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Abstract

Preschoolers have difficulties in relational reasoning tasks, which are usually attributed to their object focus. Object focus can be reduced by using basic shapes familiar to children and could differ across children. Therefore, in Experiment 1, we investigated 25 4-year-olds' performance in the relational match-to-sample task (RMTS), using basic shapes with training, and testing sameness and difference. In Experiment 2, 41 4- to 5-year-olds were tested in the RMTS, using basic shapes, manipulating familiarity, without training, and testing only sameness. We also investigated whether children's use of object property words (e.g., color, shape) was directly associated with their performance. Our results showed that children performed above the chance level when tested on sameness but not on difference (Experiment 1). Furthermore, basic shapes but not familiar shapes enhanced preschoolers' performance in the RMTS (Experiment 2). Children's use of object property words dampened their performance. These findings underline the importance of task- and child-related factors when investigating children's relational reasoning in particular and cognitive performance in general.

Keywords: relational reasoning; object focus; stimulus complexity; object words

Introduction

Relational reasoning, as an essential part of higher-order cognitive abilities, is the ability to infer shared patterns between sets of objects. Throughout development, children generally fail to reason relationally before 4 years of age (e.g., Christie & Gentner, 2014; Hochmann et al., 2017). Such failures have been attributed to children's attention to object properties (Carstensen & Frank, 2021; Christie et al., 2020; Gentner, 1988). Besides, task-related differences might also influence relational reasoning performance (e.g., Son et al., 2011). This study investigated whether children's spontaneous object property label use (i.e., color, shape) hindered their relational reasoning and whether task-related manipulations influenced their relational reasoning through a widely used relational match-to-sample task (RMTS).

Infants, from very early on, can represent abstract relations. For example, even 3-month-olds who were habituated to pairs of two same objects looked longer to the pair of two different objects (Anderson et al., 2018). Similarly, 14-month-olds could learn a rule to match cards based on sameness and difference (Hochmann et al., 2016). Despite the successful performance of 18- to 30-month-olds, 30- to 48-month-olds failed to reason based on sameness and difference between objects (Walker et al., 2016). The failure of 30- to 48-month-olds was also documented in studies using the RMTS, where children were expected to match a standard card displaying a pair of two same items (AA) with a choice card displaying another pair of two same items (BB; relational match) instead of the choice card displaying two different items (CD; non-relational foil) (Christie & Gentner, 2014). Yet, these children could choose the relational match when provided with the opportunity for analogical comparison (Christie & Gentner, 2010) and relational language (Christie & Gentner, 2014). Thus, despite their representational abilities in infancy, children around four years of age seem to require additional cues to reason relationally.

The asymmetry in the developmental trajectory of relational reasoning is attributed to preschoolers' object focus (e.g., Christie et al., 2020; Gentner, 1988). The graded representation account suggests that object properties are also represented within the relation representations (Carstensen & Frank, 2021). Thus, object focus might make relations less salient, decreasing the probability of using relational representations successfully in reasoning tasks. Two predictions might be drawn from this account. First, if object properties become less prominent, children might perform better because object properties might not have enough weight to decrease the robustness of the relation representations. Alternatively, there might be individual differences in how object properties are weighed within relation representations. Thus, some children might not prioritize objects much, leading to better relational reasoning performance.

Relational reasoning tasks using less salient shapes could enhance children's performance (Carstensen & Frank, 2021). For example, compared to basic shapes, complex stimuli similar to real-life objects decreased children's performance

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(Son et al., 2011), potentially reflecting children's increased object biases when facing complex objects. Furthermore, while the youngest age group successful in the RMTS was 5-year-olds when complex shapes unfamiliar to children were used (Hochmann et al., 2017), 4-year-olds could perform above chance level in the RMTS using simple geometric shapes familiar to children (Christie & Gentner, 2014). However, these two studies are not directly comparable due to several procedural differences. First, while Christie and Gentner (2014) tested children on sameness relation (i.e., matching AA with BB, not CD), Hochmann and colleagues (2017) tested children on both sameness and difference relations (difference: matching AB with CD, not EE). Second, the training phases before the relational reasoning tasks differed across these two studies. Furthermore, the shapes used in these studies not only differed based on their complexity (basic; Christie & Gentner, 2014 vs. complex; Hochmann et al., 2017) but also on their familiarity to children (familiar; Christie & Gentner, 2014 vs. unfamiliar; Hochmann et al., 2017).

