A method for eliciting scale errors in preschool classrooms

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\begin{abstract}
Six preschool classrooms, containing children between the ages of 4.0 and 40.0 months, were seeded with miniature items to examine how easily scale errors could be elicited. Observations occurred over a period of 3 months, with a total of 280 min of observations per classroom. A concealed observer documented all interactions with the miniature items. A total of 93 scale errors occurred, with a higher frequency committed by the younger children. These results confirm findings from previous research and suggest that scale errors can be effectively elicited in a preschool classroom. Our approach may provide a useful method for systematically studying the factors that influence scale errors.
\end{abstract}

\section{1. Scale errors in preschool classrooms}

Young children sometimes attempt actions on objects that are too small to enable the child to perform the action successfully. For example, young children may attempt to sit in a miniature chair or put their foot into a doll-sized shoe. These actions were initially documented and labeled as scale errors by DeLoache, Uttal, and Rosengren (2004), who showed that scale errors could be elicited in a laboratory environment. More recently, Rosengren, Gutiérrez, Anderson, and Schein (in press) have referred to these behaviors as \textit{body scale errors} and differentiate them from \textit{object scale errors} that involve situations where a child attempts to place an object on or within another object that does not support the action due to large size differences between the two. Object scale errors have been investigated by Ware, Uttal, Wetter, and DeLoache (2006) who showed that young children perform this type of scale error with dolls and smaller inappropriately scaled objects. These researchers found that object scale errors were more commonly committed by older children (35–40 months) than younger children (16–24 months). They
suggested, based on the observation that the older children showed more interest and engagement in the miniature toys, that these factors (interest and engagement) were important in mediating the frequency and occurrence of object scale errors.

Research by Brownell, Zerwas, and Ramani (2007) examined both types of scale errors in the context of a study examining the development of body self-awareness in 18- to 26-month-old children. Children in that study committed both types of errors, with the frequency of both decreasing with increasing age of the child.

Taken together, the results of past research on scale errors provide somewhat conflicting evidence with respect to the age range when they are most likely to occur and the relative frequency of body and object scale errors. Although Rosengren et al. (in press) studied children over a relatively large age range (13–32 months), they found that scale errors were most commonly reported in children between the ages of 13 and 27 months. This finding is similar to that reported in the original study by DeLoache et al. (2004) and that of Brownell et al. (2007). The finding by Ware et al. (2006) suggests that an increase in object scale errors with age may be the result of differences in objects and other methodological issues.

Similarly conflicting results have been found with respect to the relative frequency of the two types of scale errors. Ware et al. (2006) found a greater number of object scale errors than the number of body scale errors reported by DeLoache et al. (2004). However, both Rosengren et al. (in press) and Brownell et al. (2007) found that body scale errors were committed more frequently than object scale errors. Using parental reports Rosengren et al. found that body scale errors were about four times as common as object scale errors. This difference may be due to the fact that body scale errors are more salient to parents than object scale errors.

At present there is no method for systematically investigating factors other than the age of the child that might influence the frequency and occurrence of scale errors. The creation of such a method might also enable investigators to better understand the underlying causes of these behaviors.

Brownell et al. (2007) have suggested that scale errors arise from children’s difficulties in thinking about their bodies as physical entities. They suggest that as children gain a better understanding of their bodies, object scale errors decline. DeLoache et al. (2004) have suggested, based on research investigating the integration of visual information (Glover, 2002, 2004; Milner & Goodale, 1995), that scale errors stem from a lack of inhibitory control coupled with a lack of integration between perception and action in typically developing children. The general idea is that when a child views a small–scale replica of a common larger object, the representation of the larger object (i.e., a chair) is activated along with the typical action plan associated with that object (i.e., sitting on the chair). The child then attempts to perform the action on the smaller object (i.e., sitting on the too small chair) because he or she lacks the inhibitory control to suppress the inappropriate action. Development of a methodology that enables researchers to control certain factors (e.g., object characteristics) that might influence the frequency of scale errors may provide them with the tools to explore these behaviors in more depth.

