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# On the validity and robustness of the scale error phenomenon in early childhood

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ABSTRACT

*Scale errors* is a term referring to very young children's serious efforts to perform actions on miniature replica objects that are impossible due to great differences in the size of the child's body and the size of the target objects. We report three studies providing further documentation of scale errors and investigating the validity and robustness of the phenomenon. In the first, we establish that 2-year-olds' behavior in response to prompts to "pretend" with miniature replica objects differs dramatically from scale errors. The second and third studies address the robustness of the phenomenon and its relative imperviousness to attempts to influence the rate of scale errors.



Perception and action are intimately linked in human activity, with perception providing information to guide action and action providing feedback to direct further information seeking about the environment (Adolph, 2005; Bertenthal & Clifton, 1998; Creem & Proffitt, 2001). Although this linkage is normally seamless, it occasionally breaks down. Examples of such breakdowns involve the effects of certain types of brain damage, including a variety of perception-action dissociations. For example, some individuals have no conscious awareness of the presence of an object in one side of their visual field, but can nevertheless reach for it accurately (Milner & Goodale, 1995).

A dramatic example of such a dissociation in the use of visual information to guide action is the phenomenon of *scale errors* in very young children that was originally reported by DeLoache, Uttal, and Rosengren (2004) and subsequently replicated and extended by Brownell, Zerwas, and Ramani (2007), and Rosengren, Gutierrez, Anderson, and Schein (2009). A scale error involves a serious effort to carry out an action that is completely impossible due to a great disparity in the size of the actor and the target of the attempted action. For example, a toddler might attempt to lie down on a bed from a dollhouse or to squeeze his or her foot into a doll's shoe. The original impetus for studying this topic came from informal observations of scale errors made by young children both in their own homes and in laboratories (including many cases of toddlers sitting on the miniature chair in a scale model).

The occurrence of scale errors was originally documented in a laboratory study designed specifically to increase the likelihood that children would commit scale errors so they could be observed and analyzed (DeLoache et al., 2004). In the original study, 54 children between 18 and 30 months of age first interacted with three large objects: A child-sized chair in which they could comfortably sit, an indoor slide that they could climb up and slide down, and a car that they could get into and propel around the room with their feet. Then, while the children were out of the room, the large objects were replaced with miniature replicas nearly identical to the large ones except for size.

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Approximately half of the children in the original study committed one or more scale errors, for an average of 0.74 per child, with the peak rate of occurrence at around 2 years of age. The children made serious attempts to sit in a tiny dollhouse-sized chair, often perching precariously on top of it. They also tried to get inside a toy car by forcing their foot through its tiny door and to slide down a miniature slide. The serious intent of these behaviors is revealed in the fact that the children often attempted repeatedly to carry out these impossible actions and sometimes became upset at their lack of success.

The existence of scale errors was also independently documented by Brownell et al. (2007), with one of their tasks using a very similar procedure as in the original study with the same large and small objects. Their sample of 57 children between 18 and 26 months committed an average of 2.9 scale errors per child (a rate higher than that reported by DeLoache et al., 2004). Casler, Eshleman, Greene, and Terziyan (2011) report a similar rate for size errors made by older children using tools.

Further, a web-based survey conducted by Ware, Uttal, and DeLoache (2010) offers evidence of spontaneous *everyday* scale errors. Parents who logged onto the study website first read a detailed description of scale errors and viewed an illustrative film clip of a toddler committing a scale error. They were then asked to describe in detail any scale errors that they had ever observed being made. The respondents reported a substantial number of scale errors in the home very similar to those documented in the lab studies. Although this survey study does not establish a base rate of everyday scale errors, it does testify to the fact that they occur spontaneously in everyday settings.

Further evidence of the occurrence of everyday scale errors outside the laboratory was recently reported by Rosengren et al. (2009). Parents recorded the commission of scale errors by their 13–27-month-old children over a 6-month-period. All but one of the children was reported to have committed one or more scale errors. Rosengren, Gutierrez, and Schein (2010) also reported scale errors in the preschool classroom. Both of these observational studies provide evidence of children making spontaneous scale errors in the real world, without any prompting by experimenters, parents, or teachers.

