The Effect of Relational Reasoning on Young Children's Self-Resemblance Preference

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Abstract

Initial attraction is often based on self-other similarity along some relevant dimension. Other work reveals that children come to base their judgments of peers on physical similarities specifically. As children mature through the preschool years they come to demonstrate spontaneous sensitivity to self-resemblance in the absence of explicit mentioning of similarity or difference.

Previous research has found that young children's preferences for self-resembling others are driven by explicit similarity messages provided by an adult. Children generalize pedagogical messages like this. It is not until 6 years of age that children spontaneously compute self-other similarity in the absence of explicit similarity messages. One explanation for our prior results is that preschool-age children are on the lookout for pedagogical messages specifically about their social environment. Yet another explanation holds that the mere flagging of the concepts *same* and *different* is sufficient to engender preferences for similar others. This explanation implies that when the concepts *same* and *different* are evoked, preschool-age children will notice and value self-other similarity.

A key prerequisite for analogical reasoning, or the process of relating two distinct entities by virtue of their commonalities, is the ability to understand abstract relationships. One task often used to test this ability is known as the Relational Match-to-Sample (RMTS) task.

Here, a potential application of analogical reasoning to social-cognitive development is investigated by assessing whether experience with a RMTS task implicitly directs young children's attention to similarities in the social domain. Specifically, in Study 1, whether a RMTS task will enable children to recognize physical trait similarities between themselves and others was assessed. Here 3- and 4-year-olds were focused on, as prior work shows that although

3-year-olds attend to similarity cues in the form of explicit messages, only by age 4 do children generalize these cues.

In Study 1, it was found that neither children 3 years of age nor 4 years of age generalized similarity information from an abstract context to the social domain when primed with a RMTS task. Therefore, in Study 2, whether an explicitly pedagogical explanation of concepts of *same* and *different* through the RMTS task would affect young children's self-resemblance preference was tested. Once again, it was found that, even when emphasizing the pedagogical component, the abstract information did not penetrate the social domain. These studies suggest that domain general processes do not account for children's social preferences, and instead, messages need to be based on specifically social information. Implications on effective interventions to mitigate biases are discussed.

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The Effect of Relational Reasoning on Young Children's Self-Resemblance Preference

As the old proverb says, "Birds of a feather flock together," and this could not be truer than in humans. This adage describes the social phenomenon known as homophily, wherein like individuals tend to seek out and prefer one another. This phenomenon of homophily can be seen across demographic characteristics, like age (Bott, 1929), sex (Smith-Lovin & McPherson, 1993), race and ethnicity (Kalmijn, 1998), and educational attainment (Marsden, 1987), as well as psychological characteristics, like intelligence (Almack, 1922), attitude (Huston & Levinger, 1978), and aspirations (Richardson, 1940). Homophily effects are even present in children; by grade three, boys and girls often separate along gender lines, and these preferences remain stable over time (Martin & Fabes, 2001; Mehta & Strough, 2009; Shrum, Cheek, & MacD, 1988). Other socially salient distinctions, such as racial categories, give rise to homophily as well. These effects are present as early as middle school, when cross-race dyads make up only ten percent of expected friendships – assuming the peer group consists of racial proportions that represent the general population (McPherson, Smith-Lovin, & Cook, 2001). This potentially emerges because children infer that other individuals prefer same-race to cross-race peers (Roberts, Williams, & Gelman, 2017; Shutts, Roben, & Spelke, 2013). Specifically, White children say that friendships will and should occur between same-race and same-gender peers (Eason, 2018). Moreover, de facto race segregation is present in adulthood; thirty-four percent of workplace establishments are all White and only eight percent of adults have a network with two or more people of another race (McPherson et al., 2001). These data together suggest that de facto racial segregation emerges from a combination of self-selection and structural environmental factors, while there is also a bidirectional interplay between the two factors.

Many examples of demographic homophily rely on our ability to recognize physical similarity between ourselves and others. Gender-based homophily, for instance, requires a mechanism by which we can identity whom is in our group, and we use bodily characteristics, such as facial structure and vocal pitch, to determine others' gender (Brown & Perrett, 1993; Quinn, Yahr, Kuhn, Slater, & Pascalis, 2002; Younger & Fearing, 1999). Moreover, children and adults use other physical features, like skin tone, to determine a person's racial identity (Bar-Haim, Ziv, Lamy, & Hodes, 2006; Dunham, Stepanova, Dotsch, & Todorov, 2015; Strom, Zebrowitz, Zhang, Bronstad, & Lee, 2012). Finally, children rely on non-biological aspects of appearance, such as garb and personal effects, to signify social class. Five-year-old children, for example, evaluate others based on their material possessions (Brey & Shutts, 2015; Shutts, Brey, Dornbusch, Slywotzky, & Olson, 2016), and the presence of visual markers, like T-shirt color, indicate the presence of novel social groupings to young children (Jordan, Kalish, Brey, & Shutts, under review; Rhodes & Chalik, 2013; Dunham, Baron, & Carey, 2011).

Studying how children use physical appearance to guide their social preferences is of theoretical import. Specifically, considering what is motivating them to do so reveals how they learn social information in general. Further, evaluating the circumstances under which children display such preferences can provide insight into whether messages from the environment influence young children's social evaluations (Patterson & Bigler, 2006; Brechwald & Prinstein, 2011). This topic is also of practical importance, as these effects persist into adulthood, where homophily can negatively impact success in the workplace, particularly for underrepresented populations. For example, women's limited access to professional interaction networks is often cited as an effect of gender-based homophily, which manifests via an aggregation of *choice homophily* - when women strategically choose to affiliate with one another - and *induced*

homophily - when male exclusion leaves them with limited opportunities to interact across gender lines (Ibarra, 1992; Kleinbaum, Stuart, & Tushman, 2011).

Similarity preferences also emerge in incredibly subtle, and seemingly arbitrary ways. For example, similarity of physical appearance can have an effect on one's preference for new acquaintances and potential romantic partners. In one study involving a sequential trust game, participants trusted a player significantly more when the player's face was subtly morphed with the participant's own as opposed to a stranger's face (DeBruine, 2002). In a similar study, even children as young as 5 years of age showed a preference for a self-morphed image (Richter, Tiddeman & Haun, 2016). Another study revealed that participants were also more likely to rate a same-sex self-morph as more attractive as compared to an other-sex self-morph, which suggests self-resemblance may serve as an important cue to kinship, whereas stronger preference for an other-sex self-morph would suggest the preference is motivated by mating cues (DeBruine, 2004). Because young children show preference for those with similar appearance, it prompts the question of how these preferences come to be and what factors facilitate their emergence.

Theories of Homophily

Homophily is brought about by separate but interrelated factors known as *selection effects* and *socialization effects*. Selection effects account for our tendency to affiliate with those who we deem similar to ourselves with respect to their behavioral proclivities, as well as demographic and psychological characteristics, whereas socialization effects account for the phenomenon whereby friends become more similar to one another in terms of their attitudes and behaviors over time (Brechwald & Prinstein, 2011). Developmental studies often attempt to create a sterile environment where selection effects can be isolated.

