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PAPER

Everyday scale errors

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Abstract

Young children occasionally make scale errors *– they attempt to fit their bodies into extremely small objects or attempt to fit a larger object into another, tiny, object. For example, a child might try to sit in a dollhouse-sized chair or try to stuff a large doll into it. Scale error research was originally motivated by parents' and researchers' informal accounts of these behaviors. However, scale errors have only been documented using laboratory procedures designed to promote their occurrence. To formally document the occurrence of scale errors in everyday settings, we posted a survey on the internet. Across two studies, participants reported many examples of everyday scale errors that are similar to those observed in our labs and were committed by children of the same age. These findings establish that scale errors occur in the course of children's daily lives, lending further support to the account that these behaviors stem from general aspects of visual processing.*

Introduction

A *scale error* involves a child making a serious attempt to perform an action that is impossible due to extreme differences in the sizes of the entities involved (e.g. the child's body and the target object; Brownell, Zerwas & Ramani, 2007; DeLoache, Uttal & Rosengren, 2004; DeLoache, Vanderborght, LoBue, Chiong & Uttal, 2007; Ware, Uttal, Wetter & DeLoache, 2006). For example, a child might try to sit in a dollhouse-sized chair that is much too small to accommodate the child's body. A defining feature of scale errors is that they involve *serious* attempts to perform the given action; they are not acts of pretense. The child seriously sits on the tiny chair or tries to get into the miniature car. In addition, the child's efforts are persistent and often entail repeated attempts to get into or onto the miniature object.

The original impetus for research on scale errors stemmed from informal observations of these behaviors by researchers in their own homes and labs and from anecdotal accounts from other parents and researchers. For example, researchers observed young children trying to lie down in tiny doll beds, sit on miniature chairs, or get into very small toy cars. Although such examples indicate that children commit scale errors in the course of their daily lives, the occurrence of scale errors in children's everyday environment has not been systematically documented. Hence, the goal of the present research was to obtain examples of children making scale errors in everyday settings.

The occurrence of scale errors has been well documented in controlled laboratory studies. DeLoache *et al*. (2004) showed that 18- to 30-month-old children sometimes try to fit their own bodies into or onto miniature objects. The participants initially played with large versions of a chair, an indoor slide, and a toy car that they could interact with in a conventional manner (e.g. they could comfortably sit in the chair and easily get into the car). These objects were then replaced while the child was out of the room with very small versions (i.e. a miniature chair, a miniature slide, and a miniature car) that were identical to their larger counterparts except for size. Nearly half of the children (25 of 54) made at least one scale error. That is, they tried to get their foot through the open door of the miniature car, climb up or slide down the miniature slide, or sit in the miniature chair. (The basic results of this study have recently been replicated in a series of studies; DeLoache *et al*., 2007.)

Further research showed that scale errors are not limited to actions involving a child's own body and a miniature object – children also make scale errors involving a relative size difference between two objects (Ware *et al*., 2006). Specifically, 16- to 40-month-olds made scale errors when playing with a doll and miniature doll-related toys. A procedure similar to that of the original scale error study (DeLoache *et al*., 2004) was employed, but the children first played with a baby doll and toys (bathtub, bed, chair, hat, and wagon) that were an appropriate size for the doll. Next, miniature versions of the toys were substituted for the doll-sized ones. More

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than half of the children (46 of 74) made at least one scale error with the doll by trying to fit it into one of the miniature objects. For example, they tried to stuff the doll feet first into the tiny bathtub or the tiny wagon.

These two laboratory-based studies thus establish that young children occasionally make scale errors, both when the relevant size discrepancy is between their own bodies and an object and when it is between two objects. Notably, however, all the research on scale errors to date has been conducted in laboratory settings using procedures designed to increase the likelihood that the young participants would make scale errors during the study (DeLoache *et al*., 2004; Ware *et al*., 2006). For example, the children first played with larger versions of miniature objects on the assumption that recent exposure to the large objects might prime the behaviors associated with these objects and, thus, increase the likelihood that participants would interact similarly with highly similar miniature versions of those objects. In addition, the experimenters occasionally used verbal prompts to encourage interaction with the miniature objects: 'Can you go ''whee'' down the slide?'; 'Does the baby want to go night-night in the bed?' Importantly, more than half of the reported scale errors did not immediately follow a prompt, and there were no noticeable differences between prompted and unprompted scale errors. Nevertheless, using prompts presumably encouraged the children to commit scale errors with the miniature objects.