What underlies such dramatic perception-action dissociations? In addressing this question, it is first important to emphasize that the vast majority of very young children's interactions with miniature objects do not involve scale errors. Most of the time, toddlers' behaviors are appropriately scaled to the actual size of the objects on which they are acting. Instead of trying to go down a small toy slide themselves, they send a doll down the slide. Any momentary inclination that they might have to respond to a miniature object as if it were larger is usually inhibited. Thus, one factor that is presumably involved in scale errors is a momentary failure of inhibitory control, something quite common in very young children (Added Zelazo & Frye, 1998; Carlson, Davis, & Leach, 2005; Diamond, 2002; Zelazo, Carlson, & Kesek, 2008).

A second factor that may be an important contributor to scale errors is the relatively immature body self-awareness of very young children. In addition to their observation of scale errors involving miniature replica objects, Brownell et al. (2007) observed the same children committing other types of size errors—trying in vain to get their body through slits in barriers that were far to small to permit passage, and attempting to put on tiny doll clothes. The commission of standard scale errors with replica toys was significantly correlated with both of the other two types of body size errors.

In the research reported here, we explore the validity and robustness of the scale error phenomenon in young children. First, we address the question of whether children are truly making scale errors, or whether they might just be pretending to perform the impossible actions. Thus, in Experiment 1, we distinguish between scale errors versus pretense with replica objects. In Experiments 2 and 3, we examine the robustness of the phenomenon in the face of one experimental manipulation designed to increase the rate of scale errors and another designed to drastically decrease it.

## 1. Experiment 1

The motivation for Experiment 1 came from the fact that one of the most commonly asked questions by colleagues with respect to scale errors is whether they can be differentiated from pretense. "Might the children just be *pretending* to sit in the miniature chair rather than *really* trying to sit in it?" Such questions arise in part because both DeLoache et al. (2004) and Brownell et al. (2007) prompted their participants to interact with the miniature objects if they did not spontaneously do so. The prompts ranged from simply drawing the child's attention to the target object ("Where's the car") to suggesting that they interact with it ("Can you drive the car"). To the extent that the children merely responded to these prompts with pretense, their actions would not constitute serious scale errors.

In Experiment 1, our goal was to examine the extent to which pretense behaviors resemble scale errors. Children were presented with the same replica objects used in the original scale error study by DeLoache et al. (2004) and were prompted to "*pretend*" to go down the miniature slide, sit in the tiny chair, and get into the toy car. We wanted to see (1) how readily children would respond to such prompts by pretending and (2) to what extent their behavior in response to these prompts would resemble the scale errors originally reported by DeLoache et al. (2004).

### *1.1. Method*

#### *1.1.1. Participants*

The participants were 10 children (5 boys and 5 girls) between 25 and 29 months of age ($M$ = 27.5 months). The age range for Experiment 1 (25 and 29 months of age, $M$ = 27.5 months) was chosen based on previous research indicating that children become competent pretenders around the age of 24 months (Haight & Miller, 1993; Lillard et al., 2007; McCune, 1995). For all the studies reported here, the names of participants were obtained through birth announcements and various recruiting

**Table 1**
(A) Children's responses to pretense prompts (Experiment 1). (B) Children's Explicit rejections of experimenter's prompts (Experiment 1) age (months).

(A)

| | |
|---|---|
| Standard pretense | 4 |
| Non-pretense play | 6 |
| Other | 4 |
| No response | 7 |
| Explicit refusal | 8 |

(B)

| | |
|---|---|
| 26.1 | "Tiny." (chair) |
| 28.0 | ""I'm not little; I'm big." (chair) |
| 28.0 | "Slide's little." (slide) |
| 28.0 | "I don't fit, I don't fit." (car) |
| | "I don't fit, I don't fit." (slide) |
| 28.0 | "No, I'm too big." (chair) |
| | "I'm too big for this car." (car) |
| | "No, I have my own slide." (slide) |

events, the parents were contacted by telephone and invited to participate, and the sample was predominantly White and middle class.

### 1.1.2. *Materials*

The three small replica toys used by DeLoache et al. (2004) served as the target toys for eliciting pretend play. The target toys and their measurements were: slide—12 cm × 23 cm × 13 cm; chair—9 cm × 4 cm × 5 cm; car—8 cm × 14 cm × 15 cm. Several other non-target toys were also used, including a child-sized chair, a toy phone, a tea set, and plastic food items.