Innateness

While it is unclear exactly what the origin of social homophily is, we know that it emerges astoundingly early. Children as young as 11.5 months show a preference for others who have similar preferences for food, toys, or mittens (Mahajan & Wynn, 2012). Moreover, others' expressions of shared evaluations indicate social closeness to preverbal infants (Liberman, Kinzler, & Woodward, 2014). By 3 years of age, assignment to minimal group increases children's evaluations of fellow group members (Dunham & Emory, 2014).

There are several theories that seek to explain the emergence of similarity preferences. One such theory is predicated on the notion that we inherently value similarity- and familiarity-to-self, which implies that children will seek out those they have something in common with regardless of the social context or environmental influence. However, this theory lacks explanatory power, as many studies show that similarity preference is highly context dependent. Recall, for example, that in Debruine's facial attractiveness study, participants rated self-morphs as most attractive in same-sex as opposed to other-sex faces, demonstrating that the context of relative gender impacted the preference (DeBruine, 2004). Moreover, when experiments primed biracial children's racial identities, they observed flexibility in racial identification, indicating that shared identity preferences are contextually based (Gaither, Chen, Corriveau, Harris, Ambady & Sommers, 2014). It has also been shown that similarity preference is more pronounced along some dimensions than others. For instance, a study by Fawcett and Markson revealed that hair color was a more salient dimension of similarity than T-shirt color (Fawcett & Markson, 2009). Additionally, facial morphing experiments commonly rule out a complete reliance on just familiarity by controlling for duration of participants' exposure to the more familiar test face (DeBruine 2002; Richter et al., 2016). Finally, children do not uniformly prefer

self-resembling others: In the height of racial segregation during the civil rights movement, dark-skinned children showed a strong rejection of similar-hued children, often citing "ugliness" as a reason (Clark & Clark, 1950). Thus, social context plays an important role in similarity preference and a robust theoretical account of the phenomenon must take this into consideration.

Social and Cultural Factors

Because domain general explanations fail to account for social and cultural factors impacting similarity preferences, I turn my attention to more socially motivated explanations. Perhaps our tendency to prefer those who are similar to us results from our having shared experiences – be they intentional or incidental. People are generally grouped based on characteristics, such as geography, family, school, work, or voluntary organizations, which can each result in homophily effects. In a similar vein, the sociological approach of constructuralism posits that people who share knowledge are more likely to interact. Thus, demographic similarities, which are frequently tied to physical attributes, may indicate shared knowledge, worldviews, or common interests that people might seek out for ease of interaction (Ibarra, 1992; McPherson et al., 2001).

A final, yet important, possibility for the role of homophily in our social environment is that it suggests group membership. When human social groups were smaller, familiarity was all one needed to evaluate someone's group membership, but as groups began to grow, this became ineffective. Instead, humans relied on similarity, as individuals who grew up within the same community are more likely to be similar on various phenotypic dimensions. Such a preference for physical shared appearance would then be favored by natural selection, as interacting with in-group members would increase cooperative interaction. This would increase cultural transmission and allow locally adaptive traits to converge to an optimum (Haun & Over, 2015).

One study found that while participants are more likely to trust an individual depicted in a self-morph photo to treat them fairly, they are no more likely to reward the self-morph than a stranger-morph. This further supports the idea that we endorse appearance-based homophily because we believe that self-resemblance indicates that one will behave favorably towards us (DeBruine, 2002). Lastly, one study found that daughters' attraction to partners who share their fathers' eye color is moderated by the quality of the father-daughter relationship (Bressen & Damian, 2018). This suggests that the physical similarity indicates fit as a generic sex partner, and a closer father-daughter relationship indicates stronger sexual imprinting and, thus, a stronger model for sexual companions, once again, suggesting the connection between similarity and predictability.

However, children's preferences are attuned to specific details, such as whether the attribute on which they are similar was assigned by a third party or chosen by the individual. For example, children attend to a preference exhibited by a puppet, possibly because it would have an impact on the play interaction, but do not attend to an arbitrary sticker assignment because it gives no information about the puppet's behavior (Fawcett & Markson, 2010). The result also holds with 11.5-month-olds, when the assigned and choice scenarios are performed with identical stimuli, namely, colorful mittens (Mahajan & Wynn, 2012). This indicates that children are sensitive to more than mere perceptual similarity – they compute whose choices align with their own, although it is unclear why some aspects of perceptual similarity become the basis of homophily effects, and in some cases group distinction, while others do not.

Another important detail is how salient a certain feature is. This is especially important given that salience changes across contexts and homophily effects tend to be context dependent. For example, shape is more salient than color when comparing a red triangle and a red square,

but color is more salient than shape when comparing a red triangle and a blue triangle. This is because in the latter example color is diagnostic of the distinction between the two entities. Children as young as 3 years old are able to extract diagnosticity of a feature within a set, and they attune to that feature when categorizing objects (Sloutsky, 2003). These same skills could be applied to the social domain, where children might focus in on certain physical features and detect more abstract correlations that could assist in categorizing people in social groups.

Adults' Social Messages

Finally, children may take into account adult endorsement of which similarities are important enough to base their social decisions on. In a study in which preschool children were assigned to a certain color group in a classroom setting for three weeks, children developed biased attitudes towards the novel social in-group without any teacher input. Furthermore, if the teachers frequently used the color labels to refer to children and organize the classroom, there was some evidence that children displayed higher levels of in-group bias, though, the strength of this result is unclear and inconsistent across measures (Patterson & Bigler, 2006). Children are social learners, making them likely to over-imitate, even when the actions are disadvantageous or superfluous. Even after a single demonstration of an action by an adult, they believe that it is the normative way to complete the action and reinforce it to other children (Haun & Over, 2015). Therefore, they might treat opinions of adults in the same manner, using them as clues to inform their own preferences.

It is important to consider how an accounting of adults' social messages may cause children to value similarity along a behaviorally-irrelevant and uncontrollable dimension like hair or eye color. In recent work by Jordan and Wynn (2020), when children were told the trait labels of a set of dolls with matching or differing traits from their own, without any explicit

mention of similarity or difference, they failed to spontaneously prefer the similar doll until age 6. This suggests that automatically being attuned to trait similarity and making decisions on that basis is not innate but emerges at approximately the age when children enter school. However, as previously mentioned studies have shown, children as young as 3 prefer the similar doll when similarity and difference are explicitly pointed out by an experimenter (Jordan & Wynn, 2020). This small addition of the words "*just like you!*" or "*different than you!*" caused 3-year-old children to prefer self-resemblance as children age 6 years do.