An important issue concerns the extent to which scale errors differ from pretense. Generally, pretense behaviors involve different types of actions than those described as scale errors. For example, in pretense, rather than attempting to climb into a tiny car, children will often move the car back and forth with their hands. Past research (Brownell et al., 2007; DeLoache et al., 2004; Ware et al., 2006) suggests that scale errors and pretense can be easily and reliably distinguished from one another.

At present it is clear that scale errors can be elicited in laboratory settings (Brownell et al., 2007; DeLoache et al., 2004) and that they occur commonly in the everyday lives of children (Rosengren et al., in press; Ware, Uttal, & DeLoache, under review). We also know that they can be elicited in children between 13 and 40 months of age and that availability of miniature items, and interest and engagement appear to be important factors in the occurrence of scale errors. Presently, we do not have any methods for systematically investigating other factors that may influence the frequency of these behaviors. The goal of the present study was to investigate, using observational methods, whether scale errors could be elicited in a preschool classroom. If we could successfully elicit scale errors in this situation, it would provide us with a context in which we could systematically investigate how different object and child characteristics influence the frequency of scale errors. A secondary goal was to investigate how the frequency of scale errors might vary in the preschool classroom as a function of age and object characteristics.

2. Method

2.1. Participants

All observations were conducted at the Early Child Development Laboratory Preschool (ECDL), a day care and preschool on the campus of the University of Illinois at Urbana-Champaign. A total of 68 children were observed in 6 classrooms: 2 infant classrooms (8 children per classroom), 2 toddler classrooms (12 children per classroom), and 2 two-year-old classrooms (14 children per classroom). The age range at the beginning of data collection was between 4.0 and 4.0 months of age (infant class = 4.0–16.0 months; toddler class = 17.0–28.0 months; two year olds class = 29.0–40.0 months) and the mean age was 24.9 months (infant class = 10.6 months; toddler class = 22.7 months; two year olds class = 35.0 months). There were equal numbers of boys and girls in each of the classrooms. Children enrolled in ECDL come from families with diverse educational, cultural, and economic backgrounds from the University community and surrounding areas.
2.3. Observations

Observations were conducted from specially designed observation booths adjacent to each of the classrooms. The booths were equipped with one-way mirrors and earphones receiving input from microphones placed in different classroom locations. Observations were performed during free play time in six classrooms over a 3-month period. Over this time, an average of 70 min of observation was completed in each classroom for each of the three toy sets (including a second set of observations for toy set A) for a total of 280 min of observation per classroom. The 70-min observations were usually conducted over two sessions. Prior to each observation, an experimenter placed the items from one of the three toy sets in a location clearly observable from the observation booth. During this time the children were free to play with our toy sets, or use other toys and materials in the classroom. After each observation session, the toy set was removed from the classroom. The classrooms were all typical preschool classrooms, filled with a variety of toys and other classroom materials. To our knowledge the classrooms did not contain any other replica items other than the ones we placed in the classrooms.

The observer recorded any interactions with the target toys. When a scale error occurred it was recorded on a data sheet noting information about the specific child being observed and any reactions of the child to the scale error (i.e., surprised, embarrassed, frustrated, mad, requests for help, neutral, amused, or not sure). In addition, the researcher recorded information about the specific toy eliciting the scale error, the action performed on the object, the number of other children present when the scale error occurred, the number of attempts on the object (i.e., 1, 2, 3, 4, more than 4), and the seriousness of the scale error (i.e., 1 = definitely serious, 2 = probably serious, 3 = not clear, 4 = probably pretending, and 5 = definitely pretending).

The majority of the observations were conducted by the same experimenter. In order to determine reliability of the observations, two of the experimenters viewed 32 video-taped examples of scale errors collected from the initial laboratory study of scale errors by DeLoache et al. (2004). Each of the experimenters coded the examples for five different items: the specific toy involved in the scale error, the action performed on the toy, the number of repeated attempts, the child’s response to failure, and the rating of seriousness of the attempt. The two coders had an 87% agreement. In addition, the two experimenters independently made overlapping observations in the same preschool classrooms for a total of 210 min. During this time there was a 100% agreement that 12 serious scale errors had occurred and the two coders had 96% agreement across the specific categories. Across the live observations and the videotapes, the reliability of the coding of scale errors was 91% (agreement on 232 of 256 possible decisions).