### 1.1.3. *Procedure*

The session began with the experimenter setting up a joint-pretense framework by engaging the child in a series of pretend scenarios with the non-target toys. For example, she set out a teapot and cup and said, "I'm thirsty. Can you *pretend* to pour me some tea?" All the children participated readily and competently in these simple scenarios.

Next the experimenter introduced the three target toys and attempted to induce the child to engage in pretense with them. For each one, she first performed a pretense action with a non-target toy and then invited the child to perform a pretense action with one of the target toys. For example, she said, "See, I'm *pretending* to talk on the phone. Now I want you to *pretend* to slide down the slide [sit in the chair, drive the car]." If the child did not perform the action, the experimenter again encouraged him or her to do so later in the session.

## 1.2. *Results and discussion*

The first objective of Experiment 1 was to examine whether children would readily engage in pretend play with the replica objects when prompted. Each of the children's responses to the prompts was assigned to one of five categories: *standard pretense* (e.g., pushes car across floor, represents going down slide with hand), *non-pretend play* (e.g., puts the small car down the slide), *other* (generally explores or examines object with no pretense), *no response* (ignores experimenter's prompt), and *explicit refusal* (verbally rejects experimenters prompt—"No," "I'm too big."). One child made a spontaneous scale error; he tried to force his foot through the tiny door of the car—the most common scale error that children make with the car.[1]

Table 1A shows the children's behaviors in response to the experimenter's prompts. As is clear from the table, the children rarely performed pretend behaviors in response to the prompts. The most frequent pretense action was pushing the car around on the floor, possibly because it was the only one of the target objects that has a familiar/standard form of pretense associated with it. Overall, the most common responses to the pretense prompts were ignoring or outright refusals of them. If scale errors generally involve pretense rather than serious behaviors, they should have occurred frequently in response to the prompts. The children's lack of response to the prompts supports the interpretation of scale errors as *serious*-not pretend-attempts to perform impossible actions on miniature objects.

Although the previous analysis demonstrates strongly that children do not readily produce pretense behaviors with small replica objects of a car, a slide, and a chair, children did produce various play behaviors in response to the experimenter's prompts. Thus, the second objective of Experiment 1 was to examine whether *behavior* in response to pretense prompts would resemble scale errors. To accomplish this, two additional coders who had no prior experience with scale errors and

[1] In DeLoache et al. (2004), children interacted with large versions of the three toys before being presented with the replica items, making scale errors more likely to occur. It is likely that only one scale error occurred in Experiment 1 (a much lower overall number than in previous studies) because the children had not been primed with the large versions of the three toys before being presented with the replica items.

were blind to the purpose of the experiment coded the films of the children's behaviors toward the replica objects in the current experiment, as well as some of the original scale error behaviors first reported by DeLoache et al. (2004). Data came from only those of the original scale error participants who had been recorded in the same laboratory room used in the current experiment. This resulted in a total of 23 behaviors from the current experiment and 26 scale errors from the original study.

The two coders watched each of the 49 videos on mute (so that they could not hear the specific prompts). In order to establish whether scale errors look different from pretense behaviors, the coders were simply told to identify which of the videos were scale errors based on the original criteria used by DeLoache et al. (2004): (1) the child attempted to perform part or all of the action that he or she had earlier performed with the full-sized target object—sitting on the chair, opening the door and attempting to insert a foot into the car, and stepping on or sitting and sliding down the slide; (2) the relevant part(s) of the child's body for executing that action came into full contact with the relevant part of the miniature object; (3) the behavior was a *serious* (not pretense) effort to perform the action; and (4) the action had to be relatively persistent (more than a fleeting act).

The two coders achieved 92% consistency (Kappa = 0.83, $p < 0.01$) across the 49 clips, with only 4 disagreements. Thus, two blind coders who had never previously seen a scale error were able to differentiate scale errors from playful behaviors with 92% accuracy. Most importantly, they never mistakenly identified a pretense behavior as a scale error.