There are many components of that kind of message that could cause a homophily effect. A straightforward answer could be that an adult highlighting similarity between hair and eye colors alerts the child to the importance of those specific traits, and therefore, they come to see those traits as important to base their social preference judgments on. This explanation implies that an adult would need to explicitly highlight the specific traits to create the effect. However, the authors argue that this is not the case. In a follow-up condition, an experimenter first allowed the child to choose a scarf and a bracelet. The experimenter then explicitly highlighted the respective similarity or difference between two dolls and the child, one of which had the same color scarf and bracelet and one of which had a different color scarf and bracelet. Afterwards, the experimenter showed the child a new set of dolls, one with hair and eyes similar to the child and one with hair and eyes different from the child. Even though the experimenter did not explicitly point out the similarity/difference between the hair and eye traits to them, 4-year-old children showed a preference for the similar doll (Jordan & Wynn, 2020). Thus, an explicit social similarity message can be generalized to another situation without one. Children generalized from one set of similarities to another. This suggests that when adults point out a similarity

between a child and another person, as they age, the child comes to expect that other similarities between the self and another are important.

Abstract Relational Reasoning

While research to date suggests children are able to translate messages from one social domain to another, it is possible that children are able to extract these social signals from still more abstract messages. Might children generalize more abstract messages about similarity, perhaps from outside the social domain, to a social situation? Under this premise, even an abstract message offered by an adult about similarity/difference would engender the child's preferences for a self-resembling doll. For instance, an adult delivering a message about similarity between shapes might encourage the child to consider similarity both between the shapes and between people. Or perhaps children require even less. It is possible that for children, similarity is such a salient construct that they may not require explicit messages to form preferences on a social basis. Simply having children work and engage with the concept *same,* abstractly, may be enough to impact their similarity preferences along a social dimension. In the present studies, I test this possibility.

Much work has been done in the field of relational ability or analogical reasoning, which involves considering relational features, the association between two objects, as opposed to object attributes, characteristics of the objects themselves. This kind of reasoning is thought to be unique to humans and is important in learning abstract concepts and conceptualizing the world (Ferry, Hespos & Gentner, 2015). As opposed to a literal similarity, where both object-attributes and inter-object relationships align, to reason by analogy, one must ignore the object-attributes to instead focus on the inter-object relationship. For example, if one draws an analogy between the earth orbiting the sun and an electron orbiting the nucleus to help you learn about an atom, they

are asking you to ignore the object-attributes, i.e. that the sun is a giant, gaseous ball and the earth is a rock covered with water and flora, and instead, simply focus on the relationship between them. To do that, one creates an abstraction, in which the object-attributes are nonconcrete, such as "A rotates around B." Once that mental abstraction has been created, it can be applied to the electron and the nucleus to facilitate a better understanding of their relationship, without having to start from scratch (Gentner, 1983). When you are able to align two distinct entities and use aspects of one to inform knowledge of the other, it allows you to quickly pick up new concepts so long as you are able compare and establish parallel connectivity between the objects. This is done by broadening the scope of the concept of two objects, to make them less specific, in order to be able to abstract a general rule about the relationship between them (Gentner & Hoyos, 2017).

While this appears to be a complex stream of thought, several studies have shown that even children are able to think relationally. A common paradigm used to test this ability in both apes and humans is known as the Relational Match-to-Sample (RMTS) task. In this task, one is given a standard AA, and is then asked to choose between XX and YZ. Adults understand implicitly that AA matches XX because they both share the relational feature of *sameness*. Chimps are also able to pass this task, but only after being given hundreds of training trials. By the age of 4, children are also able to succeed at this task with no training, however, different modifications allow children to pass the task at even younger ages. When the methodology of the task is shifted to a causal scenario, where children were shown examples of similar pairs of objects that make a "blicket-detector" make music, children as young as 21–24 months chose the correct novel pair to activate the machine (Walker & Gopnik, 2014). When this concept is tested

via a looking-time paradigm, even 7–9-month-old infants abstract and understand the *same-different* relation if given multiple habituation examples (Ferry et al., 2015).

There is clearly a rich scholarly history showing that children understand complex analogical reasoning. In order to succeed at these tasks, children must comprehend and conceptualize relationships such as *similar* and *different*. If children are able to generalize ideas about similarity from an abstract comparison case to a specific social situation, then priming kids with the RMTS task should prompt them to apply the concept of *similarity* to situations in which they are asked to make social judgements. This may, in turn, affect children's choices when they are asked whether they would prefer to play with a self-resembling or non-self-resembling individual along the dimension of hair and eye colors.

Here, I examine whether experimentally combining these two bodies of work (on abstract reasoning and social preferences) will provide insight into homophily effects in children. If I find evidence that children can generalize similarity information from an abstract to a social setting, then homophily may be less domain-specific and context dependent than prior literature suggests. If I do not find evidence, it may indicate homophily effects are driven only by social messages specifically presented in the social domain.

Study 1

Study 1 examines whether children are able to generalize abstract similarity messages to the social domain. Prior work has shown a developmental change in ability to generalize between ages 3 and 4 years, such that 4-year-olds reserve strong generalizations for a property that is pedagogically demonstrated, whereas 3-year-olds do not distinguish between intentionally and pedagogically produced information (Butler & Markman, 2012; Jordan & Wynn, 2020). Thus, Study 1 focuses on 3- and 4-year-old children. In this study, children received a Relational

Match-to-Sample (RMTS) task followed by the experimenter labeling the child's hair and eye color. Then, the child receives a presentation of the hair and eye color of two dolls, one similar to the child and one different from the child, without any verbal indication of similarity from the experimenter. At test, children responded to a standard choice measure, which assessed their preference for one of two dolls. Based on previous literature, I hypothesized that 4-year-old children would be sensitive to the relational reasoning manipulation and, thus, choose the similar doll at rates above chance, but 3-year-olds performance would be more ambiguous. While 3-year-olds show mixed success in some cognitive tasks, they performed considerably different than 4-year-old in similar doll paradigms (Butler & Markman, 2012; Jordan & Wynn, 2020).

Method

Participants

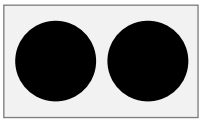
A total of 50 children completed all necessary parts of the procedure and were included in the data analysis. Twenty-two were healthy 3-year-old children (n = 10 males; M_{age} = 3.54 years, range = 3;0 to 3;11) and 28 were healthy 4-year-old children (n = 13 males; M_{age} = 4.43 years, range = 4;0 to 4;11), exposed to English at least 50% of the time (by parent report). In addition, 38 children were not included in the analysis because they: failed to complete the symbolic training in the 3-year-old age group (n = 6), incorrectly answered either catch trial (n = 26), incorrectly answered the comprehension question preceding the choice (n = 3), or failed to make an unambiguous choice (n = 3). Participants were recruited from a developmental psychology lab database, which includes children from the Connecticut region of the United States, as well as social media, flyers posted in the downtown New Haven area, and preschools located in greater New Haven area.

