny building on wheels going around it" (pp. 347–348).

Gleitman et al. (1996) provide extensive evidence for the cognitive reference point model, showing that it holds for a variety of symmetrical predicates. They demonstrated that adults prefer sentences such as "My sister met Meryl Streep" to "Meryl Streep met my sister." They also found that when presented with sentences such as "The zum met the gax," adults consistently inferred that the item in the complement position (here, *gax*) was more important, more famous, older, larger, and less mobile than the item in the subject position (here, *zum*). Here, similarity judgments are irrelevant, and the items themselves are meaningless, so Tversky's feature contrast model cannot explain these inferences. Similarly, it is not obvious that one way of framing an encounter (e.g., "The zum met the gax") should be more informative than another (e.g., "The gax met the zum"), as no projection of information is involved. The cognitive reference point

model, however, easily accounts for these inferences by positing that because the *gax* is in the complement position, it should be considered the reference point, and therefore be viewed as more prominent than the *zum*. For this reason, we adopt the mechanism of the cognitive reference point model throughout the remainder of this work.

The way a comparison is framed, then, can have an important effect on how items are interpreted. Merely structuring an utterance so that one item becomes the reference point and the other the variant might lead to inferred differences between the items, even when the content is intended to be egalitarian. Statements such as "Girls can do science as well as boys," for example, may suggest that boys (the reference point, here), and not girls, are the typical or more important scientists, essentially contrasting the two groups in addition to expressing similarity.

Considering the capacity of such directional syntax to shape assumptions in adults, it is important to determine whether children, who are rapidly building their conceptual knowledge, are similarly influenced by these linguistic cues. Simply by saying that tangerines taste like oranges, an adult may actually introduce to the child the notion that tangerines and oranges differ with respect to typicality. This inferential process would often be useful, as it would allow children to learn about the world from minimal linguistic input. This same process, however, could have unintended consequences in the social domain, potentially suggesting to children that some social groups are more important or of higher status than others.

To date, this inferential process has not been measured in children. Several studies, however, provide evidence for important *prerequisites* for these inferences. One such prerequisite, of course, is sensitivity to subject and complement positions in sentences. If children are not sensitive to these syntactic positions, then they would be unable to infer that items in the subject position are variants while items in the complement position are reference points. A number of studies since the 1980s have confirmed that English-speaking children—indeed, infants—are sensitive to subject–complement structure in syntax (e.g., Golinkoff, Hirsh-Pasek, Cauley, & Gordon, 1987; Hirsh-Pasek & Golinkoff, 1991, 1996; Hirsh-Pasek, Golinkoff, Fletcher, DeGaspe-Beaubien, & Cauley, 1985; Hirsh-Pasek, Naigles, Golinkoff, Gleitman, & Gleitman, 1988). Hirsh-Pasek and Golinkoff (1991), for example, demonstrated that even 17-month-olds could distinguish between the meanings of "Cookie Monster is washing Big Bird" and "Big Bird is washing Cookie Monster" by interpreting the subject as the *agent* of the action and the complement as the *patient*.

A second prerequisite is that children recognize that some predicates, such as *meet*, *is next to*, and *is like*, are symmetrical, while others, such as *wash* and *move*, are asymmetrical. Miller (1998) provides evidence that by around 4–5 years of age, children begin to appreciate the difference between symmetrical and asymmetrical predicates. Miller notes that, unlike asymmetrical predicates, symmetrical predicates are permissible in nondirectional statements *only* when the subject is plural (e.g., "The lion and the elephant met" is grammatical, but "The lion met" is not). When embedded in nondirectional syntax, they imply a reciprocal action (e.g., "The lion and the elephant met" entails that the lion and the elephant met *each other*); and, when embedded in directional syntax (e.g., "The lion met the elephant"), reversing the order of the noun phrases results in only a small change in meaning. (We are arguing, of course, that this difference in meaning, though small, is consistent and worthy of investigation.) Asymmetrical predicates, on the other hand, do not require a plural subject in nondirectional statements (e.g., "The lion moved"); when embedded in nondirectional syntax, they do not imply a reciprocal action (e.g., "The lion and the elephant moved" does *not* entail that they moved each other); and when embedded in directional syntax (e.g., "The lion moved the elephant"), reversing the order of the noun phrases *does* strongly change the meaning of the statement.

To determine whether children are sensitive to these differences between symmetrical and asymmetrical predicates, Miller (1998) asked children ages 4–5 to use toys to act out directional (e.g., "The lion is moving the elephant") and nondirectional (e.g., "The lion and the elephant are moving") sentences containing either symmetrical (e.g., *meet*) or asymmetrical (e.g., *move*) predicates. As an indirect assessment of children's interpretations of the sentences, adults were then asked to watch videos of the children's enactments and guess which particular sentence the children had been asked to depict. Adults had to choose between two sentences that were identical except for the order of their items (e.g., "The lion is meeting the elephant" or "The elephant is meeting the lion"; "The elephant and the lion are meeting" or "The lion and the elephant are meeting"). Miller found that when children acted out nondirectional sentences, adults were at chance at identifying the sentences the children had been given, regardless of whether they contained symmetrical (e.g., "The lion

and the elephant are meeting") or asymmetrical (e.g., "The lion and the elephant are moving") predicates. Thus, the linear order of the items in the subject position of the nondirectional sentences did not strongly influence children's interpretations. In contrast, for directional sentences containing asymmetrical predicates (e.g., "The lion is moving the elephant"), children's interpretations varied markedly according to the word order, and adults were highly accurate in their guesses (92% correct). Adults were significantly less accurate when children acted out directional sentences containing symmetrical predicates ("The lion is meeting the elephant"; 73% correct), suggesting that children did indeed treat sentences containing symmetrical and asymmetrical predicates differently. Still, however, adults were well above chance even for the directional sentences containing symmetrical predicates, suggesting that the children acted out "The lion is meeting the elephant" by privileging the lion in their movements, and "The elephant is meeting the lion" by privileging the elephant in their movements. Even though these sentences express reciprocal actions, the item in the subject position was still treated as somewhat *agent*–like.