The results of Experiment 1 indicate that even when directly prompted to pretend with the small replica objects used here, 25–29-month-old children rarely do so. Further, serious attempts to perform scale errors are readily distinguishable from playful behaviors. These findings are consistent with the interpretation of scale errors as *serious* attempts to perform impossible actions.

## 2. Experiment 2

In the commission of a scale error, young children do not take the actual size of a miniature object into account when deciding to interact with it. Perhaps anything that draws their attention to the diminutive size of a target object would substantially reduce the likelihood of a scale error. To examine this possibility, one change was made to the procedure that was used by DeLoache et al. (2004). As before, the children interacted with the three large objects and then left the playroom for a few minutes while the miniature objects were substituted for the larger ones. However, when they returned, the experimenter drew their attention to the small size of each of the miniature replacement objects: "Look there's the *little* car, there's the *little* chair, and there's the *little* slide."

We expected that explicitly drawing the children's attention the actual size of the objects would diminish the incidence of scale errors compared to previous research. If the occurrence of scale errors is due to a momentary disregard for the size of the target object, children should commit fewer scale errors when the size is emphasized.

### *2.1. Method*

#### *2.1.1. Participants*

The participants were 24 children (12 boys and 12 girls) between 18.0 and 31.5 months of age ($M$ = 24.0 months). One additional child was excluded for refusing to play with the toys. Equal numbers of males and females were randomly assigned to the "Little" Label and No Label conditions.

#### *2.1.2. Materials*

The primary materials were the same three large items and miniature versions of them used by DeLoache et al. (2004). They included a child-sized chair in which the child could comfortably sit, a slide the child could climb up and slide down, and a car the child could get in and move around the room, as well as miniature replicas of the large objects, nearly identical except for size (the same small objects used in Experiment 1). The measurements of the 3 large and the 3 small objects were, respectively: slide—76 cm × 152 cm × 76 cm and 13 cm × 23 cm × 13 cm; chair—53 cm × 33 cm × 46 cm and 8 cm × 4 cm × 5 cm; car—41 cm × 74 cm × 84 cm and 8 cm × 14 cm × 15 cm.

At the beginning of the session, the 3 large target objects were arranged around a large laboratory playroom. Several other toys were also present in the room, including a doll and items of doll clothing.

#### *2.1.3. Procedure*

The child and a female experimenter interacted in a large playroom, with the child's parent seated on the couch at one end of the room. The children were allowed to play naturally however they wanted, except that the experimenter made sure that they interacted at least twice with each of the 3 large objects. After a play period of approximately 5 min, the experimenter and child left the room and went down the hall for a drink of water. In the approximately 3–4 min that they were gone, the large target objects were replaced with the miniature replicas, which were placed in the same spatial positions in which their larger counterparts had been left.

When the child and experimenter returned to the room, the experimenter stopped the child at the entrance and drew his or her attention to the target objects. For the children in the "Little" Label condition, she pointed to and explicitly labeled each of the three objects as "little": "Look, there's the *little* chair, there's the *little* slide, and there's the *little* car." For the children in the No Label condition, the experimenter drew the child's attention to the objects without referring to their size: "Look, there's the chair,. . .".

If the child did not spontaneously interact with the replica objects, the experimenter provided a series of increasingly specific prompts: for example, "What about your chair?" "Come here and I'll read you a story." "Come sit in your chair and I'll read you a story." As in previous research, there was no discernible difference between scale errors that occurred following a prompt by the experimenter and those that were completely spontaneous (DeLoache et al., 2004).

#### *2.1.4. Coding*

The same, *very conservative* coding criteria were adopted as in Experiment 1 and in DeLoache et al. (2004): (1) The child attempted to perform part or all of the action that he or she had earlier performed with the full-sized target object—sitting on the chair, opening the door and attempting to insert a foot into the car, and stepping on or sitting and sliding down the slide; (2) the relevant part(s) of the child's body for executing that action came into contact with the relevant part of the miniature object; (3) the behavior was a *serious* (not pretense) effort to perform the action; and (4) the action had to be relatively persistent (more than a fleeting act). Multiple actions directed toward a target object in one continuing episode were conservatively scored as only one scale error; for example, if a child stepped on the stairs at the back of the slide, then stepped on the slide itself, and then sat and "slid" down the slide, only one scale error would be scored. Potential scale errors were identified by three independent raters and all three had to agree that a given episode constituted a scale error for it to be counted. Thus, every scale error in the final set had been accepted by everyone who judged it, so agreement was 100%.