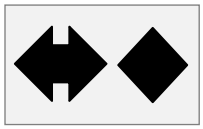
Materials & Design

Participants were presented with 8 triads of a RMTS task, composed of pairs of geometric, black and white shapes, to avoid preemptively evoking thoughts of color comparison. Each triad consisted of a standard composed of two identical shapes (e.g., two circles), a *relational match* composed of two identical shapes (e.g., two trapezoids), and a *non-relational match* composed of two different shapes (e.g., an arrow and a diamond) (Figure 1). Left and right placement of the relational and non-relational matches was counterbalanced. The 8 triads were given in sequential order, with the starting triad randomized for each participant. Abnormally difficult triads, where an excess percentage of children failed to pass, were eliminated and replaced during piloting. Participants also received two catch trials of the RMTS task at the end of the 8-trial triad sequence, wherein identical wording was used, but the relational match was scaffolded with a high object similarity match, to assure that children understood that the goal of the task was to choose the match rather than the alternative. For example, if the standard was a tree in the ground, the relational match would be another tree in the ground, and the non-relational alternative would be a pen next to an envelope. Children who did not pass both catch trials were excluded from the study. All RMTS triad images were depicted on small, laminated cards with a Velcro spot on the opposite side of the images. Children were given a foam board with Velcro and were able to move the cards on the board in order to make all choices unambiguous.

Figure 1

Example RMTS Stimuli





"Which one of these two (left/right) is most like this one (top)?"

Note. An example relational-match-to-sample trial. Children were asked to identify the relational match from the bottom two pictures, as compared to the standard, the top picture.

Based on research from Christie and Gentner (2014), while 4-year-olds choose the relational match at above-chance rates in the traditional task, 3-year-olds needed additional symbolic training to reach similar performance levels. "Training children with relational labels for *same* and *different* makes the identity relation more salient, allowing them to perceive the commonality between two instances of this relation" (Christie & Gentner, 2014). Because of this, prior to the RMTS triads, 3-year-old children received symbolic training in the form of 12 *same* picture cards (two identical geometric shapes) and 12 *different* picture cards (two different geometric shapes).

Participants also viewed two gender-matched dolls: one with hair and eyes that closely matched their own, and one with hair and eyes that noticeably differed from the child (Figure 2). The dolls were otherwise identical in all respects. Prior to testing, parents (or experimenter if testing took place at a preschool) completed a form where they selected the hair and eye color

that most closely matched the child's features on a four-shade scale, and they assigned labels for both colors (Figure 3). The similar doll's hair and eye colors match that of the parent or experimenter's selection, and the different doll's traits were two shades removed from the similar doll's traits.

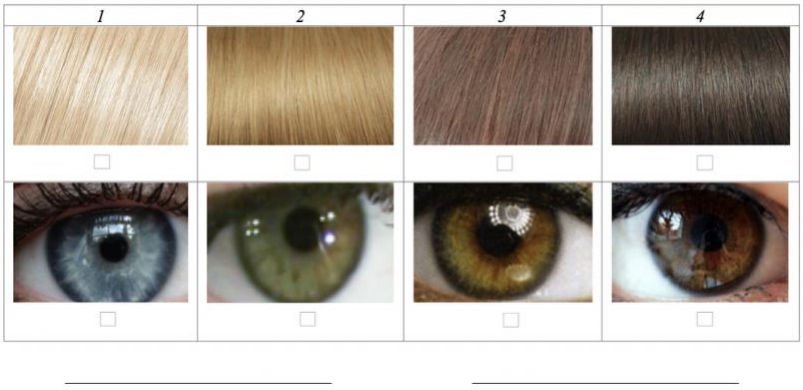
Figure 2

Example Doll Stimuli

Note. An example doll stimuli pair with hair and eye colors of 1 "blonde" and 4 "brown" respectively (left); and 3 "light brown" and 2 "green" respectively (right).

Figure 3

Hair and Eye Color Questionnaire



Note. Parents indicated which of 4 hair ("blond", "red", "light brown", and "dark brown") and eye ("blue", "green", "hazel", and "brown") colors most resembled their child's. The shades in each set were assigned a number with 1 being the lightest and 4 being the darkest. The color labels we assigned to each shade were not provided for the parent.

Procedure

Each child was tested individually, either in a quiet, testing room if run in the lab (n = 1), or in a separated area of a classroom if run in a preschool (n = 49), to minimize distractions. Parents who chose to be in the room wore opaque glasses to prevent them from potentially biasing their child. Parents were also told to refrain from speaking during the trials. Two experimenters tested each infant: a presenter who gave children the RMTS task and identified the child's hair and eye traits, and a presenter who identified the doll's traits, offered the final choice, and asked comprehension questions.

Board Training. Experimenter 1, henceforth E1, showed children a foam Velcro board on which they would stick the RMTS cards by saying, "See this board? You can stick things on it." They were then encouraged to practice placing and moving blank cards to different locations

with the prompt, “I’m going to stick this one here. Can you stick this one here?” This was to ensure children were not confused or distracted by the Velcro cards or apparatus.

Symbolic Training. For 3-year-olds only, E1 then introduced participants to a puppet monkey saying, “This is James. You can help James learn some words!” Children were then shown a *same* card with two identical shapes and asked, “Do you see these two objects? They are the same! Can you say ‘same’ so that James can learn the word?” The experimenter waited until the child repeated the word. Children who fail to vocalize at this part of the experiment did not continue on, so they would have the opportunity to return and finish later, as they had not yet seen any test stimuli. This was repeated with a *different* card which depicted two differing shapes. Children were then shown alternating *same* and *different* cards and asked, “Can you tell James if these are the same or different?” Children were given corrective feedback after each card, being told either, “That’s right!” or, “Actually, these are [the same/different], so for this card we say [same/different].” Children repeated this process until they correctly identified five cards in a row, or when they reached a total of 24 cards, including the two primary examples. This task was included to better support young children’s ability to spot a relational match between two pairs of shapes by allowing them to practice identifying relationships between a single pair. Children who did not complete the training were excluded from final analyses.

RMTS Task. E1 then placed the standard of the first RMTS triad at the top of the foam board, and then placed the two matches below the standard, at equidistant positions. She then asked, “Which of these two pictures is most like this one? Which one matches this one?” while pointing at the standard. The word *same* was avoided so as to differentiate between the object attribute similarity they are identifying in the symbolic training and the relational match they are identifying during the RMTS task. Once the child indicated one of the matches, they were asked

to move their choice to the center, right below the standard. By using a single location to represent the correct answer, children were unable to select multiple options and cause confusion. Children were given corrective feedback on the first triad, but none following. The two catch trials were presented in an identical manner following the 8 test triads.

Trait Introduction. E1 looked at the child and said, "Guess what color hair you have! It's [color]. Guess what color eyes you have! They're [color]. That's right, you have [color] hair and [color] eyes!" Color labels were based on the parents' provided labels, if testing took place in the lab, or the dictated standard labels (i.e., blonde, red, light brown, and dark brown, for hair; blue, green, hazel, and brown, for eyes) if testing took place in a preschool. This ensured that children were aware of their own hair and eye trait labels; thus, failure to observe a preference for one doll over the other could not be attributed to a failure of memory or trait recognition on the child's part. At this point, E1 exited the room and Experimenter 2, henceforth E2, entered. The decision to use a second experimenter discouraged the interpretation that the experimenter offering the choice wanted the child to select the doll with matching labels to the child.

