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Bridging the gap: Causality-at-a-distance in children's categorization and inferences about internal properties

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ABSTRACT

Previous research has shown that preschoolers extend labels and internal properties of objects based on those objects' causal properties, even when the causal properties conflict with the objects' perceptual appearance [Nazzi, T., & Gopnik, A. (2000). A shift in children's use of perceptual and causal cues to categorization. *Developmental Science, 3*, 389–396; Sobel, D. M., Yoachim, C. M., Gopnik, A., Meltzoff, A. N., & Blumenthal, E. J. (2007). The blicket within: Preschoolers' inferences about insides and causes. *Journal of Cognition and Development, 8*, 159–182]. These studies, however, only presented causal relations that acted on contact. In two studies, contact causality was replaced by distance causality. In contrast to the contact causality case, 4- and 5-year-olds extended labels to objects with similar perceptual properties over objects with similar causal properties when those properties acted at a distance. When children were asked to make inferences about object's internal properties, they were more likely to make causal responses, with 5-year-olds doing so to a greater extent than 4-year-olds. In a second study, 4-year-olds registered causal properties that acted at a distance and used them to make inferences when no perceptual conflict was present. These results support a hypothesis that young children develop an understanding of the specific mechanisms that link causal relations.

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Part of understanding the causal structure of the environment is knowing the causal properties that particular objects possess. In some cases, objects' causal powers act on contact. Car keys can unlock car doors by acting on a set of tumblers. Pressing the power button on your television can turn it on via a switch that activates the cathode ray tube (at least for older TVs). But contact is not always necessary for objects to demonstrate causal efficacy. Key fobs can unlock car doors by means of radio signals. Remote controls can turn on televisions through infrared transmissions. Perceptual similarity is often a good indicator of objects' general causal properties (keys open doors and look alike at a gross level), but is often not indicative of a particular object's causal properties. Your house key will not start your car and a Sony remote will not operate a Samsung TV. How do children learn about the causal properties of specific objects, both those that involve physical contact and those that involve causality-at-a-distance, even in light of the perceptual similarity that exists among members of a category?

One answer to this question was proposed by Piaget (1929, 1930), who suggested that "precausal" preschool-aged children understood objects in terms of perceptual appearance and did not reason about causality. Young children recognized associations among events, and any kind of mechanistic understanding that potentially separated contact from causality-at-a-distance was irrelevant until later in development. Contemporary research, however, suggests that children do understand that objects have causal efficacy. Infants register "billiard ball" causality among physical events (Leslie & Keeble, 1987; Oakes & Cohen, 1990) and young children appreciate the importance of contact among events when making causal inferences (Bullock, Gelman, & Baillargeon, 1982). Preschoolers also appreciate that some causal relations occur at a distance (Kushnir & Gopnik, 2007; Shultz, 1982; Schulz & Gopnik, 2004). More generally, by the time children enter kindergarten, they have relatively sophisticated causal knowledge about the physical world (where contact is relatively important), and also about the biological (Carey, 1985) and psychological (Wellman, 1990) domains, where some (or even many) causal relations occur at a distance.

Kushnir and Gopnik (2007) in particular, investigated children's causal inferences, pitting contact and distance causation. They found that if children were given multiple candidate causes, some that acted at a distance and some on contact, 4-year-olds would trade off between the spatial contiguity and probability information. Preschoolers would accept distance causation, but only if it was more deterministic than an alternative, contact-based cause. In the present study, we examined how this apparent reluctance to accept causality-at-a-distance affected subsequent reasoning. How do children treat distance causality when using such information for induction?

Several investigations have suggested that preschoolers use causal properties of objects when making inferences about category membership (Booth & Waxman, 2002; Gopnik & Sobel, 2000; Graham, Kilbreath, & Welder, 2004; Nazzi & Gopnik, 2000) or about whether those objects contain particular internal parts (Sobel & Munro, 2009; Sobel, Yoachim, Gopnik, Meltzoff, & Blumenthal, 2007). Similar investigations have shown that preschoolers and toddlers can reason about objects' causal properties, even from relatively little evidence (Gopnik, Sobel, Schulz, & Glymour, 2001; Schulz & Sommerville, 2006; Sobel & Kirkham, 2006, Sobel, Tenenbaum, & Gopnik, 2004). In all of these cases, children effectively reason about novel, non-obvious causal properties. However, in all of these cases, the causal properties act on contact.

