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Individual differences in children's production of scale errors

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ABSTRACT

Individual differences in the production and persistence of committing scale errors were examined in children (age range 18–29 months) attending a laboratory preschool. Miniature replica toys were placed in the classrooms during three 20-min observation periods for 10 weeks. The majority of the children (88%, $n = 24$) performed scale errors providing confirmation in a different setting (than presented in previous research) that most young children commit these behaviors. Large individual differences were found in the frequency and persistence of committing scale errors. Extended exposure to the replica items increased the number of scale errors, though the frequency of scale errors decreased over the entire observation period.

Young children sometimes attempt to perform actions, such as sitting on a tiny chair, which the object, due to its small size, cannot accommodate. Initial anecdotal reports of these behaviors, labeled as *scale errors* (DeLoache, Uttal, & Rosengren, 2004), have been confirmed by studies performed in the laboratory (Brownell, Zerwas, & Ramani, 2007; DeLoache et al., 2004; Ware, Utal, Wetter, & DeLoache, 2006), using parental diary methods (Rosengren, Gutiérrez, Anderson, & Schein, 2009b), an Internet survey (Ware, Utal, & DeLoache, 2010), and natural observation in preschool classrooms (Rosengren, Carmichael, Schein, Anderson, & Gutiérrez, 2009a). Each of these past studies reported variation across children in the frequency of scale errors, though none of these reports explicitly examined individual differences in this behavior. The aim of the present research was to more closely examine individual differences in the production of scale errors and to study the influence of repeated exposure to objects that elicit these behaviors.

Laboratory assessments of scale errors have generally involved a single session where children are exposed to miniature scale replicas of appropriately scaled chairs, slides, and toy cars (Brownell et al., 2007; DeLoache et al., 2004). In DeLoache et al. (2004), approximately half (46%; 25/54) of the 18–30-month-old children tested performed at least one scale error in the laboratory with some committing as many as four scale errors in 20 min. Their focus was on *body scale errors* (Rosengren et al., 2009a) where a child attempts to fit their own body on or in an object that is too small for them to fit on or in. Ware et al. (2006) found a slightly higher percentage of scale errors in their study of scale errors involving dolls and other objects (62%; 46/74) with older children (35–40 months of age) committing more errors than younger children (16–24 months of age). Although these authors did not report the range of scale errors, children in this study performed an average of 1.4 of these behaviors. These behaviors involving two objects have been labeled as *object scale errors* (Rosengren et al., 2009a).

A number of investigators have shown that scale errors occur in the everyday lives of children. For example, using a 6-month diary approach Rosengren et al. (2009b) found that 29 of 30 parents reported that their children (aged 13–21 months initially) committed at least one scale error. Children in this study committed between 0 and 8 scale errors over the course

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of the 6-month study. Using an Internet survey, Ware et al. (2010) found that 18% (40 of 221 participants, age data was not collected) reported at least one scale error, with 6 parents reporting that their child had committed two errors. While both of these investigations suggest that scale errors occur at home, Rosengren et al. (2009a) have also shown that scale errors can be elicited in a preschool classroom if replica items are present. In their study, preschool classrooms were seeded with replica toys while observers recorded children's interactions with the objects. When using this procedure, children averaged 2.5 scale errors over a 3-month period.

Past research does indicate that scale errors are relatively common in young children. This is an important finding because it suggests that these behaviors may be linked to other important developmental processes and may not merely be an interesting and somewhat odd behavior performed by only some young children. The current study is designed to explore the extent of individual differences in scale errors when children are repeatedly exposed to the same replica objects. Investigating individual differences in scale errors may shed insight into why they occur and why they are more frequent in children during a particular age range. In particular, individual differences in these behaviors may be related to inhibitory control (i.e., an action appropriate for one object is inappropriately directed toward another), with children who perform a large number of scale errors exhibiting lower levels of inhibitory control than those who perform few scale errors (DeLoache et al., 2004). If large individual differences are obtained in this observational study involving relatively few children, then we will design future laboratory studies to investigate the source of these differences. Thus, the main goal of this research was to document the extent of individual differences in young children's production of scale errors.

An additional goal of this research was to examine the impact of repeated contact with objects that typically elicit scale errors. Although Rosengren et al. (2009a) did provide children with repeated exposures to replica objects, their study was primarily designed to test the methodology of seeding a classroom to elicit scale errors and they varied the objects over different exposures. We extend their work by more explicitly assessing the frequency of scale errors as a function of repeated exposure to the same objects. Our expectation was that scale errors would decrease with repeated exposures to the replica objects. Finally, we were interested in confirming, using different methodology than used in past research, that most if not all young children perform scale errors during early childhood.