Doll Introduction. E2 displayed two dolls – one with similar traits, and one with dissimilar traits – on a magnetic stand across from the child. One at a time, each doll bounced forward following E2's prompt, "See this kid? See his/her hair? It's [color]! See his/her eyes? They are [color]," pointing to the doll's hair and eyes, respectively. The experimenter then confirmed, as the doll, "Yes, I have [color] hair and [color] eyes!" pointing at its own hair and eyes. Critically, E2 never explicitly mentioned similarity or difference during the doll introduction. The position of the dolls and the order of presentation were counterbalanced for each age group.

Comprehension Questions. Afterwards, E2 asked the child to identify which doll had which set of trait labels, asking, "Can you tell me which one has [color] hair and [color] eyes?" E2 asked the question up to three times until the child provided a clear, visually-guided point towards a doll. Once the child provided an answer, the same question was asked about the other set of trait labels. This allowed for assessment of the child's attentiveness to, and retention of, the dolls' trait labels. Children who incorrectly answered the first of these questions were excluded from final analyses. The order of the questions was counterbalanced.

Test choice. E2 then re-centered the child's attention on both dolls, saying, "Do you see these kids? Which one would you like to play with?" E2 then slid both dolls across the table, towards the child. The experimenter waited up to 60 seconds and offered the choice up to three times until the child made a visually guided choice, wherein they made contact with one of the two dolls while looking at it. The choice served as the main dependent measure, and children who did not make a choice were excluded from final analyses.

Follow-Up Questions. After making their choice, children were asked why they selected the doll they did. E2 then asked two additional follow-up questions: "Which one has the same hair and eyes as you?" and "Which one has different hair and eyes than you?" These follow-up questions confirmed whether children could correctly identify similarity and difference between themselves and the dolls, though this information had not been made explicit to them prior. The order of these questions was counterbalanced. Finally, E2 asked participants to state their own hair and eye color to make sure they had retained the trait labels that E1 identified prior to the doll show.

Social Match. Finally, E2 introduced a third doll, which she placed between the similar and dissimilar dolls. Based on the trait color chart, this doll had one feature that fell equidistant

between the two dolls (e.g., red hair if the similar doll's hair was blond and the dissimilar doll's hair was light brown) and one feature that was noticeably more similar to one doll than the other (e.g., blue eyes if the similar doll's eyes were dark brown and the dissimilar doll's eyes were green). E2 asked children to notice the features of the three dolls, saying of each doll in turn, e.g., "Do you see this kid? Do you see her hair? Do you see her eyes?" Then E2 asked children to point to which of the two similar and dissimilar dolls "matched" the third doll on the feature that was noticeably more similar (e.g., "Which one of these two kids has eyes that are more like this one? Which one matches this one?"). This task assessed children's attention to similarity in the social domain as a third-party observer. The experimenter counterbalanced whether she asked about hair or eyes.

Results

All tests below were conducted based on a pre-registered analysis plan (https://aspredicted.org/blind2.php) unless otherwise specified. A secondary coder scored all test choice data with video footage (88%) and obtained 100% consistency with the primary coder's scores.

Test Choice

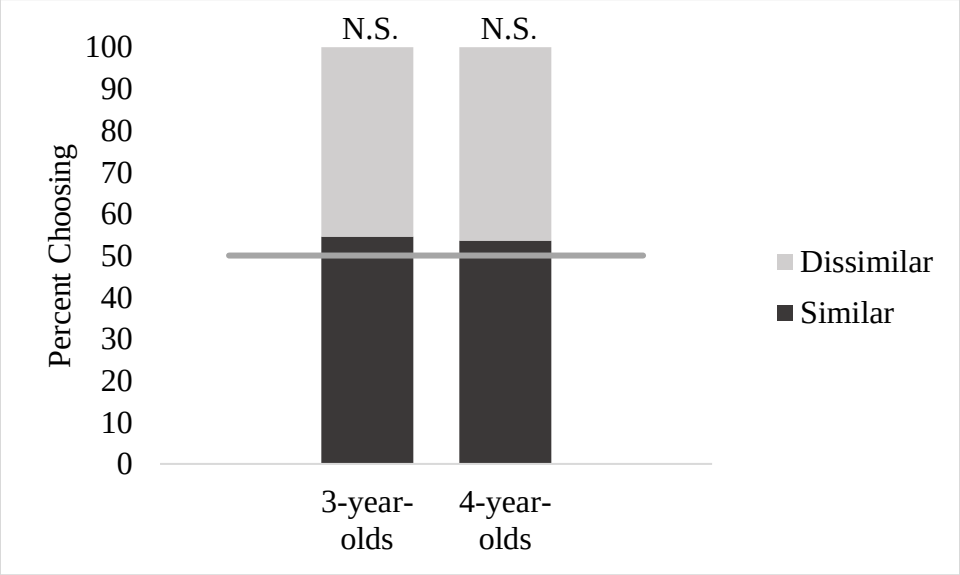
Per my pre-registration plan, I exclude data from participants who failed to answer both catch trials and the first comprehension question correctly to ensure only children who understood the goal of the RMTS task, and remembered the information from the doll introduction, were included in analyses.

Two-tailed binomial tests show that neither 3-year-old nor 4-year-old children selected the similar doll above chance: 12 of 22 3-year-olds selected the similar doll, $p = 0.42$ (1-sided), and 15 of 28 4-year-olds did so, $p = 0.43$ (1-sided). Children's choices did not differ significantly

across the two ages, χ_2 (1, N = 50) = 0.04, p = 0.85 (Figure 4). We also compared the performance of four-year-old children to that of children in a baseline condition that did not include the RMTS task. Their performance did not differ significantly from this baseline, χ_2 (1, N = 44) = 0, p = 1.00.

Figure 4

Study 1 Doll Choice



Note. The percentage of children choosing the Similar and Different dolls in Study 1. 3- and 4-year-old children selected the similar doll at chance (50%) levels, (p > .05).

These results failed to indicate that priming with a relational reasoning task influences preschoolers' preference for dolls that share their physical traits.

Given that children may have developed a societal preference for a light hair, light eyed doll (Asher & Allen, 1969; Rich & Cash, 1993), as an exploratory analysis, I separated the data by the child's features, looking at just kids with dark hair and dark eyes or just kids with light hair and light eyes. Children with mixed features (e.g., dark hair and light eyes) were excluded

from the analysis. Children with light features do not differ significantly in their choice behavior from children with dark features, χ_2 (1, N = 33) = 1.57, p = 0.21.

RMTS Performance

The remainder of analyses are exploratory. Three-year-olds on average correctly answered 57% of RMTS trials, not significantly different from chance, $t(21) = 1.77$, $p = 0.09$ (2-sided), whereas 4-year-olds correctly answered 60% which is significantly different from chance, $t(27) = 2.51$, $p = 0.02$ (2-sided), meaning we were only partially able to replicate the findings of Christie and Gentner (2013). However, it is important to note that children's relative low success on the task did not impact our results because children who performed well on the RMTS task (i.e., correctly identified at least 6 of the 8 relational matches) were no more likely to prefer the similar doll, χ_2 (1, N = 50) = 1.72, p = 0.19.