As mentioned above, research on scale errors was initially motivated by informal observations of spontaneous scale errors that occurred in the course of children's everyday lives. Thus, we assume that scale errors are a naturally occurring phenomenon and that neither immediately prior exposure to larger versions of an object nor direct verbal prompting is necessary to elicit them. However, there is no formal evidence for this view. The current study directly addresses this issue.

We conducted an internet survey to obtain examples of everyday scale errors. Participants were asked if they had ever seen a young child make a scale error and, if so, to describe the event. (We asked for examples of only scale errors involving the child's body, i.e. not ones with dolls.) In Study 1, participants completed only the internet survey. In Study 2, a second group of participants completed both the survey and a post-survey phone interview in which they were asked to provide additional details about any scale errors they had reported in the survey.

The goal of the survey was to formally document the everyday occurrence of scale errors, without trying to precisely calculate how frequently they are committed.[1] Given that scale errors occur only occasionally, we expected that many participants would report that they had never seen a scale error. However, we also expected that some participants would describe scale errors committed by young children in the home and other everyday settings. Documentation of everyday scale errors would provide evidence that the occurrence of scale errors is not limited to the laboratory and further illuminate the nature of this newly established phenomenon.

Study 1

Method

Participants

In this study, 221 participants completed the survey and are included in the final sample. Participants were not asked to report their own sex or age. An additional 15 individuals agreed to participate but were excluded from the final sample because they did not finish the survey (n = 12) or because the only event that they described did not constitute a scale error (e.g. sitting on an end table; n = 3). In the latter case, it was unclear that these participants understood the definition of a scale error. Another 75 individuals visited the website and read about the research goals, but declined to participate.

We recruited participants by advertising in local print media and directly contacting families who had previously participated in developmental studies in our labs and currently had at least one child younger than 6. The recruitment materials described the research goals and invited people to complete the survey (e.g. 'We want to see if parents have seen children make *scale errors* – an interesting behavior that we have observed in our labs.'). Parents were specifically recruited, but a few relatives, friends, and caretakers of young children also participated. It is possible that parents of children who participated in our laboratory studies on scale errors also completed the survey, as we did not exclude these families from our recruitment pool. However, as we were not aiming to calculate the frequency of scale errors, we were not concerned that recruiting these parents might lead to a selection bias that would overestimate the occurrence of everyday scale errors.

Materials and procedure

The survey consisted of a series of pages containing information about scale errors, audiovisual examples of scale errors, and survey questions. All of the information dealt exclusively with scale errors involving the child's body; we did not inform participants about scale errors involving dolls. The survey began with a description of scale errors accompanied by pictures of children making scale errors (e.g. 'Occasionally, a young child will try to interact with miniature objects as if they were actually larger objects. We call these behaviors *scale errors*.'). The

[1] Indeed, it would be difficult to accurately calculate the frequency of everyday scale errors as it would require extensive observation of play and calculating how frequently children have opportunities to make scale errors (e.g. how often they play with miniature replica objects).

purpose of the survey was described as an effort to find out how common scale errors are. Participants were told that many parents have reported seeing scale errors, while many others have not. Anyone who agreed to participate was then given additional information about scale errors (e.g. they were told that scale errors involve serious attempts to perform the given action and are not acts of pretense). They also watched a video clip of a child making a scale error.

Next, participants were asked if they had ever seen a scale error: 'Have you ever seen a young child try to sit in, lie in, climb on, or enter an object that was actually far too small for the child to fit into or onto?' If participants answered 'yes', they were asked to provide details about the event. First, they provided further information about the child who made the scale error, including the child's sex, age at the time of the scale error, and current age. Next, participants described the kind of object the child was trying to get into or onto, what action the child was trying to perform, and the child's reaction (if any) to the outcome of the event.