To summarize what is known developmentally: well before 2 years of age, children are sufficiently sensitive to syntax—namely, subject and complement positions and their respective agent and patient thematic roles—such that they clearly distinguish between sentences such as "Cookie Monster is washing Big Bird" and "Big Bird is washing Cookie Monster." By 4 or 5 years of age, children understand that reversing the word order in a directional statement changes the meaning of the sentence for both asymmetrical (e.g., who is washing whom) and symmetrical relations (e.g., who is meeting whom). They also understand, however, that the effect of word order on meaning is stronger for asymmetrical relations (Miller, 1998; see also Dessalegn & Landau, 2008; Gurcanli, 2013).

Given this sensitivity, we are now in a position to ask whether such young children, like adults, prefer directional statements expressing symmetrical relations that preserve standard variant–reference point relations, such as "The bicycle is near the building" rather than "The building is near the bicycle," or "A zebra is like a horse" rather than "A horse is like a zebra."

## Experiment 1

The purpose of Experiment 1 was to assess children's sensitivity to the linguistic framing that has been shown to shape adults' inferences when processing comparisons. Specifically, we asked whether children prefer sentences that frame the reference point as the complement and the variant as the subject when expressing spatial relations (e.g., "The bicycle 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 first tried to measure children's sensitivity by asking them questions such as "Which sentence sounds better?" or "How would you say this to a friend?" but these questions required children to keep multiple sentences in working memory, compare them, and then make qualitative judgments about which one was "best." As a result, it was difficult for children to answer these questions. We therefore devised a new procedure that would not require them to engage in such metalinguistic reasoning. In this procedure, children listened to sentences containing novel words (e.g., "A blicket is like a toma") and were then asked to identify the referents of these words in a picture (e.g., a picture of a zebra and a horse). In this procedure, children simply had to point to the referent of each novel word, and from their responses we could infer whether they preferred to say, for example, that a horse is like a zebra or that a zebra is like a horse.

We asked about both spatial relations and similarity for two reasons. First, it has been shown that adults have stronger preference for forward statements when expressing symmetrical spatial relations than when expressing similarity (Gleitman et al., 1996, Experiments 2, 3, 5). This is likely because physical spatial relations involve more literal and concrete reference points (i.e., things that are physically large and stationary) than does similarity. Thus, if children do not show sensitivity to the linguistic framing of spatial relations, it is unlikely that they would show sensitivity to the linguistic framing of similarity. Second, making judgments about the framing of spatial relations first might prime sensitivity to the implications of directional syntax when expressing similarity.

### *Selection of Items*

To identify pairs of items for the similarity condition, we asked 31 adults ages 18–66 ($M$ = 35; 13 men) on Amazon Mechanical Turk to complete a fill-in-the-blank task that would reflect preferences for forward statements for a payment of $0.15. We wanted to identify items that adults strongly prefer to compare in a particular direction and that children would also be familiar with.

In this task, adults were presented with 24 pairs of words (e.g., *zebra, horse*) that we judged to contain category members that both differ in typicality and are familiar to children. Each pair of words was followed by the sentence: "A ____ is like a ____." Adults were asked to fill in the blanks according to what felt most natural. Two item orders were used and were counterbalanced across participants. The order of the words in each word pair was also counterbalanced across participants, and for half of the word pairs that each participant viewed, the typical item (e.g., horse) was presented first.

For items to be included in our subsequent experiments, we required that at least 80% of the adults preferred to frame the comparison in the same way (e.g., "A zebra is like a horse"). Adults demonstrated consistent preferences for 18 of the 24 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, gray–black, tricycle–bicycle, slipper–shoe, pink–red, crib–bed,* and *stool–chair*. A subset of these word pairs was used in the present study.

## *Experiment 1A*

We first tested a group of adults to establish that our indirect measure of sensitivity to the implications of directional syntax would replicate previous findings.

### *Method*

*Participants.* Participants were 48 adults between the ages of 19 and 61 ($M$ = 32; 24 men) who participated through Amazon Mechanical Turk for a payment of $0.15. A total of 24 adults ages 18–61 ($M$ = 30; 14 men) completed the similarity trials first, and a total of 24 adults ages 18–61 ($M$ = 35; 10 men) completed the spatial trials first.

*Materials.* Pictures used for the similarity condition were six pairs of images that differed in typicality: *zebra–horse, stool–chair, bush–tree, slipper–shoe, tent–house*, and *crib–bed*. These pictures were always paired with written sentences containing two nonwords that the participant was told had been produced by an alien (e.g., "A blicket is like a toma"). Nonwords used for the similarity condition were: *koba–rapple*, *blicket–toma*, *tibbit–zuni*, *modi–feppet*, *tamble–gazzer*, and *tupa–fengle*. Each nonword pair was always used with the same picture, and the order of the nonwords was counterbalanced across participants. For the similarity condition, image pairs were presented in a vertical alignment to adults, after it became apparent in pilot work that adults displayed a strong side bias with a left–right alignment. The order of the images in each picture was counterbalanced both across trials (i.e., the variant was on the top for half of the trials) and across participants (i.e., half of the participants saw a particular variant on the top, and half saw it on the bottom).

Pictures used for the spatial condition were six scenes with two objects that differed in size and mobility, oriented in different ways (i.e., arranged horizontally or diagonally from each other at varying distances). The object pairs used were 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 written sentences containing two nonwords that the participant was told had been produced by an alien (e.g., "The doppit is across from the cloopa"). Predicates used were *next to*, *close to*, *far from*, *across from*, *near*, and *attached to*. Again, the order of the variant and reference point in each picture was counterbalanced both across trials and across participants, this time with the variant being on the left for half of the trials and half of the participants seeing a particular variant on the left. We did not see the need to modify these pictures as we did the pictures in the similarity condition because they did not result in a strong side bias during pilot testing. Nonwords used for the spatial condition were *gaffa–nopper*, *doppit–cloopa*, *timbu–gozi*, *plig–fem*, *mido–tima*, and *kubi–fappo*. Again, each nonword pair was always used with the same picture, and the order of the nonwords was counterbalanced across participants.