Follow-Up Questions

Similarity and Difference. Both 3-year-olds and 4-year-olds were correctly able to identify which doll was similar and different to them with 77% of 3-year-olds correctly answering the first question (only the answer to the first question was analyzed due to the pragmatic implications of asking similar questions back to back), $p < 0.01$ (1-sided), and 75% of 4-year-olds correctly identifying the similar or different doll, $p < 0.01$ (1-sided).

Trait Labeling. Only 4-year-olds verbalized their own trait labels, with 76%, of those who answered providing the correct label, $p < 0.01$ (1-sided). However, 3-year-olds answered at chance, with only 50% of those who answered using the correct label, $p = 0.59$ (1-sided).

Social Match.

Both ages answered the social match questions well above chance, with 95% of 3-year-olds correctly identifying the most similar doll, $p < 0.001$ (1-sided), and 81% of 4-year-olds, $p < 0.01$ (1-sided).

Study 2

Although children in Study 1 accurately identified which doll was similar or different and were also able to identify similarity among third parties, they were no more likely to prefer the similar doll. Here, I turn my attention to two alternative explanations of why children in a previous study were able to generalize between social conditions, from similarity in scarves and bracelets to similarity in hair and eye color, but not from an abstract case to a social domain (Study 1). One possibility is that the relationship between the geometric shapes and the dolls is too distant for children to generalize similarity messages. Another possibility is that the paradigm did not incorporate proper pedagogical cueing to the importance of similarity. The RMTS task was used to evoke the concept of similarity via abstract relations without explicitly discussing self-resemblance with participants. However, if a key factor in children's development of self-resemblance preference is their internalization of *pedagogical* similarity messages from an adult source, Study 1's procedure may have failed to fully probe for the effect. While Study 1's procedure tapped into abstract similarity judgements by prompting participants to find similarity between geometrical shapes, it lacked a pedagogical component where an adult was delivering a message about abstract similarity to the participant.

To address this issue, Study 2's procedure features the addition of a pedagogical training phase, in which an experimenter explicitly points out the relation, *similar*. Because appreciating this relation is required for success on the RMTS task, and prior work indicates that children's

self-resemblance preferences are impacted by explicit pedagogical messages (Jordan & Wynn, 2020), children received 2 trials in which an experimenter explained the RMTS task before offering the doll choice. I elected to test 4-year-olds only, as prior work shows that they are best able to generalize pedagogical cues (Butler & Markman, 2012), and they proved they could label their own traits in Study 1. Thus, I predicted that participants would show a preference for the self-resembling doll after receiving the pedagogical RMTS training. If children form a similarity preference after receiving pedagogical messages, it would indicate that they extrapolated from a set of abstract examples to the social domain.

Method

Participants

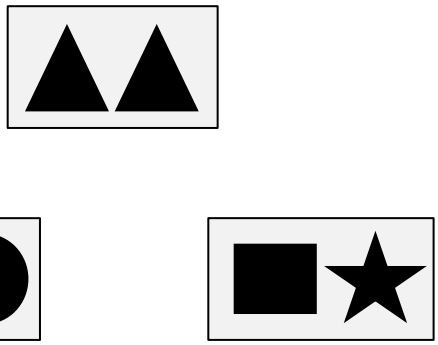
A total of 25 healthy 4-year-old children (n = 15 males; *M* age = 4.5 years, range = 4;0 to 4;11), exposed to English at least 50% of the time (by parent reports), completed all necessary parts of the procedure and were included in the data analysis. In addition, 4 children were not included in the analysis because they: incorrectly answered either catch trial (*n* = 3) or did not meet language requirements (*n* = 1). Children were recruited via the same means as Study 1.

Materials & Design

Materials were identical to Study 1, with the addition of two new RMTS triads, constructed in a similar manner, using namable shapes ideal for descriptive teaching (Figure 5). Two *same* and *different* cards from the symbolic training were also used in a follow-up choice, to ascertain whether the pedagogical training influenced children's similarity preference in a purely abstract context.

Figure 5

Example RMTS Pedagogical Training



"These are the same because they're both triangles. This one (triangles) matches this one (circles) because they're both the same."

Note. An example pedagogical relational-match-to-sample training. An experimenter explained both the relation portrayed in each picture, as well as the relation between picture cards, to the child.

Procedure

Children were tested in conditions identical to Study 1. In Study 2, Experimenter 1 administered the pedagogical RMTS training trials then labeled the child's traits. Experimenter 2 presented the dolls' traits, administered the test choice and follow-up questions, and then presented the RMTS task. I elected to move the RMTS task to the end of the experiment because the primary variable of interest is whether the pedagogical teaching of abstract similarity impacts the test choice, rather than the RMTS task itself. However, I decided to retain these trials in the procedure, as children's performance might illustrate the efficacy of the pedagogical training. Thus, I predicted that children's RMTS performance would improve from Study 1. Finally, children did not complete the social match procedure, as I observed near-ceiling performance in

Study 1 and did not anticipate movement on this variable; instead children completed an abstract similarity preference task.

Board Training. Children were introduced to the foam board by E1 in an identical fashion to Study 1.

Pedagogical RMTS Training. Identically to Study 1, E1 presented the standard along with the relational match and non-relational alternative. E1 then pointed to and identified each shape in the standard, saying, e.g., "Do you see this shape? It's a triangle! Do you see this shape? It's also a triangle! These are the same because they are both triangles!" E1 then gave an identical explanation of the shapes in the relational match. Afterward, she pointed to both the standard and the relational match saying, "This one matches this one because they are both the same!" E1 then went on to identify the shapes of the non-relational alternative (e.g., "These are different because a rectangle and a star are different!"). Next, she pointed to both the standard and the non-relational alternative saying, "This one does not match this one because these are different and these are the same!" The experimenter repeated this sequence with a second set of stimuli. E1 alternated the side position of the relational match between trials.

Trait Introduction. E1 labeled the child's traits identically to Study 1.

Doll Introduction and Comprehension Questions. E2 conducted the doll show and comprehension questions, which did not differ from those of Study 1.

Test Choice and Follow-Up Questions. The test choice procedure and follow-up questions were identical to those of Study 1.

RMTS Task. E2 administered eight trials of the RMTS task, followed by the two high similarity catch trials, as in Study 1.

Abstract Similarity Preference. The final addition to Study 2 will be another forced choice paradigm. E2 will show the child a *same* and *different* symbolic training card in each hand saying, "Do you see these?" then sliding the cards across the table, towards the child saying, "Which one do you like?" The experimenter will wait up to 60 seconds for the child to make a clear, visually guided choice, and offer the choice up to three times. This will act as a control to see if an abstract, pedagogical paradigm might encourage children to prefer similarity in all contexts, even as it does not relate to them personally, or other social creatures. We predict, even if the similarity measure is delivered in an abstract context, children will still only prefer similarity in a social context because children's preference for similarity is exclusive to the social domain, even if it can arise from prompting in an abstract domain.

Results

All tests below were conducted based on a pre-registered analysis plan (https://aspredicted.org/blind2.php) unless otherwise specified. A secondary coder scored all test choice data with available video (92%) and obtained 100% consistency with the primary coder's scores.

Test Choice.