1. Method

1.1. Participants

The participants included 24 children ($M = 23.6$ months, range = 18–29 months) equally divided between two preschool classrooms at a laboratory preschool at a large Midwestern university. There was no difference in the ages of the children across the two classes. One class had an equal number of boys and girls while the second class had 7 boys and 5 girls. All of the children enrolled in this laboratory preschool come from families affiliated with the University community and surrounding areas; there is wide diversity in terms of educational, cultural, and economic backgrounds.

1.2. Materials

Stimuli for this study included four items that had been found to elicit scale errors in previous studies (DeLoache et al., 2004; Rosengren et al., 2009a). The items were a small-scale couch ($10.0 \times 8.0 \times 21.5$ cm), a slide ($14.0 \times 13.0 \times 23.0$ cm), a bed ($21.5 \times 19.0 \times 40.5$ cm), and a toy car ($15.0 \times 8.0 \times 14.0$ cm).

1.3. Procedures

Observations were conducted from booths equipped with one-way mirrors and headphones adjacent to each of the classrooms. During the first, fifth, and tenth weeks of the study, observations occurred for 20 min, three times per week in both classrooms. In the other weeks, an additional 3×20 min of observation occurred in one classroom, except for the 7th week when the preschool was closed. During the 3 weeks when both classrooms were observed, observations were done directly after each other to avoid a time-of-day effect.

Prior to each observation, an experimenter spread the toys at a location clearly observable from the observation booth. After each session, the toys were removed. Two observers were present whenever the objects were in the classroom. Two coders independently made overlapping observations in the same preschool classrooms for a total of 720 min.

When a scale error occurred with one of the target objects, the two observers recorded the behavior, the specific child 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 the time of observation, the specific toy eliciting the scale error, the action performed on the object, whether it was a body scale error or an object scale error, 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). Reliability overall was 91.5%. The data that is included in this report represents only the instances of scale errors that were recorded and agreed upon by both observers.

The observers were trained together in a 60-min session. During this session an experimenter defined the different types of scale errors. The observers were then shown six videotaped examples of scale errors as the experimenter oriented them

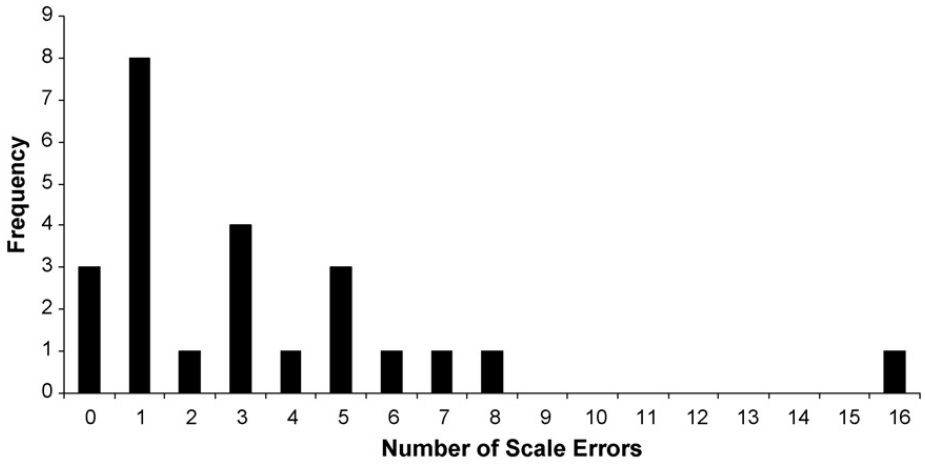

Fig. 1. Frequency of scale errors produced.

to the data sheet and explained how each of the examples would be rated. Next, the observers were shown four additional videotaped examples of scale errors (three body scale errors and one object scale error) and asked to independently code these examples. The experimenter and observers discussed the observers' coding and resolved any differences through discussion and further viewings of the examples. The observers also had two 20-min sessions of on-site training, wherein they followed the procedure of the study (setting the objects in a classroom, doing live observations from the booths) but did so in two classrooms that were not to be included in this inquiry. Repeated attempts to perform a scale error on the same object multiple times without interruption were coded as only a single error (e.g. if a child tries to put his/her foot into the toy car several times in a row, this was counted as a single scale error with repeated attempts). Persistence in scale error performance was defined as repeated attempts on the same object taking place more than 1 min apart, or repeated attempts on the same object separated by some other behavior performed by the child. Thus, if a child performed the same type of scale error on a particular toy but it was separated by more than 1 min or across more than 1 day of observation it was counted as an example of persistent behavior towards the object.

2. Results

Across the two classrooms children performed an average of 3.3 scale errors ($SD = 0.7$). The majority of these were body scale errors ($M = 2.8$, $SD = 0.7$) rather than object scale errors ($M = 0.5$, $SD = 0.2$, $t(23) = 3.0$, $p = .007$). Of the 24 children present in the two classrooms, 21 (87.5%) performed at least one scale error during the observations.