To determine if the reported events were true scale errors as defined in prior research (DeLoache *et al.*, 2004), it was important to know whether they involved an extreme size discrepancy between the child's body and the target object. Participants were asked to describe the relative size of the object and to estimate its length, width, and height in inches. The first 44 participants who reported an event (n = 140) were not explicitly asked to provide the precise dimensions of the target object. We still considered these events in our coding; but, as discussed below, we included an event only if the participant clearly described the object's size in some way (e.g. 'dollhouse-sized rocking chair', 'for a very small doll, 0.5 in. long').

To further determine whether the reported events constituted scale errors, participants were specifically asked if the child seemed to be *seriously* trying to interact with the target object or merely pretending. They rated the child's efforts using the same 5-point scale from the prior laboratory studies (DeLoache *et al.*, 2004; Ware *et al.*, 2006), selecting from the following options: *definitely serious*, *probably serious*, *probably pretending*, *definitely pretending*, and *I'm not sure*.

Finally, participants were asked if they had seen more than one scale error and, if so, to describe up to two additional examples.

Data coding

Participants reported 204 events that they considered to be scale errors. We used very conservative criteria to code the events, excluding any that did not provide definitive evidence of constituting a scale error (n = 158). Specifically, we eliminated any event that did not fit the criteria for a scale error set out in the original report of the phenomenon (DeLoache *et al.*, 2004). The number of excluded events and our reasons for excluding them are summarized below and in Table 1.

Table 1 *Number of reported events included and excluded from scale error count in Studies 1 and 2*

	Study 1	Study 2
Total no. of reported events	204	66
Total no. of events counted as a scale error	46	16
Total no. of excluded events	158	50
(itemized below by reason for excluding)		
Did not involve body or 3-D object	8	0
Child's actions rated as pretense	41	11
Event description lacked detail	13	1
Object was too large in size	96	38

Note: The data for Study 2 include only those events reported by participants who completed the follow-up phone interview.

We first excluded errors that were not clearly scale errors – that is, they did not specifically involve a child trying to fit his or her body into or onto a miniature, three-dimensional object (e.g. trying to sit on a tiny chair in a book, trying to fit a large stuffed animal into a miniature car; n = 8). Next, we excluded any reported events that participants did not judge to be serious in nature (n = 41), only retaining events for which they rated the child's efforts as *probably serious* or *definitely serious*. We also excluded an event if the participant did not describe it clearly enough for us to judge whether or not it constituted a scale error (n = 13).

Moreover, we only included events that involved an extreme size discrepancy between the child's body and the object. We used very conservative size criteria to ensure that the included scale errors involved very tiny objects. Specifically, we eliminated any event with a target object larger than approximately 15.25 cm in length, width, *and* height. For the initial participants who were not asked to estimate the target object size precisely, we considered phrases such as 'miniature', 'dollhouse-sized', or 'very tiny', to indicate that the target objects were small enough to be counted. Many participants also specifically mentioned the brand name of the target object (e.g. 'Barbie™ chair'), allowing us to locate exact information about the object's size. Thus, for each reported event, we had multiple pieces of information that jointly helped us to gauge the target object's size.

In total, 96 events were excluded because the target object was too large to count as a scale error. Notably, however, nearly all of these events involved objects that were definitely too small for a young child to interact with in the attempted manner (e.g. medium-sized toy cars or furniture intended for baby dolls). The relative size difference for some of these events was fairly substantial, but others involved objects that were large enough for the child to almost squeeze into entirely. Hence, there seems to be a continuum of size errors that children make in their daily interactions with small replica objects, ranging from extreme scale errors to errors involving larger, yet still too small objects. We return to this point in the General Discussion. For the present purposes, however, we focus on the most extreme scale errors because they were most comparable to scale errors observed in prior laboratory studies.

Lastly, when coding the events, we also considered the amount of time elapsed between the reported event and the survey response. We did not notice any obvious differences in the clarity or amount of detail provided with respect to event recency. Hence, we did not exclude any event specifically because of the amount of time that had passed since the event occurred.