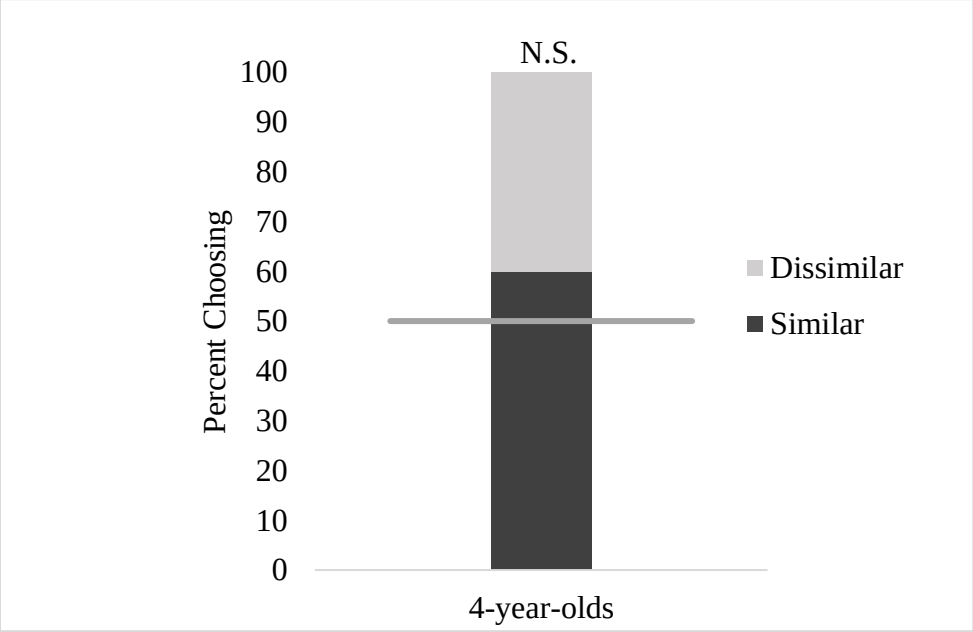
As in Study 1, per my pre-registration, I exclude data from participants who failed to answer both catch trials and the first comprehension question correctly to ensure that only children who understood the goal of the RMTS task, and remembered the information from the doll introduction were included in analyses.

Two-tailed binomial tests show that 4-year-olds did not select the similar doll above chance: 15 of 25 children selected the similar doll, $p = 0.60$ (1-sided) (Figure 6). We also

compared the preferences to those of four-year-old children in Study 1 and found their performance did not differ significantly, X_2 (1, N = 53) = 0.04, p = 0.85.

Figure 6

Study 2 Doll Choice



Note. The percentage of children choosing the Similar and Different dolls in Study 2. 4-year-old children selected the similar doll at chance (50%) levels, (p > .05).

These results failed to indicate that priming with a saliently, pedagogical relational reasoning task influences preschoolers' preference for dolls that share their physical traits.

Follow-Up Questions

Similarity and Difference. Four-year-olds identified which doll was similar to, or different from, them at rates above chance, indicated by a binomial test, with 22 of 25 participants, 88% correctly identifying the similar or different doll, $p < 0.001$ (1-sided). This finding is consistent with that of 4-year-old participants in Study 1.

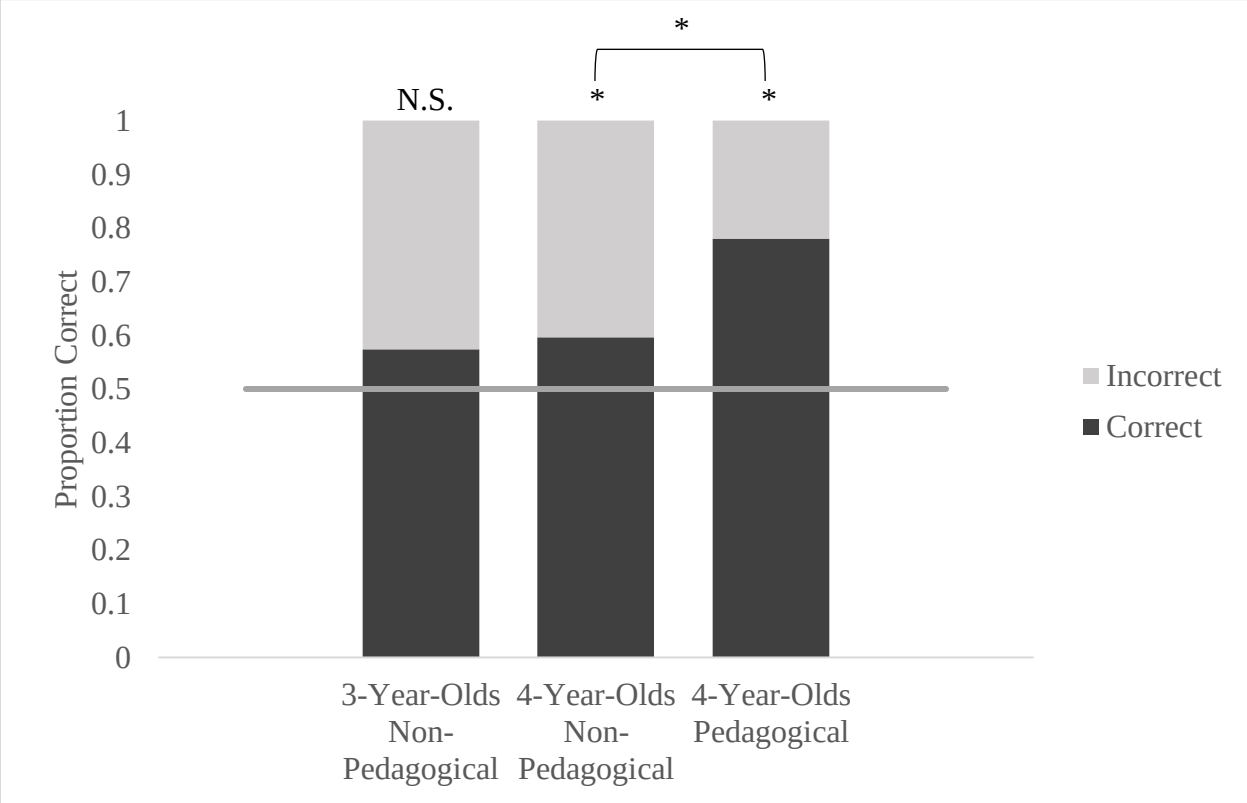
Trait Labeling. Replicating the results with 4-year-old children in Study 1, a one-tailed binomial test revealed that children verbalized their own trait labels, with 19 of 23 participants, 83% answering correctly, $p < 0.01$ (1-sided).

RMTS Performance.

As in Study 1, 4-year-old children, on average, correctly answered 78% of RMTS trials which is significantly different from chance (50%), $t(24) = 6.11$, $p < 0.001$ (2-sided). Moreover, 4-year-old children's RMTS task performance in Study 2 significantly increased as compared to their performance in Study 1, $t(48.3) = -3.08$, $p < 0.01$ (2-sided) (Figure 7), suggesting, while the pedagogical RMTS training did not have an impact on self-resemblance preference, it did significantly increase performance on the RMTS task.