The procedural differences in these two studies should be addressed first to understand what aspect of stimuli makes the objects less salient for children (Experiment 1). Then, there should be an investigation regarding whether the changes in relational reasoning performance are due to stimuli familiarity or complexity (Experiment 2).

Regardless of the stimuli presented in the relational reasoning tasks, children might differ in how objects are weighed in relation representations. For example, due to cultural or linguistic factors, Western individuals focus more on objects and their properties, while East Asian individuals focus more on the relations between objects (Varnum et al., 2010; Christie et al., 2020). Similar differences in object vs. relational focus were sometimes observed in preschoolers from these groups (Kuwabara & Smith, 2012), but sometimes not (Senzaki et al., 2016). Such differences in preschoolers might also lead to differences in relational reasoning (Carstensen et al., 2019; Kuwabara & Smith, 2012; Richland et al., 2010; but also see Murphy et al., 2021 for cross-cultural similarity).

Children within a single cultural or linguistic group also differ in how they allocate their attention to objects and relations. For example, studies using eyetracking suggested that individual differences in children's attention to objects (Guarino et al., 2021) and relations (Starr et al., 2018) in the relational reasoning tasks predicted their performance. Yet, these results were not replicated (Guarino et al., 2022). Furthermore, children differed in their explanation of how they solved the relational reasoning tasks. For example, children who provided object-based justifications performed worse than children who used relation-based justifications at the end of the task (Hochmann et al., 2017). Children can also label object properties during the task. When children label an irrelevant aspect in a cognitive task, their attention could also shift to the labeled aspect (Mulvihill et al., 2021) because the use of irrelevant verbal labels (i.e., object properties) might hinder representing the task rule (i.e., relations) (Zelazo & Frye, 1997). Thus, investigating children's spontaneous use of object property labels can provide further insights regarding individual differences in object focus.

In sum, preschoolers generally fail in relational reasoning tasks due to their object focus. Therefore, we asked whether (i) using basic or familiar shapes in the RMTS enhanced preschoolers' performance and (ii) children's spontaneous use of object property labels (i.e., using color or shape words) during the RMTS trials was related to their performance.

Experiment 1

In Experiment 1, we tested the above questions in a relational match-to-sample task with initial training and tested both the sameness and difference relations (similar to Hochmann et al., 2017). We tested 4-year-old Turkish-learning children, as this age group performed around the chance level in a previous study (Turan et al., 2021). This experiment differed from Hochmann et al. (2017) in terms of stimuli. While Hochmann and colleagues (2017) used complex shapes that were unfamiliar to children, our stimuli comprised basic geometric shapes (triangles, circles) that were expected to be familiar to children (as in Christie & Gentner 2014). We hypothesized that children's performance in this experiment would be better than the ones in Hochmann et al. (2017) due to the stimuli simplicity or familiarity. As in Hochmann et al. (2017), we expected the performance in trials testing sameness and difference to be the same. We also expected that the probability of choosing a relational match would decrease if children spontaneously used a color or shape word during the RMTS trials. Using those labels even without being instructed could reflect either their spontaneous bias regarding how the cards should be matched or their attention to the object properties.

Method

Participants Our sample consisted of 25 Turkish-speaking children (M_{age} = 48.87 months, *SD* = 1.84, Range: 46 to 54 months). A certificate of attendance and an e-gift card from Amazon Turkey worth ₺50 were provided for children and parents.

Materials The RMTS task used in this experiment was composed of 16 trials. The first four trials were for training, and the remaining were for tests. Half of both training and test trials tested the sameness relation, and the remaining half tested the difference relation, as in Hochmann et al. (2017). The shapes used in the trials were square, triangle, circle, plus sign, star, diamond, and hexagon, as in Christie and Gentner (2014).