*Procedure.* Participants completed either the similarity trials first or the spatial trials first, and this was counterbalanced across participants. Two versions of each condition were constructed, which varied the order in which items were presented. Item order was also counterbalanced across participants.

Participants began by reading the following instructions on a computer screen: "An alien looks at the following pictures and describes what she sees. She uses her alien language, though, so it is your job to figure out what her words mean in English." Beneath each picture, adults saw a sentence that said, for example, "She says, 'Look! A blicket is like a toma!'" Below each sentence, adults

were asked what they thought each nonword referred to, and they answered this by filling in a blank on the computer screen.

*Results*

The dependent measure was the proportion of responses that reflected forward statements (e.g., "A zebra is like a horse"; "The broom is far from the closet"). Chance was defined as 50% for each condition, since one of two potential responses for each trial was a forward statement. Adults demonstrated preference for forward statements reliably above chance in both the similarity condition ($M = 0.69$, $SE = 0.03$), two-tailed $t(47) = 6.13$, $p < .001$, $d = 0.88$, and the spatial condition ($M = 0.95$, $SE = 0.02$), two-tailed $t(47) = 25.89$, $p < .001$, $d = 3.74$, replicating previous findings.

To test the effects of condition and task order on performance, we used a mixed effects logistic regression model with fixed effects of condition and task order and a random effect of participant. Including a fixed effect of gender did not improve model fit, $\chi^2(1) = 0.006$, $p = .94$, so this variable was not included in the model. Adults displayed significantly stronger preference for forward statements in the spatial condition than in the similarity condition, $\beta = 2.18$, $p < .001$, replicating previous findings that adults display stronger framing preferences for symmetrical spatial relations than for similarity (Gleitman et al., 1996, Experiments 2, 3, 5). Adults also displayed significantly stronger preference for forward statements in both conditions when the spatial trials were completed first rather than second, $\beta = 0.73$, $p = .01$ (see Figure 1). This supports our hypothesis that completing the spatial trials first would prime sensitivity to the implications of directional syntax on the similarity trials, increasing preference for forward statements. To explain the slight drop in performance on the spatial trials when the spatial trials were completed second—which we did not predict—it is likely that the similarity trials were subtle and difficult enough to confuse the adults, resulting in more random responding on the spatial trials. There was no significant interaction between condition and task order.

It is important to note that we expected adults' preference for forward statements on the similarity trials to be stronger than it was. In Tversky's (1977) original study, for instance, he notes that "66 subjects selected the phrase 'North Korea is similar to Red China' and only three selected the phrase 'Red China is similar to North Korea'"

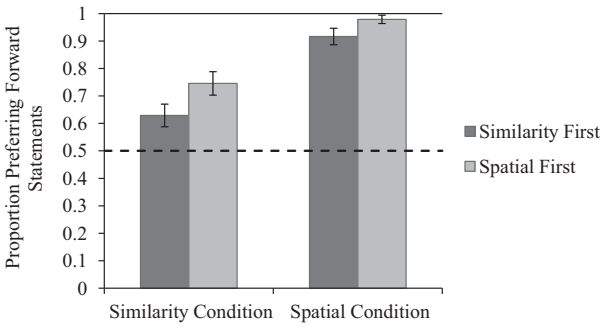


*Figure 1.* The proportion of adults' responses in Experiment 1 that reflected preference for forward statements in each condition and task order. The error bars represent the standard error of the mean.

when they were asked to state which of the two phrases they would prefer to use (p. 334). Also, in our own fill-in-the-blank task that we used to identify items that adults have strong framing preferences for and that children would likely be familiar with, we found that adults preferred forward statements for the similarity items used in the present study an overwhelming 87% of the time. But in our nonword paradigm, they preferred forward statements in the similarity condition only 69% of the time. There are two possible reasons for this discrepancy.

First, several adults showed a visual bias in the similarity condition, even though we presented images to them in a vertical alignment. That is, 17 adults total (6 of whom completed the spatial trials first and 11 of whom completed the similarity trials first) consistently declared that the item on top was like the item beneath it across all trials. It is likely that as the adults read each sentence, their initial response was to map the first nonword they read onto the first image they saw. When adults do not need to make inferences about pictures—when they only need to fill in the blanks in a simple verbal task—this bias might be avoided. Similar biases were not found for the spatial trials; in fact, only one adult showed a consistent side bias across these trials, identifying the image on the left as the subject, or variant. The difference between conditions was significant, with more adults displaying a side bias in the similarity condition ($n = 17$) than in the spatial condition ($n = 1$), binomial sign test, $p < .001$. Adults likely did not show a strong side bias in the spatial condition because the spatial trials depicted scenes oriented in different ways and because spatial relations elicit stronger framing preferences in participants (Gleitman et al., 1996, Experiments 2, 3, 5).

A second reason why adults displayed weaker preference for forward statements in the similarity condition of this task could be that the present study involved making inferences about the meanings of nonwords. In addition to considering variant–reference point relations, adults had to process nonwords and then map those nonwords onto images in a picture. This is different from simply choosing a sentence that "sounds better"—which is arguably easier for adults than it is for children—and could have weakened preference for forward statements. Again, adults' more robust preference for forward statements when expressing spatial relations, and the different orientations of the objects in the spatial trials, could explain why this mapping procedure did not seem to reduce performance in the spatial condition.

## *Experiment 1B*

Even if we had expected adults' preference for forward statements to be stronger than it was, it was still robustly above chance, and so we used this paradigm to measure children's preference for forward statements, as well.

### *Method*

*Participants.* Participants were 45 native English-speaking children between the ages of 5;0 and 6;11 ($M$ = 5;10; 24 boys) from predominantly middle- to upper-middle-class families in the San Francisco area. An additional three children participated but were excluded either because they did not understand the task, as judged by a side bias across all trials (i.e., selecting the image on the left for every trial in both conditions; $n = 1$) or because they failed to complete the task ($n = 2$). A total of 23 children completed the similarity trials first ($M$ = 5;10, range = 5;0–6;10; 12 boys), and a total of 22 children completed the Spatial trials first ($M$ = 5;10, range = 5;0–6;11; 12 boys). Children were recruited from local nursery schools and a children's museum.