Two coders coded the data to determine whether the reported events met the criteria for a scale error. A primary coder rated all of the events. A secondary coder rated 45% of the events that participants had judged to be serious in nature. Agreement between the two coders was high (93.2%, Cohen's K = .84). Disagreements were easily resolved through discussion.

Results

Of the 221 participants, 81 (37%) said that they had never seen a scale error before and 100 (45%) only reported an event(s) that did not meet our criteria for a scale error as described above. Thus, 40 (18%) reported at least one event that was counted as a scale error. Six of these participants described two scale errors, resulting in a total of 46 examples of scale errors. Most (n = 36) were reported by parents who had observed their own children making scale errors. On average, less than two years (M = 1.76, SD = 2.52) had elapsed between the reported scale error and the survey response. Examples of participants' accounts of scale errors are provided in Table 2.

We first examined the sizes and types of objects involved in the scale errors. On average, the objects were 10.39 cm long (SD = 5.91), 6.17 cm wide (SD = 3.77), and 6.87 cm high (SD = 3.88).[2] Hence, they were quite tiny and were well within the size range (M = 13.67 × 9.67 × 11 cm) of the miniature objects used in prior research (DeLoache *et al*., 2004).

As in the previous laboratory studies, most of the reported scale errors involved children trying to get into or onto miniature versions of objects from highly familiar categories. The scale errors involved a variety of miniature objects, which we grouped into four categories: *clothing*, *vehicles*, *furniture*, and *animal figurines*. Clothing errors (n = 18) involved children trying to put on baby or doll clothes or accessories (e.g. a doll's sweater or shoe). Vehicle errors (n = 14) involved attempts to fit into or onto miniature vehicles (e.g. toy cars or trucks). Furniture errors (n = 11) involved children trying to get into or onto furniture (e.g. chairs, beds) sized for very small dolls or dollhouses. Animal figurine errors (n = 3) involved children trying to straddle and ride miniature horses or cows. (An example of a reported scale error from each of these four categories is provided in Table 2.)

[2] These calculations are based on 28 scale errors. One participant neglected to report the object's size dimensions and the remaining 17 errors were reported before we added specific questions about the object's dimensions to the survey.

We next examined the sex and age of the children. There were no sex differences – roughly the same numbers of reported scale errors were made by girls (n = 23) and boys (n = 18).[3] The child's age at the time of the scale error ranged between 12 and 36 months (M = 21.26, SD = 5.07). The frequency of scale errors by age is shown in Figure 1, with children divided into five age groups. Scale errors were not evenly distributed across age, χ^2 (4, n = 46) = 30.14, $p < .001$. Rather, the distribution exhibited the same inverted-U-shaped function reported by DeLoache *et al*. (2004), with scale errors being most frequent around 2 years of age. (The age ranges for the three intermediate groups in Figure 1 are comparable to the age groups tested in the previous study.)

Discussion

This study documents the occurrence of everyday scale errors and thus formally demonstrates that scale errors are not an artifact of laboratory procedures. Moreover, the scale errors reported in the survey are similar to those observed in prior laboratory studies. In particular, they involved children between 1 and 3 years of age attempting to fit their bodies into or onto miniature replica objects.

However, one limitation of this study is our use of an internet-based data collection method. Although internet surveys have the advantage of allowing researchers to collect numerous responses from a wider range of the population, they also have certain drawbacks (Birnbaum, 2004; Reips & Birnbaum, 2000; Schmidt, 1997). For one, the researcher has less information about the participants. We do not know why individuals did or did not opt to complete our survey, or whether they completed it multiple times. (However, similarities in language use helped to indicate multiple entries from a single individual and only one survey entry was excluded because it was nearly identical to a prior entry.) For example, it may be that some of the individuals who declined to participate did so specifically because they had never seen a scale error before. However, as we were not aiming to calculate the actual frequency of everyday scale errors, this possibility is not problematic.