Stimuli were created in Microsoft Powerpoint. The slides were 13.33 inches in width, 7.5 inches in height and had a light gray background. In each slide, there were three white cards (2.91 inches in height, 2.08 inches in width). The cards had shading to ensure differentiation from the background. The first card (the standard card) appeared in the middle of the upper half of the slide. Two choice cards were placed symmetrically in the lower half of the slide. The cards were

1.45 inches away from the left and right border. The example displays for RMTS trials are presented in Figure 1.

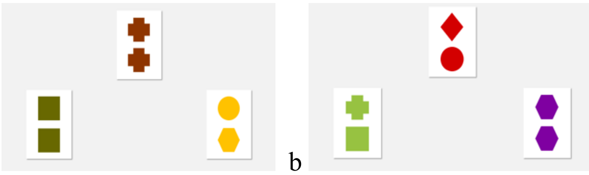


Figure 1: Example displays of the sameness (a) and difference (b) trials in RMTS

Procedure The experiment was conducted online via a virtual meeting using Zoom. The virtual meeting was recorded. The experimenter shared their screen with the children, where children saw the Microsoft Powerpoint file for the task. Children were assigned to one of the two conditions that differed in the order of trials. The order of trials was determined semi-randomly with two constraints. First, children were not tested based on sameness and difference in more than three consecutive trials. Second, one of the conditions started the training and test trials with the sameness relation and the other with the difference relation.

Before starting the task, children were presented with an empty display and told that they would play a card-matching game. Then, a blank card appeared corresponding to the location of the left choice card. Children were asked to raise their hand corresponding to the place of the appearing card (i.e., left). After a successful hand raise, the blank card went to the location of the right choice card, and again children were asked to raise their corresponding hand. Finally, children were told that they would raise their hands like they had done before when indicating their responses for the upcoming trials.

The children then proceeded to the training trials. In the first two trials (one sameness, one difference), children were first presented with the standard card by asking them to look at that card. The wrong answer appeared on the screen, and the experimenter said that those two cards did not match with each other because they did not go with each other while indicating the cards with their cursor. Then, the correct answer appeared on display. By indicating the standard card and the correct card with the cursor, the experimenter said that those two cards match each other since they go with each other. At the end of the trial, children were expected to raise their hands to indicate the correct answer. If children raised their wrong hand, the experimenter told children that the correct answer was on that side (indicating with the cursor) and asked children to raise their hands corresponding to the correct side.

In the third and fourth training trials (one sameness, one difference), children were first presented with the standard card by asking them to look at it. Then, both choice cards appeared on the screen. The experimenter asked which card (indicated by the cursor) went with the standard card. Children were then provided with feedback if they were right or wrong. If they were wrong, the experimenter repeated how to make correct matching as in the first two trials and told children to look at each card as a whole. These instructions were the same as Hochmann et al. (2017).

Before the test trials, children were told that the experimenter would not say the correct answer in the remaining. The test trials were the same as the third and fourth training trials, except that there was no feedback at the end of the trials.

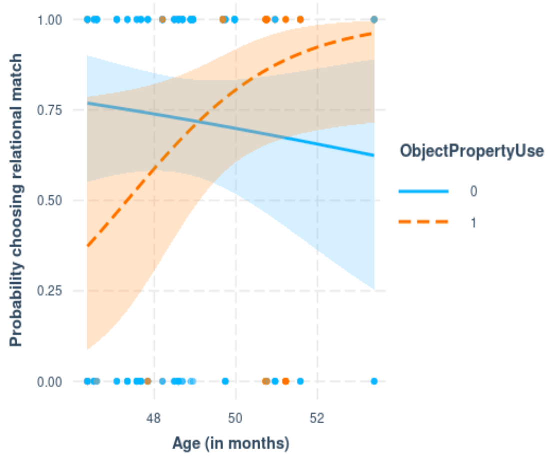
Coding One coder watched the recording of each session and coded children's answers as 0 (if wrong) or 1 (if true). The percentage of trials children who chose the relational match was used to examine our first question, while trial-level performance was used to address our second question. Furthermore, we coded whether the child spontaneously produced a color or shape name within a test trial (from when they first saw the standard card to when they saw the new standard card). This coding was also binary such that they received 0 if they did not produce any words about color or shape and 1 if they said at least one color or shape word in a single trial.