*Materials.* The same items were used for children, except that image pairs in the similarity condition were presented in a horizontal rather than vertical alignment. We maintained this alignment because we did not expect children at this age to have a strong reading bias, and because children would be hearing rather than reading the sentences.

*Procedure.* Children completed either the similarity trials first 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 the session by introducing children to a puppet named Blue, who was described as a friend from a different planet who spoke an alien language. The experimenter told children that they were going to view a series of pictures, and that Blue would tell them about what he saw in each picture using his alien language. The experimenter explained that she needed the children's help to figure out what Blue's words meant. The experimenter then showed children the pictures one at a time, and Blue stated 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 children what they thought the nonwords referred to, asking, for example, "What do you think the blicket is?" If children did not verbalize their response, the experimenter encouraged them to indicate their response by pointing to an image in the picture. Each child completed 12 trials total, with 6 trials for each condition.

### *Results*

The dependent measure was the proportion of responses that reflected forward statements (e.g., "A zebra is like a horse"; "The broom is far from the closet"). On three occasions in the spatial condition, children mapped the word in the complement position onto an image that was not one of the target images (e.g., the wall instead of the door for the trial with a picture attached to a door), but in each of these cases the image selected served as a second feasible reference point and was coded as such. Chance was defined as 50% for each condition, since one of two potential responses for each trial was a forward statement. Children demonstrated preference for forward statements reliably above chance in both the similarity condition ($M = 0.61$, $SE = 0.03$), two-tailed $t(44) = 3.71$, $p < .001$, $d = 0.55$, and the spatial condition ($M = 0.68$, $SE = 0.04$), two-tailed $t(44) = 5.12$, $p < .001$, $d = 0.76$ (see Figure 2).

To measure the effects of condition, task order, and age (continuous) on performance, we analyzed our results using a mixed effects logistic regression model with fixed effects of condition, task order, and age, and a random effect of participant. Again, including a fixed effect of gender did not improve

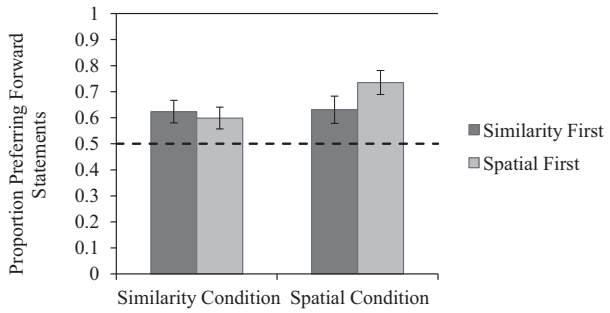


*Figure 2.* The proportion of children's responses in Experiment 1 that reflected preference for forward statements in each condition and task order. The error bars represent the standard error of the mean.

model fit, $\chi^2(1) = 1.53$, $p = .22$, so this variable was not included in the model. We found no significant interactions or main effects, suggesting that all children performed similarly in each condition regardless of the order in which they completed the trials. Completing the spatial trials first, then, did not prime sensitivity to the implications of directional syntax on the similarity trials.

A side bias was also present in children's responses in the similarity condition. This bias further demonstrates the difficulty of the similarity trials, as children often revert to biased responding on difficult tasks. Eight children total ages 5;0–6;1 ($M$ = 5;6) declared that the item on one side was like the item next to it across all similarity trials. While one of these children consistently stated that the item on the right was like the item on the left, seven of these children consistently stated that the item on the left was like the item on the right, which could have reflected nascent reading skills. Again, similar biases were not found for the spatial trials—in fact, no children displayed a side bias across all six spatial trials. This difference was significant; more children displayed a side bias in the similarity condition ($n$ = 8) than in the spatial condition ($n$ = 0), binomial sign test, $p = .008$.

In sum, like adults, children were sensitive to the linguistic framing of both symmetrical spatial relations and similarity, showing above-chance preference for forward statements in both conditions.

### *Discussion*

In Experiment 1, we sought to determine whether children, like adults, prefer to frame reference points as complements and variants as subjects when expressing symmetrical spatial relations and similarity. Our results suggest that children as young as 5 years old have an emergent, above-chance preference for this framing.

Our task also served as a measure of the kinds of inferences children make based on directional syntax. Since children most often mapped the novel word in the complement position of each sentence to the larger, less mobile objects in the spatial condition and to the more typical objects in the similarity condition, children must associate these features with that syntactic position. In other words, they must infer from sentences such as "The zum is next to the gax" that the *gax* is larger and less mobile than the *zum*, and from sentences such as "The blicket is like the toma" that the *toma* is more typical than the *blicket*.

It is worth emphasizing that the difference between, say, "A tent is like a house" and "A house is like a tent" is subtle. These statements could be used to express the same symmetrical relation in the world, and as Gleitman et al. (1996) and Miller (1998) have demonstrated, they are judged by adults to have very similar meanings. Nevertheless, both children and adults seem to interpret these sentences differently, ultimately preferring the statement that frames the item they consider the more appropriate reference point as the complement.

Given that by 5 years of age, children seem to have acquired some sensitivity to these implications of directional syntax, in Experiment 2 we asked whether even younger children make similar asymmetric interpretations.

## Experiment 2

In Experiment 2, we presented 4-year-old children with similar spatial and similarity trials. Since we found no evidence that the spatial trials primed children's performance on the similarity trials in Experiment 1, in Experiment 2, 4-year-olds participated in only one condition: either the similarity condition or the spatial condition.