2.1. Individual differences in the performance and persistence of scale errors

One child committed 16 scale errors, 8 children performed only one scale error (38%), and 6 children each performed 2–4 (25%) or 5–8 scale errors (25%; see Fig. 1). Fig. 2 shows the frequency distribution for the number of days when children performed scale errors. Nine children performed scale errors on only one occasion. These behaviors were not limited to the

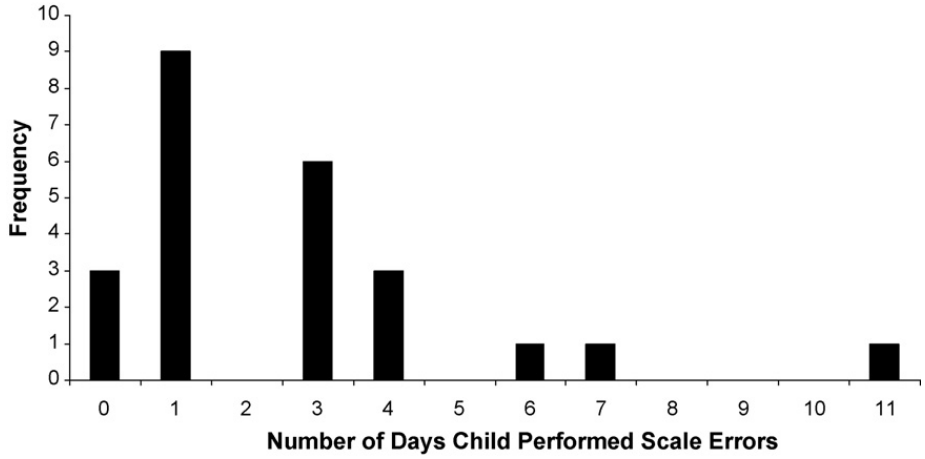

Fig. 2. Persistence of scale errors across days.

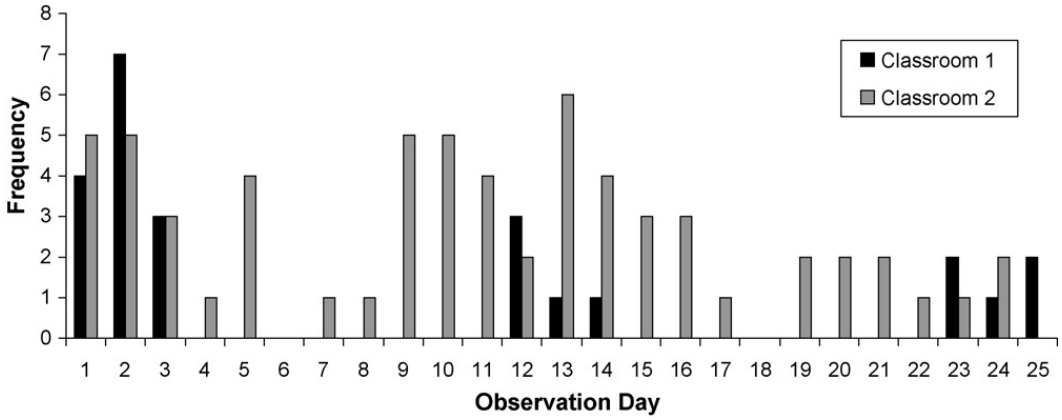

Fig. 3. Frequency of scale errors as a function of exposure.

initial exposure of the replica objects in the classroom but occurred throughout the observation period. Twelve children (50%) performed scale errors over 3 or more days and the child who committed the most scale errors (16) performed these over 11 different days.

The persistence of performing scale errors across days was not clustered around a particular time period or limited to single objects. Rather these events were clustered for some children and spread across the entire observation period for others. While some children performed scale errors involving only one object ($n = 12$), other children performed scale errors on two or more of the replica objects ($n = 8$), and one child performed scale errors on all 4 objects.

2.2. Characteristics of children who perform more scale errors

The frequency of scale errors was not significantly related to age using either parametric ($r(24) = .14$, n.s.) or non-parametric approaches (Spearman *rho* (24) = .22, n.s.). Girls performed significantly more scale errors ($M = 4.8$, $SD = 4.4$) than boys ($M = 1.9$, $SD = 2.0$, $t(22) = 2.2$, $p < .05$). However, when we excluded the one girl who had committed 16 scale errors from the analysis, no significant gender differences remained. There was also no difference between boys and girls on the number of days scale errors were performed ($t(22) = 1.7$, n.s.).