Results & Discussion

We first investigated children's performance level in the RMTS by calculating the proportion of correct answers for sameness, difference, and all trials. Children's performance did not change based on the order of trials ($t(23) < -.609$, $ps > .548$). Overall, children performed above the chance level ($t(24) = 2.838$, $p = .009$, $M = .617$, $SD = .206$). However, children's performance was significantly above the chance level only for the sameness relation ($t(24) = 4.536$, $p < .001$), not for the difference relation ($t(24) = .594$, $p = .558$). The difference in children's performance in sameness and difference was significant ($t(24) = 2.85$, $p = .009$) such that children performed better in trials testing sameness ($M = .700$, $SD = .220$) than in trials testing difference ($M = .533$, $SD = .206$).

Then, we examined children's use of object property labels. On average, children used object property labels in 2.84 of 12 trials. Out of 300 trials from 25 participants, object property words were used in 71 trials (23.67% of all trials) by 15 participants (60% of the participants). Thirty-one of the trials where object property words tested difference relation, whereas the remaining 40 trials tested the sameness relation. Age and object property word use was significantly correlated ($r = .278$, $p < .001$). Overall performance in the RMTS did not differ between children who used object property words and those who did not ($t(23) = -.993$, $p = .331$).

Next, we investigated whether children's performances were related to their use of object property words in the trials with generalized binomial linear mixed effects modeling (*glmer*) with random intercepts for participants and trials using lme4 package (Bates et al., 2015) in R (R Core Team, 2022). With this approach, the random variability due to participants and trials was eliminated. We started building the model with three variables (i.e., age, tested relation, and use of object property words), including all interactions among these variables. Then, by eliminating the nonsignificant interactions, we chose the best fitting model, that is, the one with the lowest Akaike Information Criterion (AIC) value. The first model (RelationalMatch ~ ObjectPropertyUse*Age*TestedRelation + (1| Participant) + (1|Trial)) yielded significant effects of tested relation and the interaction between age and use of object property words. The final model (RelationalMatch ~ ObjectPropertyUse*Age + TestedRelation + (1| Participant) + (1|Trial)) also yielded the same results. The probability of choosing a relational match significantly decreased if the trial tested the difference relation (B = -.842, SE = .297, p = .005). Additionally, the probability of choosing a relational match



was lower in younger children if they used object property labels (B = 1.141, SE = .543, p = .034). The interaction plot is presented in Figure 2.

Figure 2: Probability of choosing a relational match as a function of Age in Month and Object Property Word Use in Experiment 1.

These results suggested that children's overall performance was above the chance level, which was better compared to the previous study (i.e., Hochmann et al., 2017). Unlike Hochmann et al. (2017), in our study, children performed above the chance level only in the sameness trials but not in the difference trials. Thus, basic shapes decreased children's object focus only on the sameness trials. Yet, to specifically understand the underlying reason for the performance increase, two things required further investigation. First, basic shapes in Experiment 1 also differed in their familiarity to children compared to the complex stimuli in Hochmann et al. (2017). Furthermore, Hochmann and colleagues (2017) used objects only in a single trial, while we used the same shapes in different trials, increasing children's familiarity to the stimuli. Thus, the performance increase we observed might be due to the familiarity of the stimuli. Second, the procedure of Experiment 1 differed from Hochmann et al. (2017) in terms of the number of training trials and from Christie and Gentner (2014) in terms of training before the test, which might also account for better performance.

Furthermore, we expected that the direct measure of object focus (i.e., object property label use) was negatively associated with decreased performance, but we found this relation only for younger participants. There could be two ways in which spontaneous use of object property words was related to children's performance. First, using such words might reflect children's inductive bias that the cards should be matched based on object properties, possibly decreasing their performance on the RMTS because this task requires children to match cards based on the depicted relations between objects. However, if such word uses had reflected children's inductive biases, we should have found this association for all children, not only the younger participants.