### *Method*

#### *Participants*

Participants were 40 native English-speaking children between the ages of 3;10 and 4;11 ($M$ = 4;5; 20 boys) from predominantly middle- to upper-middle-class families in the San Francisco area. An additional 2 children participated but were excluded because they failed to complete the task. A total of 20 children participated in the spatial

condition ($M$ = 4;6, range = 3;10–4;11; 10 boys), and a total of 20 children participated in the similarity condition ($M$ = 4;4, range = 3;10–4;11; 10 boys). Children were recruited from a university preschool and a children's museum.

### *Materials*

The items were identical to those used in Experiment 1B, with the addition of two items per condition to increase the sensitivity of the task. The pictures in the similarity condition were the following pairs of images: zebra–horse, stool–chair, bush–tree, slipper–shoe, tent–house, crib–bed, helicopter–airplane, and vest–shirt. These pictures were always paired with sentences containing two nonwords: *koba–rapple*, *blicket–toma*, *tibbit–zuni*, *modi–feppet*, *tamble–gazzer*, *tupa–fengle*, *clomi–freeba*, and *minku–rizza*. The items in the similarity condition were also arranged in a vertical rather than horizontal alignment to reduce potential side bias, and the order of the variant and reference point in each picture was counterbalanced both across trials and across participants.

The pictures in the spatial condition were the following pairs of objects arranged horizontally or diagonally from each other at varying distances: 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, a bicycle and a building, a shoe and a couch, and a soccer ball and a fence. Predicates used were *next to*, *close to*, *far from*, *across from*, *near*, *stuck to*, *touching*, and *against*. These pictures were always paired with sentences containing two nonwords: *gaffa–nopper*, *doppit–cloopa*, *timbu–gozi*, *plig–fem*, *mido–tima*, *kubi–fappo*, *gerpa–bippit*, and *harple–fova.* Again, the order of the variant and reference point in each picture was counterbalanced both across trials and across participants.

### *Procedure*

The procedure was the same as in Experiment 1, except children completed eight trials rather than six and participated in only one condition. Trials were presented in random order.

### *Results*

As in Experiment 1, the dependent measure was the proportion of responses that reflected forward statements (e.g., "A zebra is like a horse"; "The broom is far from the closet"). On six occasions in the spatial condition, children mapped the word in the complement position onto an image that was not one of the target images, but in each of these cases the image selected served as a second feasible reference point and was coded as such. Chance was 50% for each condition. Four-year-old children preferred forward statements reliably above chance in both the similarity condition ($M$ = 0.58, $SE$ = 0.04), two-tailed $t(19) = 2.10$, $p = .04$, $d = 0.47$, and the spatial condition ($M$ = 0.71, $SE$ = 0.04), two-tailed $t(19) = 6.03$, $p < .001$, $d = 1.35$.

To test the effect of condition on performance, we used a mixed effects logistic regression model with a fixed effect of condition and a random effect of participant. Including a fixed effect of gender did not improve model fit, $\chi^2(1) = 0.35$, $p = .55$, so this variable was not included in the model. Unlike the older children in Experiment 1, 4-year-olds did show stronger preference for forward statements in the spatial condition than in the similarity condition, $\beta = 0.58$, $p = .01$. Why might the younger children in this experiment, but not the older children in Experiment 1B, have shown this difference between conditions? One possibility is that including condition as a between-subjects factor simply allowed us to capture children's preference for forward statements more accurately.

Seven 4-year-olds ages 4;1–4;10 ($M$ = 4;5) also displayed position biases in the similarity condition, selecting either the top or bottom picture across all trials as the subject of the sentence. Again, as with the older children, no 4-year-olds displayed a side bias on the spatial trials. The difference between conditions was significant; more children displayed a position bias in the similarity condition ($n = 7$) than in the spatial condition ($n = 0$), binomial sign test, $p = .02$.

### *Discussion*

Like the older children, 4-year-olds preferred to frame reference points as complements and variants as subjects when expressing both symmetrical spatial relations and similarity. This suggests that they, too, make inferences about size, mobility, and typicality based on syntactic positioning.

While their preference for forward statements in the spatial condition was robustly above chance, it was weak in the similarity condition, supporting the idea that the strength of framing preferences for directional statements depends on the predicate used and the abstractness of the relation between the two items in the sentence. Spatial relations, as noted earlier, involve literal reference points, and so children at very young ages—perhaps even

younger than 4 years old—are able to identify standard variants and reference points for sentences containing symmetrical spatial predicates with relative ease. Similarity, on the other hand, involves relating two items on a conceptual level, and identifying the appropriate reference point requires that the child consider abstract features such as typicality, prominence, or importance in addition to concrete features such as size and mobility.

It is important to point out that using the phrase *is like* to express similarity does not specify how items should be thought of as similar. Instead, it is a general and unconstrained expression of similarity, requiring the listener to spontaneously consider typicality when identifying which item should serve as the reference point. The vagueness inherent in the phrase *is like*, then, might have contributed to children's weaker preference for forward statements on these trials.

Would we see stronger framing preferences, then, when this vagueness is reduced? One way of making a comparison less vague is by making the dimension of the comparison explicit. Instead of stating that one item is generally *like* another, for example, we can state that one item *plays soccer like* the other (e.g., "The blicket plays soccer like the toma"), in which case the reference point (here, the toma) should be the more skilled soccer player. Second, we could replace the comparative *like* with the comparative *as well as* (e.g., "The blicket plays soccer as well as the toma"), which presupposes some kind of skill in addition to expressing equivalence, thus strengthening the asymmetry of the comparison. If Alex plays soccer as well as Henry, then Henry must have at least some level of soccer-playing ability. Third, we could include the modal *can* as a modifier of the predicate (e.g., "The blicket can play soccer like the toma"). While the generic phrase "girls play soccer" implies that playing soccer is something that girls routinely do (Gelman, 2004), for example, the generic phrase "girls can play soccer" seems to suggest that girls have some ability to play soccer, or are allowed to play soccer, without entailing that they actually do play. The modal *can*, in other words, tempers the relation between the subject, or variant, 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" (Clark, 1987; Grice, 1975)—and that there are important, meaningful reasons for this (e.g., perhaps girls do not enjoy playing soccer or are not particularly skilled at it). In this way, the modal *can* may imply further differences between the items framed as the variant and reference point.