### *2.2. Results and discussion*

Contrary to our original expectation, hearing the word "little" applied to the miniature target objects did not lead to fewer scale errors by the children in the "Little" Label group than by those in the No Label group. Twelve out of 24 children made a total of 20 scale errors with the target objects, for an overall average of 0.83 scale errors per child (quite similar to the rate of 0.74 in the original study—DeLoache et al., 2004). A total of 12 of the scale errors were made by 7 children in the "Little" Label group, and 8 scale errors were committed by 5 children in the No Label group. Three additional spontaneous scale errors occurred with non-target objects: attempts to put on the doll's shoe, to get into the doll's stroller, and to lie down in the doll's bed.

There was no difference in the number of scale errors made in the two conditions ($t = 0.84$, *ns*). In fact, the children committed slightly more scale errors in the "Little" group than did those in the No Label group.

The fact that children made scale errors even after the small size of the objects had been pointed out explicitly to them is quite remarkable. These results thus testify to the robustness of the scale error phenomenon in very young children.

## **3. Experiment 3**

Experiment 2 offered evidence of young children's insensitivity to an effort to decrease the rate of scale errors. In Experiment 3, an effort was made to do the opposite—to *increase* the incidence of one particular type of scale error—attempts to sit in the miniature chair. During the interval between the initial familiarization with the large toys and subsequent exposure to their miniature counterparts, the children interacted with several different child-sized chairs. In the process, they saw several chairs, heard the words "chair" and "sit" repeatedly, and engaged in the action of sitting multiple times.

This procedure was essentially a form of priming—a manipulation designed to activate the children's mental representations of the object category "chair" and of the action category of sitting, as well as the motor program involved in actually sitting. The expectation was that this multi-modal priming experience with multiple chairs would increase the rate of scale errors with the miniature chair.

### *3.1. Method*

#### *3.1.1. Participants*

The participants were 44 children (22 boys and 22 girls) between 17 and 32 months of age ($M = 24.0$ months). The age range was similar to that used in the original scale error study (DeLoache et al., 2004).

#### *3.1.2. Materials*

The materials were the same as those in Experiment 2 for the initial familiarization period and the subsequent test period—most notably the large and small slides, chairs, and cars. For the chair-exposure period in between familiarization and test, 8 child-sized chairs were lined up along the walls of a 3 m × 5 m room (next to the observation room). As Fig. 1 shows, the chairs differed substantially in appearance, ranging from a plain wooden chair to a pink plush Sesame Street armchair.

#### *3.1.3. Procedure*

The initial period of familiarization with the large objects in the playroom was the same as in Experiment 2. Next, the experimenter escorted the child out of the large room directly into the "chair room," where she attempted to get the child

**Fig. 1.** 2-Year-old child sitting in one of the 8 chairs in the sitting room. The experimenter attempted to induce each child to sit at least once in each of the chairs.

to sit a total of 10 times in as many different chairs as possible. Thus, all the children saw the array of chairs and repeatedly heard the words "sit" and "chair." In addition, most (all but 5) of the children sat in one or more chairs: some spontaneously sat in all the chairs, going rapidly from one to another; others needed encouragement to sit at all. The average number of sits was 8.2 (range = 0–16). The sitting session in the chair room varied in length (2:20–10:29 min, *M* = 5:18), depending on how readily the child complied with the experimenter's encouragement to sit in the chairs. (The enthusiastic child with the 16 sits spent only 2:46 min in the process of doing so.)

After the session in the chair room, the child and experimenter immediately returned to the playroom where the large objects had been replaced with the miniature ones. Nothing was said about the size change. As before, prompts were given if the child did not spontaneously interact with the miniature objects.

#### *3.1.4. Coding*

Coding of scale errors was the same as in Experiment 2.

### *3.2. Results and discussion*

If the priming procedure effectively increased the number of scale errors with the chair, we would expect that the children would make more scale errors with the chair than with the slide or the car, and that they would make more scale errors with the chair in the current experiment than children have made with the chair in previous work (e.g., Experiment 2).