2.3. Repeated exposure

To examine the effects of repeated exposure we performed two different analyses. First we conducted independent sample *t*-tests examining the overall number of scale errors and the number of days when scale errors were performed across the two different classrooms. The children in the classroom with greater exposure to the replica items performed significantly more scale errors ($M = 4.7$, $SD = 4.1$) than children in the classroom with less exposure ($M = 1.5$, $SD = 1.7$, $t(22) = 2.1$, $p < .05$.). Children in the classroom with more exposure to the toys performed scale errors over more days ($M = 3.8$, $SD = 2.8$) than children in the other class ($M = 1.5$, $SD = 1.7$, $t(22) = 2.3$, $p < .03$).

We performed a second analysis to examine whether the frequency of scale errors decreased over the entire course of our observation. For this analysis we only examined the weeks where both classrooms were observed (1, 5, 10). We conducted a 2 (classroom: low exposure, high exposure) by 3 (observation: 1, 5, 10 weeks) mixed ANOVA with observation as a repeated measure. Only a significant main effect of observation was obtained, $F(1, 20) = 8.1$, $p = 0.01$, $\eta^2 = 0.29$. Post hoc analyses (LSD) showed that significantly more scale errors were obtained at week 1 ($M = 1.0$, $SE = 0.3$) compared to week 10 ($M = 0.3$, $SE = 0.1$). The frequency of scale errors at week 5 was not significantly different from those of the other two observation times ($M = 0.7$, $SE = 0.2$).

3. Discussion

The goal of our investigation was to examine individual differences in children's performance of scale errors and their persistence in performing scale errors over repeated days. We were also interested in examining whether the majority of children in a preschool classroom would commit scale errors given ample opportunity.

We found large individual differences in children's performance of scale errors and whether they performed them repeatedly. Only three children did not perform any scale errors. Half of the sample performed two or more scale errors with one child performing 16 total scale errors. As shown in Figs. 2 and 3, there is substantial variability between children in the frequency and perseveration of performing scale errors. At present, using this observational approach it is not clear what factors might be the source of these individual differences.

Two factors that we were able to explore with respect to the frequency and perseveration of scale errors were age and gender. We found no differences in the performance of scale errors by age. Children in our sample were between the ages of

18 and 29 months. This is the age range where other studies have shown these behaviors to occur and follow a curvilinear pattern of development (Brownell et al., 2007; DeLoache et al., 2004; Rosengren et al., 2009a,b; Ware et al., 2006). Due to our relatively small sample size, restricted age range, and use of correlational methods it is not surprising that we did not find a significant effect of age.

Once we removed the one girl who performed twice as many scale errors as the next most frequent child, no gender effects were found in the frequency of scale errors. At present only one study has found a significant effect of gender (Ware et al., 2006) and these researchers only examined object scale errors committed by children interacting with dolls and small objects. As Ware and colleagues suggest these items may be more often used by girls than boys. Our results replicate the majority of the existing research in this area showing no difference in these behaviors between boys and girls.

One limitation of our investigation is that our methodology of seeding a preschool classroom does not enable us to collect sufficiently large samples to explore more clearly the source of potential individual differences. Future work should attempt to examine in larger samples whether characteristics such as differences in inhibitory control or executive function might be related to the individual differences we have documented.

Our results do show that there are large individual differences in children's production and persistence in making scale errors when replica objects are available on a regular basis. Some children performed scale errors at the beginning of our observation period, others performed them halfway through our observation period, and a few children performed them throughout the entire observation period.

We also observed more overall scale errors in the classroom that received more exposure to our items. Thus, having access to the replica items does increase the likelihood that a child will perform a scale error and that for some children they will persist in performing them. At the same time repeated exposure to the items led to an overall decrease in the production of scale errors in both classrooms as more scale errors were observed in week 1 than week 10. It would be interesting to examine whether the decrease in scale errors is accompanied by an increase in pretend play with the objects or merely a loss of interest in the objects when they are found not to afford certain actions. As our observations focused only on the performance of scale errors we are not able to address this issue in the current data, but are investigating this issue in ongoing research. Our expectation, based on the pattern of individual differences obtained in the present study, is that some children will perform a scale error and then quickly switch to using the replica items in a more size-appropriate manner. Other children, perhaps those with poor inhibitory control, will continue to persistently perform scale errors for a prolonged period.

Our data does suggest that scale errors do occur in the everyday lives of children. The majority of children (87.5%) we observed over the 10-week period performed at least one scale error. Laboratory (DeLoache et al., 2004; Ware et al., 2006) and Internet studies (Ware et al., 2010) have generally reported much lower percentages of children performing scale errors than was found in the current study. However, Brownell et al. (2007) and Rosengren et al. (2009b) reported that most of the children in their studies performed scale errors. Our study provides converging evidence using a different methodology that with ample exposure to replica objects most, if not all children, perform scale errors during early childhood.

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