In our third experiment, we manipulated the comparisons used in Experiments 1 and 2 to have these characteristics.

## Experiment 3

In Experiment 3, rather than presenting children with sentences containing the general predicate *is like*, we used predicates that specified the dimension of the comparison and denoted a skill, such as *dances like* (e.g., "The blicket dances like the toma"). We also presented children with sentences that contained the comparative *as well as* (e.g., "The blicket dances as well as the toma"), which presupposes that the complement is skilled, and the modal *can* (e.g., "The blicket can dance like the toma"), which may pragmatically suggest that the subject is not particularly skilled.

To measure children's sensitivity to the implications of directional syntax in these sentences, we used the same novel word paradigm used in Experiments 1 and 2, except that the pictures children viewed always contained two people rather than two objects. The two people in each picture were 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 intended that for all sentence types in Experiment 3, the adult character should be placed in the complement position and the child character in the subject position because adults are generally considered to be more skilled and of higher status than children (i.e., adults are more appropriate reference points in these contexts).

To determine the development of this sensitivity, we tested children ages 4 through 8, and divided them into two groups: younger children (ages 4–5), who had shown weak framing preferences in the similarity conditions of Experiments 1 and 2, and older children (ages 6–8).

### *Method*

#### *Participants*

Participants were 96 native English-speaking children between the ages of 4;0 and 8;8 ($M$ = 6;1; 48 boys) from predominantly middle- to upper-middle-class families in the San Francisco area. An additional 4 children participated but were excluded because they failed to complete the task.

Children participated in one of the three conditions that differed in sentence type, and 32 children participated in each condition. Gender was fully counterbalanced across conditions. Of the 32 children in each condition, half were between 4 and 5 years old ($M$ = 4;11, range = 4;2–5;11 in the *specific predicate* condition; $M$ = 5;0, range = 4;0–5;7 in the *can* condition; $M$ = 4;11, range = 4;4–5;9 in the *as well as* condition) and half were between 6 and 8 years old ($M$ = 7;4, range = 6;4–8;2 in the *specific predicate* condition; $M$ = 7;1, range = 6;2–8;8 in the *can* condition; $M$ = 7;3, range = 6;2–8;8 in the *as well as* condition). Children were recruited from a university preschool and a children's museum. A group of 47 adults ages 20–59 ($M$ = 33; 23 men) also participated through Amazon Mechanical Turk for a payment of $0.15, 16 of which ($M$ = 35, range = 25–59, 5 men) of which participated in the *specific predicate* condition, 15 of which ($M$ = 33, 21–52, 9 men) participated in the *can* condition, and 16 of which ($M$ = 32, 20–59, 9 men) participated in the *as well as* condition. One adult was excluded for not following instructions.

### *Materials*

Eight pictures were used, each of which contained an adult character and a child character dressed in similar uniforms. The pairs of characters were dressed as soccer players, chefs, cowboys, construction workers, dancers, baseball players, swimmers, or karate students. The characters in each pair were always of the same race and gender. Five pairs were male, and three pairs were female, based on the availability of pictures of women, men, girls, and boys in these uniforms. To avoid potential side biases, the characters in each picture were arranged diagonally from each other. Child and adult characters appeared equally often in each corner of the picture across all trials, and the arrangement of the characters in each picture was counterbalanced across participants.

*Specific Predicate Condition.* Children in this condition heard sentences comparing two nonwords along specific dimensions (e.g., "The mido plays soccer like the tima"). Predicates used were *plays soccer*, *cooks*, *rides horses*, *builds things*, *dances*, *plays baseball*, *swims*, and *does karate*. Nonwords used were *mido–tima*, *gubi–fappo*, *wug–plom*, *timbu–gozi*, *doppit–cloopa*, *gaffa–nopper*, *kolva–bippit*, and *harple–fova*. Each nonword pair was always used with the same picture, and the order of the nonwords was counterbalanced across participants.

*As Well As Condition.* The sentences and nonwords were the same as those used in the *specific predicate* condition, except that the word *like* in each sentence was replaced with *as well as* (e.g., "The mido plays soccer as well as the tima").

*Can Condition.* The sentences and nonwords were the same as those used in the *specific predicate* condition, except that the modal *can* was added to each sentence (e.g., "The mido can play soccer like the tima").

### *Procedure*

As in Experiment 2, children were introduced to Blue, who spoke an alien language. The experimenter told the child that they were going to view a series of pictures with people in them, and that Blue was going to say something about the people in the pictures 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 first picture, and Blue told the child about the people in the picture (e.g., "Hey! The mido plays soccer like the tima!" in the *specific predicate* condition; "Hey! The mido plays soccer as well as the tima!" in the *as well as* condition; "Hey! The mido can play soccer like the tima!" in the *can* condition). 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 plays soccer like the tima!"), and the experimenter asked the child what he or she thought the nonwords referred to, asking, for example, "Which one is the mido?" If children did not verbalize their response, the experimenter encouraged them to indicate their response by pointing to a person in the picture. 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. Each child completed eight trials, which were presented in random order.

### *Results*

The dependent measure was the proportion of responses in which participants placed the adult character, who was intended to be the reference point in each situation, in the complement position of the sentence (e.g., *tima* in, "The mido plays soccer as well as the tima"). We again fit the data using a mixed effects logistic regression model,

with fixed effects of condition and age group (younger children, older children, or adults) and a random effect of participant. Including a fixed effect of gender did not improve model fit, $\chi^2(1) = 0.05$, $p = .82$, so this variable was not included in the model. Planned contrasts showed that adults ($M = 0.92$, $SE = 0.04$, $n = 47$) were more likely to place the adult character appropriately in the complement position than were younger children ($M = 0.58$, $SE = 0.07$, $n = 48$), $\beta = 1.47$, $p < .001$, or older children ($M = 0.68$, $SE = 0.07$, $n = 48$), $\beta = 1.00$, $p < .001$. Older children were also more likely to place the adult character in the complement position than were younger children, $\beta = 0.46$, $p = .03$. There was no a main effect of condition nor a significant interaction between age group and condition, suggesting that the three conditions did not differ in difficulty, and that older children and adults did not show a selective advantage for any one or two conditions in particular.