As in previous studies, the number of scale errors made by the children was identified for three age groups: 17–20-month-olds ($n = 12$), 21–25-month-olds ($n = 19$), and 26–31-month-olds ($n = 13$). In general, 16 (36%) of the 44 children committed a total of 23 scale errors for a mean of 0.52 scale errors per child, an overall rate somewhat but not significantly lower than the average of 0.83 in Experiment 2 and 0.74 in the original scale error study. The number scale errors the children made varied as a function of the age of the child. The average number of scale errors for the youngest, middle, and oldest age group was 0.83, 0.47, and 0.30, respectively.

Sixteen out of 44 children made scale errors, and the total number of scale errors per target object were slide—15, chair—7, and car—1. A 3 (stimulus: chair, car, slide) by 3 (age group: youngest, middle, oldest) ANOVA yielded only a significant effect of stimulus, $F(1, 123) = 5.4$, $p < 0.01$. Post hoc tests (Tukey) indicated that the children made significantly more scale errors with the slide than with the car, $p < 0.01$, but no other comparisons were significant. The number of scale errors for each stimulus broken down by age is shown in Table 2.

Clearly, the activities designed to prime chair scale errors—hearing the words "chair" and "sit" repeatedly, and actually sitting multiple times in multiple chairs—did *not* increase the relative rate of scale errors with the miniature chair. In fact, rather than being higher than the 41% for the chair scale errors reported in Experiment 2, the rate in Experiment 3 was actually somewhat lower—30% of the total scale errors. The *overall* rate of scale errors was somewhat lower than in Experiment 2 as well (36% of children made them as opposed to 50% in Experiment 2).

With respect to the priming manipulation, there was no relation between the children's experience with the chairs during their interval in the chair room and whether they committed a scale error with the miniature chair; the average number of times the children sat on the chair in the priming event was identical for those children who did and those who did not make

**Table 2**
Children's scale errors by age (Experiment 2).

| | Chair | Slide | Car |
|---|---|---|---|
| 17–20-month-olds | 1 | 8 | 1 |
| 21–25-month-olds | 4 | 5 | 0 |
| 36–31-month-olds | 2 | 2 | 0 |
| Total | 7 | 15 | 1 |

a scale error with the chair. Further, the two groups of children had spent virtually the same amount of time interacting with the chairs during the priming procedure ($m = 5$ min 29 s for children who made scale errors; $m = 5$ min 11 s for children who did not). Thus, neither the number of times that the children sat in a chair nor the overall time spent in the chair room was related to their subsequent commission of scale errors with the miniature chair.

## 4. General discussion

In three experiments, we further investigated the scale error phenomenon first reported by DeLoache et al. (2004). In Experiment 1, we found that naïve observers are readily able to distinguish between scale errors and pretense behaviors. Experiments 2 and 3 examined the robustness of the phenomenon by attempting to modify the rate of scale errors, but neither had much impact. In Experiment 2, pointing out the small size of the replica objects did not decrease their frequency, and in Experiment 3, priming children to make more scale errors was equally ineffective in increasing their frequency.

This research has both empirical and theoretical implications. Empirically, it serves as further confirmation of the existence of scale errors. Theoretically, this work provides additional support for the existence of a dissociation early in life in the use of visual information in the commission of scale errors, proposed be DeLoache et al. (2004).

A notable aspect of the results in Table 1 is the fact that in all but two of the children's explicit rejections of the experimenter's prompts ("tiny" and "slide's little"), they referred to their *own size* ("I'm too big."). This focus on their own body size when rejecting the experimenter's prompts reflects conscious body self awareness (Brownell et al., 2007): Saying "I'm too big" indicates *explicit* awareness of the relation between their own size and the size of the target object, but with the primary focus on themselves rather than the object. Given the view of Brownell et al. (2007) that immature body self awareness is one factor underlying scale errors, one would expect that young children who display this sort of explicit awareness of their own size might commit fewer scale errors than other children of the same age. This idea could be explored in future research with a large sample of participants. It might also be interesting to attempt to get children who have committed a scale error to offer some attribution for why their effort failed: Would they tend to attribute their lack of success to the inadequate size of the object ("too little"), rather than to their body being too large.