3. Results

Thirty-six children committed a total of 93 scale errors during the observation period, with an average of 2.6 scale errors per child. This represents 52.9% of the children in the six different classrooms, or 58.1% of all mobile children (not all the children in the infant classes were mobile since the ages ranged from 4.0 to 16.0 months), committing scale errors. Out of the 93 observed scale errors, 13 (14.0%) were considered “pretense” scale errors, 2 (2.1%) were coded as “not sure” and 78
Fig. 1. Number of serious scale errors observed by toy set and class.

(83.9%) were rated as “serious” scale errors. Serious scale errors were observed in 31 of the participating children, with an average of 2.5 serious scale errors per child. About half (52.4%) of the scale errors committed by children in the two-year-old classrooms were coded as “not sure” or “pretense,” while the majority (94.4%) of the scale errors committed in the younger classrooms were coded as serious scale errors. In addition, 85 of the scale errors were labeled as body scale errors (91.4%) while 8 were labeled as object scale errors (8.6%); the four children who committed the object scale errors were all in the toddler class. For the remaining analyses, only the observed serious scale errors will be taken into account; these will be labeled as “scale errors”.

There was a fairly even split between the scale errors committed by females and males: female children (n = 15) committed an average of 0.63 (SE = 0.11) scale errors while males (n = 16) committed an average 0.66 (SE = 0.11) scale errors. Children in the toddler class committed more scale errors (n = 46) than children in the infant class (n = 22) or the two year olds class (n = 10). They also had a higher percentage of children committing scale errors (79.2%) when compared to the infant (31.3%) and two year olds (25.0%) classes. In order to examine the effects of age more closely we performed a one-way ANOVA. For this analysis we included only the ten infants in the youngest classrooms who were mobile. Thus, this analysis compared the number of scale errors for 10 children in the infant classrooms, compared to 24 children in the toddler classrooms, and 28 children in the two-year-old classrooms. Both the infants (M = 2.2 scale errors, SE = 0.9) and the toddlers (M = 1.9 scale errors, SE = 0.3) committed more scale errors than the two year olds (M = 0.36 scale errors, SE = 0.1; F(2,59) = 8.2, p = .001).

3.1. Object characteristics related to frequency of scale errors

The toys that were used in the study to elicit scale errors were divided into three sets and presented to the children one set at a time. To examine whether there was a significant difference in the number of scale errors elicited by the different toy sets and to determine whether there were any effects of gender we conducted a 4 (toy set: A1, B, C, A2) by 2 (gender: female, male) repeated measures ANOVA with toy set as a repeated measure. This analysis only included children who committed at least one serious scale error (n = 31). We found only a significant effect of toy set (F(3,87) = 5.0, p = .003, partial eta squared = .15). Post hoc LSD analyses revealed that toy set B (i.e., rocking chair, Hummer vehicle, and bed; total scale errors = 34) elicited more scale errors than any other toy set, followed by set A2 (second exposure of convertible car, toy slide, and sofa; total scale errors = 26), set A1 (first exposure of set A; total scale errors = 12), and set C (i.e., bathtub, Little Tykes car, and toy red wagon; total scale errors = 6) (see Fig. 1). As mentioned earlier, the Hummer in set B did not elicit any scale errors, however the rocking chair elicited 14 scale errors and the toy bed elicited 20 scale errors. The item that elicited the second highest number of scale errors was the sofa with a total of 15 scale errors.

We conducted a number of analyses to examine whether certain object characteristics were associated with a greater number of scale errors. Specifically, we examined whether object size, as determined by height, length, width, or volume, was related in any way to the frequency of scale errors. Although the largest item by volume, the bed, garnered the most scale errors (n = 20), no systematic relation between object size and frequency of scale errors was observed in the data (see Table 1).