Figure 7

RMTS Task Performance



*Note. The proportion of participants responding to the relational-match-to-sample trials correctly in Studies 1 and 2. 4-year-olds and 4-year-olds in the pedagogical condition responded correctly to the trials at rates greater than chance (50%; *p < .05); 4-year-olds in the pedagogical training group performed at higher rates than 4-year-olds who were not pedagogically trained (*p < .05).*

Abstract Similarity Preference.

For the abstract similarity preference, 27 of 46 of the children's choices, 59%, were the card that depicted two identical shapes as opposed to the card that depicted two different shapes, and a one-tailed binomial test indicated this percentage did not differ from chance performance

(50%), $p = 0.15$ (1-sided). Thus, the pedagogical training has no impact on preference for similarity, even within the same domain as the training.

General Discussion

Together, these results failed to reveal an effect of abstract similarity messages on young children's preference for a similar appearing doll – this was regardless of whether children received the message in an explicitly pedagogical manner or not. In light of the previous research described earlier that follows a similar doll paradigm (Fawcett & Markson, 2012; Jordan & Wynn, 2020), these findings suggest that similarity messages, which prompt a self-resemblance preference, must be 1) concrete, and 2) about the social domain. While 4-year-olds are able to robustly generalize social information from one context to another (Butler & Markman, 2012), and this process has been shown to impact children's social preferences (Jordan & Wynn, 2020), the current studies suggest the information must be generalized from one social context to another. In the present studies, I evoked the abstract concept *same* in children through a RMTS task with the expectation that children would generalize from a case outside the boundaries of the social domain to a social scenario. However, the present studies suggest that messages outside the social domain, even when about the abstract concept *same*, do not penetrate children's social decision-making mechanisms.

These studies tested whether domain general processes account for children's similarity preference through two studies: one in which children were simply primed to use relational reasoning to complete a matching task, and one in which children received explicit pedagogical messages to use those same relational skills. While both approaches attempted to answer the same question, I found it important to emphasize the pedagogical component in Study 2 because pedagogical messaging accounted for children's ability to generalize from a social comparison

on scarfs and bracelets to a social comparison on hair and eye color (Jordan & Wynn, 2020). Because of that, Study 2 focused specifically on 4-year-olds, the age that is defined by robust utilization of pedagogical information (Butler & Markman, 2012). The results suggest that social preferences are somewhat modular, in that they function without interference from domain general similarity computations (Samuels, 2000). Thus, a preference for similar-appearing others needs to be buttressed by specific available social information.

Importantly, while the pedagogical explanation given in Study 2 did not have an impact on children's doll choice, it had a significant impact on their performance on the RMTS task, with children increasing by almost 20% in the proportion they answered correctly. This tells us the manipulation did have an effect on children's learning, and therefore, was successfully pedagogical; yet, the manipulation only impacted the cognitive task on which children were trained. Thus, not only did children retain the relational information, but they internalized the information without it impacting their similarity preference. This supports the point that it is not enough to receive pedagogical information about similarity; the social context is required. This suggests domain general information is not enough to elicit a social preference, but that something specific to the social domain is required.

One limitation of the current study design was the high exclusion rate, particularly for 3-year-olds. Over half of the 3-year-olds tested in the study did not pass one or more of the required comprehension checks. This might suggest the included data may only represent a specific type of 3-year-old in our data (e.g., highly attentive), although age does not appear to be a factor, as the younger half of participants were equally likely to be included as the older half, X_2 (1, N = 52) = 0, p = 1. While this causes some concern, the fact that similar preference data exist among the 4-year-olds, who had a much higher inclusion rate, suggests that the effect did

not exist among the younger sample either, especially given the developmental change in the ability to generalize between approximately 3 and 4 years of age. If there is not an ability to generalize from abstract to social in 4-year-olds, there is likely not an effect in a younger sample of 3-year-olds.

Future research should look into whether references to the child need to be self-referential for the child to internalize and apply similarity information to themselves. For example, if the experimenter explicitly highlighted the similarity between two dolls (or between a doll and another kid), would the participant still prefer the doll that matches their appearance, as they did in previous studies with explicitly highlighted similarity information, even though the situation does not require them to consider similarity between *themselves* and either doll? Another important future direction is to examine whether children learn from example like they do from pedagogical explanation. For example, if a participant saw another child or adult choose between the two dolls and verbalize that they chose the similar doll because it looks just like them, would participants be more likely to spontaneously compute the similarity between themselves and the dolls and select the self-resembling option? If such an effect exists, would it be stronger if a child saw another child choose a similar doll, or if they saw an adult do so? The former may highlight the importance of peer influence in children.

In summary, findings from the studies presented here are consistent with the claim that adults' pedagogical similarity messages must be socially contextualized in order to impact children's preference. This falls in line with the work of Clark and Clark (1950) discussed earlier, wherein both Black and White children preferred others with light skin. Even Black children preferred the white skinned doll, potentially because social messages about race were so salient in the 1950's. The importance of social messaging is further suggested by the fact that

children in mixed school in the North show stronger preference for light skin color than children in Southern segregated schools. Counterintuitively, by desegregating schools, this is evidence that Northern Black children may have been exposed to more racist messages from their White classmates than southern students in a more homogenous environment. With the separation of people by skin tone on buses, in schools, in restaurants, and at water fountains, children were constantly receiving messages about social similarity. Using the water fountain for those "just like you" and avoiding the one for those "different than you" closely parallels the style of messaging used in prior studies, which served as the basis for the present work (Fawcett & Markson, 2012; Jordan & Wynn, 2020). Thus, the manner in which children come to internalize adults' pedagogical messages about similarity and difference may scale up to the manner in which they come to understand social groups and hierarchies, as well as their related norms and stereotypes.

This has important implications and consequences for how children realize and internalize messages about similarity in their surrounding social environment. It is not simply that by understanding relational reasoning and being able to map the connections between various abstract ideas, children are set down the road of prejudice. Instead, these results suggest adults' social messages encourage children to interact with those who are physically similar. An adult pointing out a seemingly unimportant similarity or difference between two parties can have unforeseen consequences, since children are able to generalize between social domains, and interpret that message as applying to all social similarities.

As we look forward to what interventions might be useful to mitigate the biases that lead to homogenous, and often unequal, groups, the study suggests that adult messages about the social domain play a key role in creating these biases, and perhaps it is adult messages that could

lessen them. It is important to address that adults may have conscious or unconscious biases that lead them to transmit certain social messages to children, so a first step is for adults to be aware of their own perceptions. The current research suggests that interventions that propose de-emphasizing difference, often referred to as colorblindness, might be misled. Since children are attending to their parents' messages, delivering positive messages about diversity might be more effective. Since children are young and malleable to their parents' statements, perhaps an adult demonstrating positive reactions to, and interactions with, someone different would also be internalized, and children would apply the message about similarity of a group and generalize to multiple scenarios. More research will have to look into what the mechanisms are used for unlearning information. My research suggests that the mechanism must involve social information, as opposed to creative metaphors one might think would be more palatable to children.

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