To get a better sense of each age group's framing preferences in each condition, we also compared performance against chance. Chance in this task was 50%. Adults were at ceiling in placing the adult character in the complement position in the *specific predicate* condition ($M = 0.91$, $SE = 0.05$), two-tailed $t(15) = 7.51$ $p < .001$, $d = 1.88$; the *can* condition ($M = 0.95$, $SE = 0.03$), two-tailed $t(14) = 15.32$, $p < .001$, $d = 3.95$; and the *as well as* condition ($M = 0.91$, $SE = 0.04$), two-tailed $t(15) = 10.07$, $p < .001$, $d = 2.52$. Recall that in the similarity condition of Experiment 1 (e.g., "A blicket is like a toma"), adults preferred forward statements on 69% of trials. Specifying the dimension of the comparison, adding the modal *can*, including the comparative *as well as* and, perhaps, arranging the images diagonally from each other in the present task, then, resulted in stronger framing preferences in adults.

Overall, children were significantly above chance in placing the adult character in the complement position in the *can* condition ($M = 0.67$, $SE = 0.05$), two-tailed $t(31) = 3.49$, $p = .001$, $d = 0.62$, and the *as well as* condition ($M = 0.63$, $SE = 0.05$), two-tailed $t(31) = 2.48$, $p = .02$, $d = 0.44$, but not in the *specific predicate* condition ($M = 0.58$, $SE = 0.05$), two-tailed $t(31) = 1.60$, $p = .12$, $d = 0.28$. When age groups (4–5 or 6–8) were analyzed separately, older children were above chance in placing the adult character in the complement position in the *can* condition ($M = 0.73$, $SE = 0.07$), two-tailed $t(15) = 3.35$, $p = .004$, $d = 0.84$, while younger children were not ($M = 0.61$, $SE = 0.07$), two-tailed $t(15) = 1.62$, $p = .13$, $d = 0.41$. Older children were also above chance in placing the adult character in the complement position in the *as well as* condition ($M = 0.70$, $SE = 0.07$), two-tailed $t(15) = 2.86$, $p = .01$, $d = 0.71$, while younger children again were not ($M = 0.55$, $SE = 0.07$), two-tailed $t(15) = 0.75$, $p = .47$, $d = 0.19$. In the *specific predicate* condition, however, neither younger children ($M = 0.56$, $SE = 0.06$), two-tailed $t(15) = 1.02$, $p = .33$, $d = 0.25$, nor older children ($M = 0.60$, $SE = 0.08$), two-tailed $t(15) = 1.21$, $p = .25$, $d = 0.30$, were above chance in placing the adult character in the complement position (see Figure 3). Both the modal *can* and the comparative *as well as* therefore strengthened framing preferences in the older, but not the younger, children.

Additionally, since images were arranged diagonally from each other rather than horizontally or vertically, side biases in children's responses were significantly reduced. In this task, only four of the 96 children displayed consistent side biases across all trials.

### *Discussion*

Instead of using the general and vague predicate *is like*, in Experiment 3 we specified the dimension of the comparison (e.g., *plays soccer like*), making the comparison more explicit, and added either the comparative *as well as* or the modal *can*, which we predicted would strengthen asymmetric interpretations of the sentences.

Children ages 6–8 years old were reliably above chance in placing the adult character, the reference point, in the complement position in both the *can* and *as well as* conditions, while the youngest children did not show reliable framing preferences in any condition. Thus, modals such as *can* (e.g., "The blicket can play soccer like the toma")—which temper the relation between the subject and the predi-

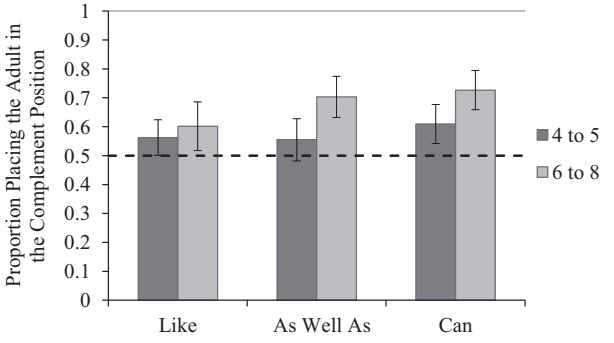


*Figure 3.* The proportion of children's responses in each age group and condition in Experiment 3 that placed the adult in the complement position. The error bars represent the standard error of the mean.

cate and may suggest that the subject is not particularly skilled—and comparatives that presuppose skill such as *as well as* (e.g., "The blicket plays soccer as well as the toma")—which frame the complement as highly skilled—may play an important role in biasing older children toward associating the complement with greater skill and status.

One reason why younger children showed weaker framing preferences in this task could be that the task was simply too difficult for them. First, this task required children to keep in mind long and complex sentences. Although children this age could successfully complete a similar task in Experiments 1 and 2, the sentences used in those experiments were simpler. Second, this task required children to keep track of two novel words and to assign those novel words to referents in a picture. Had we devised a task involving familiar (e.g., *girl*) rather than novel words, the sentences might have been easier to process, and we might have found stronger framing preferences in this age group. This reasoning, of course, holds for all three experiments, and it is possible that our novel word paradigm in general underestimated children's sensitivity to the implications of directional syntax.

Also, sentences such as "Sarah plays soccer like Molly" may remain vague with respect to skill level and status. Stating that Sarah plays soccer like Molly does not necessarily imply that Molly is *good* at soccer; rather, it could be the case that they both simply use a similar style. Sentences in the *specific predicate* condition, therefore, might have still been too general, unconstrained, and unrelated to ability for children to have made inferences about skill and status based on directional syntax.