Alternatively, children's use of object property words might have explicitly reflected what they focused on during a trial, which hindered their success in relational matching. The task stimuli could induce a bias towards objects that made children talk about those objects. Yet, older children might be able to inhibit this focus or represent competing object properties and relations in their working memory, which allows them to choose the relational match. However, considering the limited age range of this study (46- to 54-month-olds), the oldest children might still have such executive function difficulties. Thus, replicating these results in a wider age group is needed. Along with the issues regarding stimuli familiarity and training effect, a further investigation of object property word use was targeted in Experiment 2.

Experiment 2

In Experiment 2, we tested the remaining questions from Experiment 1 in a relational match-to-sample task, which had no training at first and tested only the sameness relation (as in Christie & Gentner, 2014) with Turkish-speaking 4- and 5-year-olds. To understand whether stimuli complexity or familiarity leads to differences in performance, we used only basic shapes that differ in their familiarity for children. The geometric shapes that are unfamiliar to preschoolers could be the basic shapes deviating from their prototypical representations (e.g., rotated objects; Kalenine et al., 2011; Walcott et al., 2009) or the ones not included frequently in preschoolers' books (e.g., parallelogram, trapezoid; Nurnberger-Haag, 2017). Children's worse performance in trials with unfamiliar shapes might indicate the importance of object familiarity in relational reasoning bias. If they performed similarly across the familiar and unfamiliar trials, not familiarity but object complexity would be responsible for performance differences. Furthermore, since children did not receive any training in this experiment, we expected a lower performance than in Experiment 1. We also expected to replicate the effect of object property word use found in Experiment 1.

Method

Participants Our sample consisted of 41 Turkish-speaking children (M_{age} = 59.01 months, SD = 6.41, Range: 48 to 71 months) with 21 4-year-olds (M_{age} = 53.72 months, SD =

3.92, Range: 48 to 59 months) and 20 5-year-olds. (M_{age} = 64.56 months, *SD* = 2.88, Range: 59 to 71 months) A certificate of attendance and an e-gift card from Amazon Turkey worth ₺50 were provided for children and parents.

Materials The RMTS task used in this experiment comprised 12 test trials. In half the trials, the participants saw familiar shapes (i.e., triangle, circle, square, diamond, star, and heart). In the remaining trials, they saw unfamiliar shapes (i.e., rotated rectangle, rotated obtuse triangle, parallelogram, trapezoid, hexagon, and ellipsis). Stimuli were created in Microsoft PowerPoint with the same specifications in Experiment 1.

Procedure & Coding The procedure and coding were the same as in Experiment 1, except for the lack of training trials and additional manipulation check questions at the end. Instead of the training trials, children had an example matching trial. They saw a picture of a cat in the standard card, along with two choice cards involving a mouse or a dog. Children were asked to indicate which choice card went with the standard card. After the children gave their choices by raising their hands, the experimenter proceeded to the test trials. At the end of the experiment, children's knowledge of the name of the shapes used in the RMTS was tested expressively and receptively (with two choice options). Then, the answers to the RMTS trials and spontaneous use of object property words were coded as in Experiment 1.

Results & Discussion

We first investigated children's performance level in the RMTS by calculating the proportion of correct answers for sameness, difference, and all trials. Children's performance did not change based on the order of trials ($t(39) < -.399$, *ps* > .692). They also knew the shapes in familiar trials better than the ones in unfamiliar trials both expressively ($t(40) = 16.36$, $p < .001$) and receptively ($t(40) = 6.94$, $p < .001$).

Children performed above the chance level overall ($t(40) = 5.32$, $p < .001$, $M = .695$, $SD = .235$) and in both familiar ($t(40) = 4.64$, $p < .001$, $M = .683$, $SD = .252$) and unfamiliar conditions ($t(40) = 5.00$, $p < .001$, $M = .707$, $SD = .266$). The difference in children's performance in familiar and unfamiliar trials was not significant, even when controlling for age ($F(1, 39) = 1.017$, $p = .320$).