A more pressing drawback of using an internet-based method is that it prevented us from ensuring that participants provided clear and detailed responses and did not skip any questions. Without direct contact with participants, we were unable to ask them to clarify their responses or provide additional details where necessary. Indeed, 39 of the reported events were missing responses for at least one survey question. In most cases, this did not greatly reduce the detail or clarity of the event description and only four events were excluded specifically because the participant skipped pertinent questions (e.g. about the target object's size).

[3] Participants neglected to report the child's sex for five scale errors.

Table 2 *Examples of participants' descriptions of scale errors*

Object type	Size description	Child's actions	Child's reaction
Doll's shoe	For a very small doll; ½'' long.	Tried to put it on.	None.
Toy truck	Size of a little car that you can hold inside your hand, like a Hot Wheels® car.	Tried to put leg inside the door as if he was going to drive it.	He was very mad. He asked me to help him get in the truck.
Miniature chair	Miniature, 4 in. high.	Tried to sit on it.	Actually broke chair, but didn't seem to mind. Neutral.
Toy horse	About the right scale for a dollhouse doll to ride.	Tried to get on the horse's back and ride it.	She tried a few times, seeming determined to ride it.

Note: Some descriptions have been edited for length or grammar.

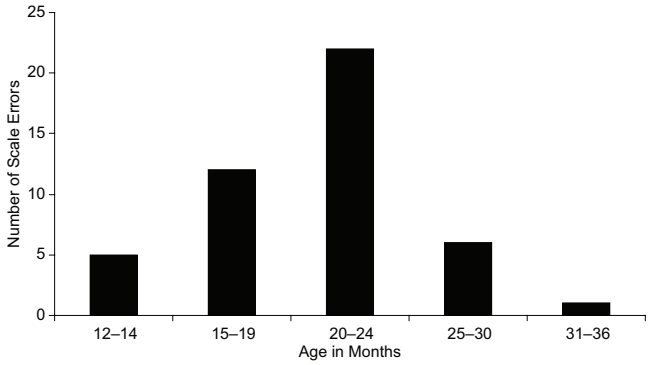

Figure 1 *Distribution of the number of scale errors reported in Study 1 by child's age at the time the error occurred.*

Finally, we cannot be certain that participants' descriptions of the object and the child's behaviors were always accurate. This makes it possible that we counted events as scale errors that we might otherwise have excluded had we had further details about the event. However, given that we used such conservative coding criteria, we think this possibility is unlikely. It seems more likely that we excluded events that would have been counted as scale errors had we been able to gather more information about the target object and the child's behaviors.

To address this possibility and to assess the reliability of our coding criteria, we conducted a second study in which a new group of participants first completed the internet survey. Then, we conducted follow-up phone interviews with participants who reported a potential scale error in the survey. This allowed us to gather additional information about the event in order to decisively judge whether the reported events were scale errors.

Study 2

Method

Participants

In this study, 84 participants completed the survey and 41 of these individuals also completed a follow-up phone interview. An additional 22 individuals viewed the website but declined to participate. Participants were recruited by emailing families who had participated in developmental studies in our labs. The recruitment materials were identical to Study 1.

Materials and procedure

The internet survey was identical to Study 1 except that participants were also informed that they might be contacted by phone for a follow-up interview to get further details about their survey responses. They were asked to provide a phone number and time at which they could be reached. At the end of the survey, participants were also asked if they had completed a similar survey before (i.e. whether they had also participated in Study 1).

Only participants who reported seeing an event that they thought was a scale error were called for follow-up interviews; we did not contact participants who said that they had never witnessed a scale error. A single researcher conducted the interviews. Participants were called within 2 weeks of their survey response. If they were unavailable, we tried to reach them several additional times.

During the interview, participants were first asked to provide answers to any questions that they had skipped when completing the survey. Next, they were asked a series of questions for each event that they had reported in the survey. The questions asked for further information about the target object and the child's behaviors. They are listed in the Appendix. After asking the questions for the first reported event, the researcher repeated the questions for each additional event that the participant had reported in the survey.

Data coding

Participants' responses were coded before the follow-up phone interview to determine whether the reported events met the criteria for a scale error used in Study 1. The events were coded again after the interview to determine whether the additional information obtained in the interview led to any coding changes.