The results of Experiment 3 ultimately suggest that from 6 years on, children are sensitive to subtle linguistic cues in comparisons—namely, word order, the modal *can*, and the comparative *as well as*—that, *despite explicitly expressing similarity*, imply differences between the items in the subject and complement positions. As Experiments 1 and 2 demonstrated that children use directional syntax to make inferences about typicality, the present experiment shows that children use these linguistic cues to make inferences about skill and status, as well.

## General Discussion

In this work we have explored whether children are sensitive to the implications of directional statements containing symmetrical predicates. Directional syntax, which contains items in the subject and complement positions, shapes the way adults interpret sentences (e.g., Gleitman et al., 1996). Adults strongly prefer to say, for example, "A zebra is like a horse" rather than "A horse is like a zebra." This is because grammatical principles require more prominent or typical items (i.e., reference points) to be placed in the complement position of sentences, and atypical or deviant items (i.e., variants) to be placed in the subject position. The impact of this linguistic framing can be seen in sentences containing completely novel words: Upon hearing, "A blicket is like a toma," adults tend to infer that the *toma*, by virtue of being framed as the complement, is the reference point and therefore more prominent or typical than the *blicket*. Thus, even when a predicate clearly expresses a symmetrical relation, in fact, even when the predicate expresses *similarity* (e.g., *is like*), the syntax of directional statements nevertheless has the power to imply differences. This process of associating certain features with items framed as subjects or complements in directional comparisons can be useful in that it might allow children to learn about relations between category members without the speaker having to state them explicitly: Saying that a helicopter is like an airplane, for example, could signal to children that airplanes are more common and typical than helicopters.

In Experiments 1 and 2, we explored children's preferences for framing reference points as complements and variants as subjects in sentences expressing symmetrical spatial relations (e.g., "The bicycle is next to the building") and similarity (e.g., "A zebra is like a horse"). We found that children ages 4–6 did indeed have strong preferences for framing larger and less mobile items as complements in sentences expressing symmetrical spatial relations. They also preferred to frame more typical items as complements in sentences expressing similarity, but this preference in the youngest children was weaker.

In Experiment 3, we asked whether children prefer to frame reference points as complements and variants as subjects in more specific comparisons that also contained other linguistic elements that could contribute to the asymmetry of the comparison. Since the comparisons in this task expressed people's abilities to do various activities, the features associated with the reference point were now higher levels of skill and status. The comparisons that children heard contained more specific predicates (e.g., "The blicket plays soccer like the toma"); the modal *can* (e.g., "The blicket can play

soccer like the toma"), which pragmatically may suggest that the subject is not particularly skilled; and the comparative *as well as* (e.g., "The blicket plays soccer as well as the toma"), which presupposes that the complement is skilled. While the youngest children (ages 4–5) did not show any framing preferences in this task, older children (ages 6–8) were above chance in identifying the more skilled and higher status person (i.e., the reference point) as the complement for comparisons containing both the modal *can* and the comparative *as well as*, and adults were above chance for all comparisons used. Thus, by early elementary school, the modal *can* and the comparative *as well as* may strengthen the association of the complement with greater skill and status.

Taken together, the results of these three experiments suggest that a sensitivity to the implications of directional syntax is emerging at least by late preschool and becoming more robust by early elementary school age. We found strong framing preferences, even in 4-year-olds, for statements expressing symmetrical spatial relations (e.g., "The bicycle is next to the building). Framing preferences for statements expressing similarity (e.g., "A zebra is like a horse"; "The kid dances as well as the adult"), however, were significantly weaker in our youngest participants. The concrete and literal nature of reference points in spatial relations (e.g., a building can be a literal, physical reference point for a bicycle) likely makes those reference points easier to conceptualize and identify. Similarity, on the other hand, is more abstract and somewhat underspecified, requiring children to spontaneously reason about features such as typicality and importance. Moreover, younger children might still be in the process of building the categorical knowledge necessary to identify more typical category members, making it harder for them to determine, for example, whether a horse or a zebra would serve as a better reference point.

We would like to highlight another reason why the implications of these directional comparisons might be inherently challenging for children to process. In particular, in sentences such as "A zebra is like a horse" or "The kid dances as well as the adult," there is a conflict between the symmetry of the predicate and the asymmetry of the directional syntax. While the predicate expresses similarity between the two items in the comparison, the syntactic structure of the sentence implies *differences*, by virtue of framing one item as the variant and the other as the reference point. These contradictory components of the sentence somehow need to be detected and reconciled. Integrating these two components, however, is likely difficult for very young children, and as a result, the symmetry of the predicate may dominate their interpretation of the comparison. We have shown that by early elementary school age, children are able to take into account both the symmetry of the predicate and the implications of the directional syntax and thus judge, for example, that if John dances as well as Tim, then Tim is probably the more established or important dancer.

Considering these results, it may be important for adults to carefully consider how they frame comparisons for children, particularly when trying to express equivalence between social groups. Directional statements such as "Girls can do math as well as boys"—which is a common way of expressing gender equality as concern grows for the underrepresentation of women in STEM (science, technology, engineering, and math) fields—may backfire on a number of levels, despite being well intentioned and egalitarian on the surface. The framing of *girls* as the variant and *boys* as the reference point may cause children to associate boys with greater status and math ability, the modal *can* may suggest that doing math is atypical of girls, and the comparative *as well as* may strengthen the idea that boys are typically better at doing math. Importantly, not only might directional comparisons both reflect and perpetuate stereotypes and social hierarchies, but they might also themselves *introduce* contrasts between category members to children who are not yet aware of the stereotype. Attempting to counter gender stereotypes by saying, "Girls can do math as well as boys," then, could actually instill beliefs about gender differences in children and suggest that boys set the standard.

Future work should address alternative ways of effectively expressing gender equality that avoid the potential pitfalls of these directional comparisons. Based on the existing literature, one good candidate for this would be nondirectional statements, which do not contain variant–reference point relations (Gleitman et al., 1996; Miller, 1998). Nondirectional statements such as "Girls and boys can do math," which do not frame either gender as the variant or reference point, might well serve as a better alternative for expressing gender equality.

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