The results of Experiment 2 specifically show that pointing out the small size of the objects does not diminish the number of scale errors. In retrospect, this result is not surprising. The fact that young children *ever* commit scale errors means that they are capable of ignoring the omnipresent abundance of visual information about the actual size of objects. Indeed, the children occasionally committed a scale error with a miniature object that they had appropriately played with just moments before. Thus, these errors result not from a failure ever to notice the size of the object, but from a momentary failure to incorporate that information into the *planning* of actions to be performed with the object. Only in the *execution* of the action plan does object size get incorporated.

One potential explanation for the results of Experiment 2 is that the use of a definite article ("the") actually promoted scale errors. That is, when the experimenters said, "Look, there's the little car," it lead the children to infer that the miniature replica was the same car that they had seen previously, not just any little car. Future work could further explore this possibility by using an indefinite ("a") article when calling attention to the objects' sizes, instead of the definite ("the") article.

Similarly, in Experiment 3, priming children to sit on the chair did not increase the number of scale errors. A contributor to the particularly low rate of chair scale errors in this study might have been the highly explicit nature of the prime itself. The children's exposure in Experiment 3 to multiple chairs and sitting actions almost certainly had the intended result of activating their mental representation of chairs and sitting. However, being consciously aware of the array of chairs in the chair room may have had the unintended result of making them also aware of the actual size of the miniature chair when they returned to the test room. Such hyper awareness of its real size may then have inhibited scale errors to it.

This account is consistent with *reverse* priming—a common finding in the social cognition literature (e.g., Added Lombardi, Higgins, & Bargh, 1987; Martin, Seta, & Crelia, 1990; Strack, Schwarz, & Gschneidinger, 1985). When behavioral and conceptual priming, mood manipulations, and other influence attempts are explicit, participants are likely to focus their attention directly on the behavior, concept, or affect of interest. As a result, priming is either not observed or is reversed, such that the behavior is less likely among participants who received the prime than among those who did not. Thus, our unexpected result may represent the first example of reverse priming in young children of which we are aware.

An alternative explanation is that by seeing a variety of chairs and being repeatedly prompted to sit, the children became habituated to the chairs. In other words, after being exposed to a variety of chairs, it is not surprising that when presented with another chair, a slide, and a car, they were more drawn to and made more errors with one of the newer objects. Thus, children might simply have been showing a novelty effect. Future research further examining the effects of priming might elucidate these possibilities.

It is important to note that although the number of scale errors produced in the current experiments is similar to that reported in DeLoache et al. (2004), other researchers (e.g., Brownell et al., 2007; Casler et al., 2011; Rosengren et al., 2009, 2010) have reported higher numbers of children performing scale errors. These studies all differ on various dimensions that could account for the differences in number. First, the time frame in which observations were made differed across studies. For example, in the current research and in DeLoache et al. (2004), only one experimental session was used to elicit scale errors. In contrast, Rosengren et al. (2009, 2010) allowed 6 months for parents to report on scale errors through diary reports and a number of weeks for scale errors to be reported in preschools. Another important difference has been the number of tasks used to elicit scale errors. For example, in the current study and in DeLoache et al. (2004), only one manipulation was used to produce scale errors. In contrast, Brownell et al. (2007) and Casler et al. (2011) used a series of different tasks and reported higher numbers of children performing scale errors. Thus, although in the current work it was difficult to diminish the number of scale errors or increase them with priming, extending the time frame of data collection or the number of tasks given to each child might result in the observation of more scale errors.

Although the experiments reported here demonstrate that the scale error phenomenon is robust, it is important to emphasize that the occurrence of scale errors is relatively rare. One obvious reason for this is the fact that scale errors are triggered by only a fairly small set of objects—miniature replica objects that are familiar to young children and that they can interact with successfully. Many of the objects that are commonly available for young children, including toys such as stuffed animals, do not elicit scale errors.

In conclusion, the studies reported here provide additional documentation of the existence of the relatively recently identified category of behaviors known as scale errors. Of particular importance, they testify to the validity of the interpretation of the nature of scale errors by clearly distinguishing them from pretense.

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