Results

Of the 84 participants who completed the survey, 34 (40%) said that they had never seen a scale error, and one

reported a single event that was clearly not a scale error (a child trying to step into a puddle in a book). The remaining 49 participants reported at least one event that they thought constituted a scale error. We were unable to reach eight of these participants for follow-up interviews. One of these unreachable participants reported an event that clearly met the criteria for a scale error as coded without a phone interview; however, in reporting the results for this study, we focus exclusively on participants who completed the interview.

The 41 participants who completed the phone interview reported a total of 66 events that they considered to be scale errors. Table 1 shows the number of events that were included and excluded from the scale error count after the final, post-interview coding of the events. In total, 12 participants reported an event that met our criteria for a scale error, four of whom described two scale errors, resulting in a total of 16 scale errors. Thus, 14% of the total number of participants who completed the survey in this study (n = 84) reported a scale error. All of the participants who reported scale errors indicated that they had not completed a similar survey before. Hence, these were entirely new examples of scale errors and not repetitions of those obtained in Study 1.

Notably, only one event was excluded because the participant's description was not clear enough for us to determine whether the event actually was a scale error (Table 1). This illustrates that conducting the follow-up interviews helped us to gather any missing or additional information needed to decisively judge whether or not an event was a scale error. Indeed, there were five events that were not counted as scale errors prior to the interview but were determined to be scale errors based on the interview. One was an entirely new event that the participant had not described in the survey. For the other four events, the participant had not provided enough details about the target object or the child's behaviors in their original survey response. The additional information gathered in the interview allowed us to decisively conclude that these events met the criteria for a scale error.

There was only one coding change made in the opposite direction. That is, only one event was counted as a scale error prior to the interview but was excluded based on the interview. This event was excluded because the participant's description of the object's size differed substantially across the survey and the interview so we could not be certain that the object was tiny enough to constitute a scale error.

The reported scale errors were similar to those reported in Study 1 in most respects. First, all but one were reported by a parent of the child who committed the error. On average, less than one year (M = .75, SD = .69) had elapsed between the reported scale error and the survey response. Second, the target objects were very tiny – on average, they were 8.41 cm long (SD = 4.42), 7.14 cm wide (SD = 3.96), and 8.65 cm high (SD =5.19). Third, the scale errors involved children trying to fit into or onto miniature versions of familiar objects, including clothing (n = 9), vehicles (n = 4), and furniture (n = 3). Fourth, the children were between 12 and 36 months of age when the scale error occurred, and the average age was around 2 years (M = 23.5, SD = 7.7).

The only noticeable, albeit minor, difference from the scale errors reported in Study 1 is that participants in the current study reported fewer errors for boys than girls. Specifically, 25% (n = 4) of the errors in the current study were committed by boys, compared to 44% (n = 18) of the errors in Study 1. The reason for this difference is not clear; however, we suspect that it is due to the smaller sample of errors in the current study.

Participants' responses to the interview questions also provided additional information that demonstrates that the reported scale errors were both spontaneous and serious in nature. First, 63% (n = 10) occurred without any prior play with the target object (see Appendix, question 3a). Moreover, when describing the scale error from start to finish, participants never mentioned any direct verbal prompting immediately prior to the event. Hence, the majority of the scale errors occurred completely spontaneously. Second, 94% (n = 15) of the scale errors were persistent in nature, involving more than one attempt by the child to fit into or onto the target object (question 3b). Third, during 88% (n = 14) of the scale errors, the child exhibited an emotional reaction after the failed attempt to fit into or onto the object (question 4). For example, the child was upset, frustrated, confused, surprised, and/or shed tears. These results confirm that the reported scale errors were serious attempts, not acts of pretense.