When investigated for different age groups, 4-year-olds perform above the chance level overall ($t(20) = 2.62$, $p = .016$, $M = .623$, $SD = .215$) and in unfamiliar condition ($t(20) = 2.68$, $p = .014$, $M = .659$, $SD = .271$), but not in familiar condition ($t(20) = 1.76$, $p = .094$, $M = .587$, $SD = .227$). However, the performances in familiar and unfamiliar conditions did not differ significantly ($t(20) = -1.28$, $p = .215$). On the other hand, 5-year-olds performed significantly above the chance level overall ($t(19) = 5.14$, $p < .001$, $M = .771$, $SD = .236$), in familiar ($t(19) = 5.23$, $p < .001$, $M = .783$, $SD = .242$) and unfamiliar conditions ($t(19) = 4.51$, $p < .001$, $M = .758$, $SD = .256$). To test whether age groups performed differently, a 2 (Age: 4-year-olds, 5-year-olds) x 2 (Stimuli Familiarity: Familiar, Unfamiliar) ANOVA was run, which revealed only a significant effect of age such that 5-year-olds performed better than 4-year-olds, $F(1,39) = 4.41$, $p = .042$. The effect of trial type and its interaction with age was nonsignificant (*ps* > .162).

To test whether children's performance changed due to the training, we compared performance in the sameness trials in Experiment 1 with 4-year-olds' overall performance in Experiment 2. The effect of the training was not significant ($t(44) = 1.19$, $p = .239$).

Then, we examined children's use of object property labels. On average, children used object property labels in 1.48 of 12 trials. Out of the 492 trials from 41 participants, object property words were used in 61 trials (12.40% of all trials) by 14 participants (34.15% of the participants). Thirty-three of the trials where objects property words were used had familiar shapes as stimuli, whereas the remaining 28 trials had unfamiliar shapes. Overall performance in the RMTS of children who used object property words ($M = .589$, $SD = .210$) was significantly lower than the ones who did not ($M = .750$, $SD = .231$, $t(39) = 2.17$, $p = .036$).

Next, we investigated whether children's performances related to their use of object property words in the trials, using the same analysis strategy as in Experiment 1. The *glmer* model (RelationalMatch ~ ObjectPropertyUse * Age +StimuliFamiliarity + (1| Participant) + (1|Trial)) revealed significant effects of Object Property Word Use ($B = -.860$, $SE = .427$, $p = .044$) and Age ($B = .519$, $SE = .232$, $p = .025$), but not their interaction ($B = -.527$, $SE = .476$, $p = .269$). The probability of choosing a relational match decreased for the trials where children produced object property words and for younger children. No other effects and interactions were significant. The effect of age and object property word use on the probability of choosing a relational match is presented in Figure 3.

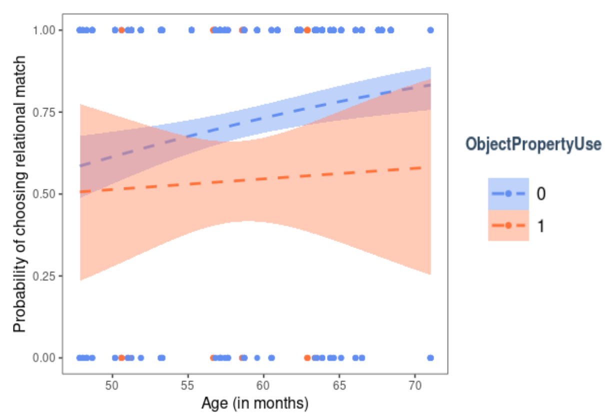


Figure 3: Probability of choosing a relational match as a function of Age in Month and Object Property Word Use in Experiment 2.

These results suggested that 4- and 5-year-olds' performances were above chance (as in Christie & Gentner, 2014), regardless of the stimuli type (i.e., familiar vs.

unfamiliar). Previous studies found lower performance levels with complex and unfamiliar stimuli (e.g., Carvalho et al., 2018; Hochmann et al., 2017). However, Experiment 2 showed that the decreased performance levels were not due to stimuli familiarity. Furthermore, the comparison between the performance in sameness trials in Experiment 1 and Experiment 2 revealed that the use of training at the beginning of the task did not change children's performance throughout the test trials.