Although we had at least one item in each set that had elicited scale errors in past research (i.e., the toy slide, rocking chair, and Little Tykes car), the Little Tykes car did not elicit any scale errors in the present study. Two other vehicles were included in the sets. One of these items, the Hummer, did not elicit any scale errors, while the Barbie convertible elicited 11 scale errors. The two vehicles that did not elicit any scale errors both required children to open a door and attempt to climb in. These objects contrasted with all of the other items that children could attempt to sit upon rather than climb in.
4. Discussion

Over the course of a 3-month observation period, 78 serious scale errors were observed in preschool classrooms suggesting that these behaviors can be effectively elicited in a classroom setting. Overall, the approach of the present study looks promising as a method for systematically studying the factors that influence scale errors.

Past research has suggested that the frequency and occurrence of scale errors varies as a function of age, and interest and engagement with the particular items. While three studies have shown a decrease with age in the production of scale errors over the period of 13–40 months (Brownell et al., 2007; DeLoache et al., 2004; Rosengren et al., in press), one study has reported an increase over the same age range (Ware et al., 2006). The results from the present study also support a decrease in the frequency of scale errors with age. It is likely that the conflicting results obtained by Ware et al. can be attributed to their focus on object scale errors whereas the primary focus of both our and others’ investigations has been on body scale errors.

Although we were able to elicit scale errors in preschool classrooms our methods did not allow us to examine how frequent these behaviors are compared to other behaviors that might be occurring in the classroom. In future research it would be useful to compare the frequency of scale errors to other behaviors using the same or similar items and to examine if the frequency of scale errors performed on particular items changed with increasing exposure to the item.

Our method allowed us to examine a number of object factors that might influence the frequency and occurrence of scale errors. Within the range of sizes (of objects) that we investigated, we found no impact of size in terms of height, length, width, or volume. It may be that items significantly smaller than the ones we used would inhibit the production of scale errors, but future research is needed to examine this issue. We did find, however, that the items that most frequently elicited scale errors were ones that represented replica furniture (i.e., a chair, a bed, and a sofa) and that involved sitting on, rather than climbing in the object.

We had two toys that did not elicit any scale errors, including a Little Tykes car that had been used in previous research and had elicited scale errors in a laboratory setting. It is not clear why this car, which was paired with a bathtub and a small red wagon, did not elicit any scale errors in the preschool classrooms. The other two items that were part of this set (C) elicited very few scale errors (i.e., bathtub elicited only one scale error and the wagon only five). It may be that taken together this particular toy set was not as engaging as the other ones. These items were part of set C, which was the third set to be introduced into the classroom. This might suggest that after two other sets of replica toys were introduced in the classroom, the third one may not have been as engaging. However, if this was the case, we should not have found an increase in scale errors when set A was introduced the second time. This increase in scale errors with the second exposure is interesting in that it suggests that novelty or one’s first exposure to the toy is not necessary to elicit scale errors. Of the children who committed scale errors on toys in set A, 4 children only committed them on the first exposure, 6 children committed them on both exposures, and 8 children committed scale errors only on the second exposure. Although this result suggests some interesting individual differences in the production of scale errors, further research is needed to understand this finding.

The remaining item that did not elicit any scale errors was the toy Hummer. This item was originally chosen to offset the Barbie convertible and to provide a toy that boys might be interested in. However, the Hummer looked more like a replica of the actual vehicle and for this reason may not have been viewed as something that children could control.

Although it is not entirely clear why children commit scale errors, our method of seeding a classroom with particular toys may enable us to examine how the production of scale errors can be more easily elicited or inhibited. This method should allow us to examine more closely how certain object characteristics such as size, similarity to a larger scale item, or the frequency of exposure influence the occurrence of these behaviors. Once we have a better understanding of the situations and object characteristics that are most likely to elicit scale errors, we will be in a better position to examine the child characteristics that might relate to the frequency and persistence of performing these behaviors. One possibility, for example, would be to study if children who have problems with inhibition both commit more scale errors and continue to commit them for a longer time period.

References