Discussion

In conjunction with Study 1, these findings corroborate the occurrence of everyday scale errors that are similar to scale errors observed in prior laboratory studies. Moreover, these results demonstrate that our initial coding of the events reported in the internet survey remained quite consistent after we obtained additional details about the events in follow-up phone interviews. This confirms that participants' survey responses – in both Studies 1 and 2 – were detailed enough for us to reliably judge which events were truly scale errors. If anything, the data indicate that our original coding of the internet survey responses in Study 2 was overly conservative. Specifically, there were several events that were judged to be scale errors only after we obtained more information about them in the interviews. It is thus possible that applying such strict coding criteria led us to exclude some events in Study 1 that would have been judged to be scale errors if we had followed up with a phone interview. Despite this limitation, however, we still obtained numerous examples of everyday scale errors.

General discussion

The research reported here provides the first formal documentation of young children making scale errors in the course of their daily lives. The scale errors that the survey participants reported were generally quite similar to those previously documented in the lab, with a preponderance of attempts to get into or onto miniature replica objects. Thus, scale errors are not limited to laboratory settings designed to promote their occurrence.

A notable similarity between the current and previous research (DeLoache *et al.*, 2004) is that the reported scale errors occurred most frequently at around 2 years of age, with a lower incidence for both younger and older children. In fact, *all* of the scale errors reported in the survey were made by children between 1 and 3 years of age. Although there were 14 events reported across the two studies that involved children as young as 9 months and as old as 84 months, they were excluded because they did not meet the criteria for a scale error. (Most were rated either as pretense or involved too-large objects.) Thus, the current findings strongly suggest that true scale errors involving serious attempts with very tiny objects primarily occur within a small developmental window – specifically 1 and 3 years of age.

Although our focus in the two studies reported here was the everyday occurrence of true scale errors, the participants reported a continuum of size errors that children made in their daily interactions with small replica objects, ranging from true scale errors – defined as involving an extreme discrepancy between the relative sizes of the child's body and the target object – to errors involving objects that were larger, but still too small, to afford the attempted action. It is notable that our participants reported so many events involving young children attempting to get into or onto larger (but still too small) objects after being solicited for examples of scale errors with miniature objects. This suggests that there are some similarities between the events lying along this continuum. However, we chose to focus on the most extreme scale errors because the striking magnitude of these errors suggests that they constitute a qualitatively distinct class of events. In contrast to scale errors, events involving slightly larger objects might simply represent problems in estimating the size of the object, the size of the body, or both (Brownell *et al.*, 2007). Although scale errors might involve some of these underlying factors to some degree, they clearly also involve an extreme failure to take account of the real size of the miniature object.

There was also one noteworthy difference between the results of the internet survey and the previous laboratory studies. Specifically, the incidence of scale errors reported in the survey was substantially lower than that observed in the prior research (DeLoache *et al.*, 2004; Ware *et al.*, 2006). Whereas 46% of the children in the original study made scale errors (DeLoache *et al.*, 2004), only 17% of the survey respondents (across both Studies 1 and 2) reported observing an event that met the criteria for a true scale error. A direct comparison of these two sets of findings is not warranted as there were many differences between these two data collection methods. Nevertheless, the substantially higher rate of scale errors in the lab studies suggests that, as was assumed would be the case, the lab procedures predisposed the children to commit scale errors. In particular, participants in the lab studies were encouraged to play with larger objects immediately prior to encountering the miniature versions, and this might have primed the behaviors associated with those objects. The use of verbal prompts in the lab studies also presumably increased the frequency of scale errors. Importantly, however, the present findings establish that neither immediately prior exposure to a larger version nor verbal prompting is *necessary* for a scale error to be made with a miniature object. Although it is possible that some of the scale errors reported in our survey involved one of these factors, the interviews in Study 2 demonstrate that the occurrence of completely spontaneous everyday scale errors is relatively frequent. Thus, recent exposure to a larger version and verbal prompting simply increase the likelihood of a scale error.

The examples of everyday scale errors reported here are consistent with our previous account of scale errors in terms of visual processing involved in object recognition, action planning, and on-line action control (DeLoache *et al.*, 2004; Ware *et al.*, 2006). Scale errors occur when visual information about object size is not integrated with a child's decision to act on a miniature object. Seeing a miniature version of an object from a familiar category activates a stored mental representation of a larger version or of the general object category, including the motor plan for interacting with the larger version of the object (Barsalou, Simmons, Barbey & Wilson, 2003; Tucker & Ellis, 1998, 2004). Normally, visual information about the miniature object's actual size is integrated with action planning and inhibits initiation of the action, and the child interacts with it appropriately. Occasionally, however, the relevant size information is not integrated into the formation of the action plan, leading the child to attempt to execute the motor routine associated with a larger version of the object.