Last, different from Experiment 1, we found a significant effect of object property word use, which revealed the detrimental effect of object focus on relational reasoning for the entire age group, not just the younger ones. Considering the children's above-chance performance levels, their use of object property words was directly related to the trials where they did not choose a relational match. Thus, although they generally focused on relations, using such words might reflect their focus on objects in specific trials where they performed worse.

General Discussion

In this study, we investigated whether task-related differences and children's spontaneous use of object property labels were associated with children's relational reasoning performance in a widely used relational match-to-sample task. In Experiment 1, we found that children performed better than chance level, but only in the trials testing sameness. Additionally, their object property word use in the test trials was negatively associated with only younger participants' relational reasoning performance. In Experiment 2, we found that despite receiving any training, children performed above the chance level when tested on the sameness relation. Furthermore, children's use of object property words was negatively associated with their relational reasoning for the entire sample.

Previous work on children's relational reasoning suggested a performance increase around four years of age when children started to focus more on objects (Christie et al., 2020). Yet, task-related differences when testing 4-year-olds led to inconsistent results. For example, studies that used complex stimuli indicated the failure of 4-year-olds (Carvalho et al., 2018; Hochmann et al., 2017); however, 4-year-olds performed better when simple geometric shapes were used in RMTS (Christie & Gentner, 2014). Yet, these studies were not directly comparable due to the differences in the experimental procedures. With Experiment 1, we reconciled the procedural differences, which revealed an enhanced performance in sameness trials but not in difference trials. This could be because of the difficulty of representing difference compared to sameness (Hochmann, 2021). Due to the difficulty of representing difference, changes in stimuli characteristics were not reflected in children's performance, whereas the ease of representing sameness reveals itself when interacting with basic shapes. This explanation could support the graded representation of relations (Carstensen & Frank, 2021) because object properties differentially influenced children's relation representations.

Although Experiment 1 provided insights regarding the role of stimuli complexity, it did not determine whether the performance differences were specifically due to stimuli complexity. Previous studies used complex stimuli that also differed from geometric shapes regarding their familiarity (Carvalho et al., 2018; Hochmann et al., 2017). To address this possibility, we conducted Experiment 2, which revealed that children could succeed in the trials with unfamiliar and familiar shapes. Thus, performance was not affected by stimuli familiarity, pinpointing the specific role of stimuli complexity. As preschoolers' familiarity to objects did not relate to their performance, it can be concluded that the use of the same shapes across different trials in RMTS did not affect their performance.

Experiment 2 also allowed us to examine whether the training procedure helped children to succeed. In Experiment 2, children performed above the chance level even without training. This might be due to the training procedures that limit the use of relational language. Getting feedback for their responses might not help children understand that they need to respond based on relations (Christie & Gentner, 2014). If children focus on objects, the corrective feedback might only change the object property based on which they respond. Thus, attempting to improve performance by providing corrective feedback is not enough to override object focus.

Although task-related differences can provide evidence for the role of object focus, this type of evidence does not reveal individual differences in object focus. Previous studies that measure children's looking behavior during relational reasoning tasks revealed inconsistent results regarding object focus. For example, looking patterns to the distractor object predicted children's performances only in some experiments (Guarino et al., 2021, 2022).

Therefore, in this study, we measured children's object focus through their spontaneous use of object property labels (e.g., color, shape) during the relational matching task. In two experiments, we found that children's use of object property words decreased their performance. Although not asked, children used these words potentially due to their increased attention to these objects during the RMTS. In the RMTS, object properties are irrelevant to the performance in the task. Using task-irrelevant names hindered children's action planning and attention (Mulvihill et al., 2021), possibly due to the importance of verbal labels in representing task rules (Zelazo & Frye, 1997). Thus, using words that are relevant to object properties in a trial might distract children's attention to the relevant rule (e.g., relations) and lead them to reason based on objects. However, this methodology led us to miss participants who were not talkative during the task but had an object focus. Thus, future research is needed to capture these participants as well.

In conclusion, the present study provided further evidence regarding the role of object focus on relational reasoning. Our findings indicated that basic shapes, regardless of their familiarity for children, enhanced children's relational reasoning, yet their spontaneous use of shape or color words in the task dampened their reasoning based on relations.

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