Once the child begins to carry out the faulty action plan, however, visual information about the actual size of the miniature object influences the calibration of the child's movements (DeLoache *et al.*, 2004; Ware *et al.*, 2006). In the commission of a scale error, children precisely adjust their actions to the actual size of the miniature object. For example, they very carefully and precisely position themselves over the tiny chair and sit down right on top of it (DeLoache *et al.*, 2004) and they painstakingly lower the doll's feet directly towards the open basin of the miniature bathtub (Ware *et al.*, 2006).

This account of scale errors as involving a dissociation between the use of visual information for object recognition and action planning on the one hand and on-line action control on the other is consistent with dual process accounts of visual processing (e.g. Gentilucci, 2002; Glover, 2004; Glover, Rosenbaum, Graham & Dixon, 2004; Milner & Goodale, 2006). The phenomenon of scale errors extends dual process theories in two important ways. First, it broadens the developmental application of such accounts. Most of the research and theorizing in this domain has involved adults and non-human animals (e.g. Ungerleider & Mishkin, 1982), and most of the prior developmental research has focused on infants (e.g. Bertenthal, 1996; Mareschal & Johnson, 2003; Newman, Atkinson & Braddick, 2001; Vishton, Ware & Badger, 2005; von Hofsten, Vishton, Spelke, Feng & Rosander, 1998) or special populations (Landau, Hoffman & Kurz, 2006). The account of scale errors offered here and in our previous studies (DeLoache *et al*., 2004; Ware *et al*., 2006) extends the dual process framework to young children.

Second, scale errors provide evidence for the dual process account *within* individuals. Previous investigations of dissociations in visual processing have generally involved comparisons across subjects or tasks. During scale errors, however, an individual child fails to use visual size information when deciding to act on an object, but then does use it moments later to guide the execution of the action plan.

In summary, the current research establishes that scale errors occur in typical, everyday settings and are not limited to laboratory situations. Despite the fact that the internet survey and the prior laboratory studies assessed the occurrence of scale errors in extremely different contexts, the results converge both in the documentation of scale errors and in the identification of specific characteristics of these errors, including the types of objects and actions involved and the age of the children most prone to commit them. Together, these two lines of research indicate that scale errors constitute an important phenomenon that provides insight into aspects of the early development of visual processing.

Appendix

Follow-up phone interview questions from Study 2

(1) You described a scale error that involved a child trying to _____ into/onto a _____. Can you describe the scale error to me, telling me exactly what happened from the start to the end of the event and adding any further information that might come to mind? Please include as many details as you can remember about what happened.
(2) Is there anything else that you can tell me about the type or size of the object that the child tried to get into/onto?
    a. Was the object a toy that is associated with a specific brand name, such as a 'Matchbox' car or a 'Barbie' chair?
    b. Was the object large enough that the child could almost have squeezed his/her body into or onto the object?
(3) Now I am going to ask you some specific questions about the child's behaviors during the scale error:
    a. Had the child been playing with the object before the scale error occurred? Or, was the scale error the first thing the child did with the object?
    b. Can you tell me more about what the child did? How persistent was he/she? Was it really a sustained effort to interact with the object? Did he/she make multiple attempts?
    c. When asked whether you thought the child's efforts to fit into the object were serious, you responded (participant's seriousness rating inserted here). Can you explain why you marked this choice?
    d. Did the child make any comments about what he/she was doing? For example, did he/she mention that the object was 'too small' or that he/she was 'too big'?
(4) Did the child have any emotional reaction to having made a scale error?
    a. Did he/she laugh, look embarrassed, or get upset?
    b. If so, can you describe how extreme the reaction was?
(5) Is there anything else about the scale error that you think we should know?

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