In the present work, we extended the procedures from two studies in which objects' causal properties were contrasted with their perceptual appearance. The first, by Nazzi and Gopnik (2000), examined how children extend novel labels based on objects' causal properties and perceptual features. In this experiment, 3- and 4-year-olds were shown a set of three objects, labeled here A, AI, and BI (Fig. 1). Each object was placed on a machine, which activated when some objects came into contact with it. Objects A and AI looked the same, but AI made the machine operate while A did not. AI and BI looked different, but both activated the machine. Thus, there was a conflict between the perceptual similarity among the objects and those objects' causal properties. The experimenter then picked up object AI and told the child that it was a "blicket." The child was asked to show the experimenter which of the remaining two objects was the other blicket. A clear developmental difference appeared between 3- and 4-year-olds' responses. The younger children mostly responded on the basis of the perceptual features of the objects, choosing A, while the older children more often responded based on the objects'

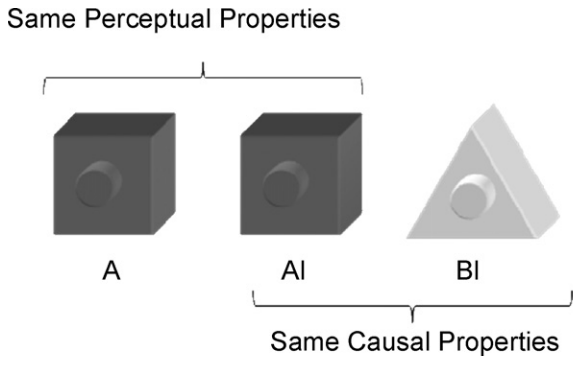

Fig. 1. Stimulus sets used in the insides and categorization conditions.

causal properties, choosing BI. However, 4-year-olds did not make the causal response more often than at chance levels. Other experiments using more complex procedures showed similar results (Gopnik & Sobel, 2000).

The second procedure we extended was initially described by Sobel et al. (2007), who investigated whether children understood the relation between objects' causal properties and their insides. They used objects similar to the ones shown in Fig. 1—with dowels covering cavities that potentially contain internal parts. In their procedure, 3- and 4-year-olds saw a set of three objects, which had the same perceptual features and efficacy as in Nazzi and Gopnik's (2000) procedure (A and AI looked the same, and different from BI; AI and BI activated the machine, object A did not). The dowel on object AI was removed, to reveal that it had a particular internal part (a plastic sphere inside). Children were asked which of the other two objects had the same inside. Again, a developmental difference was observed, with 3-year-olds mostly responding based on the external perceptual similarity among the objects and 4-year-olds more likely to base their responses on the objects' causal properties. In contrast to Nazzi and Gopnik's (2000) results, 4-year-olds used the causal properties of the objects significantly more often than chance would predict. This suggests that 4-year-olds understand the relation between an object's causal properties and its insides more than its category membership, especially in light of competing information such as perceptual similarity.

In Study 1, we replicate the categorization procedure used by Nazzi and Gopnik (2000) and the insides procedure used by Sobel et al. (2007), replacing contact causality with causality-at-a-distance. We had two goals. First, we wanted to examine whether introducing causality-at-a-distance affected how children reasoned about the relations among objects' category membership, internal properties, and causal efficacy. Second, there are few investigations that directly contrast what children know about causes and labels with what they know about causes and insides. The experiments described above suggest that 4-year-olds are more likely to understand the relation between objects' causal properties and their insides than their labels. We examined this possibility.

1. Study 1

Children were shown the causal properties of objects, then asked to infer which objects shared a common label or which objects shared a common internal part. Objects' causal properties conflicted with their perceptual properties (as shown in Fig. 1) and were determined by holding each object over a machine, which activated only in the presence of certain objects. We examined 4-year-olds to allow comparison with established findings using similar procedures with contact causality (Nazzi & Gopnik, 2000; Sobel et al., 2007). Because 4-year-olds had some difficulty with causality-at-a-distance in Kushnir and Gopnik's (2007) experiments, we examined groups of 5-year-olds as well.

1.1. Method

1.1.1. Participants

The final sample included thirty-four 4-year-olds (10 girls, $M = 54$ months, range = 47–62 months) and thirty-two 5-year-olds (13 girls, $M = 71$ months, range = 63–77 months). One additional 5-year-old was tested, but excluded because of experimenter error. About half the children were tested in a laboratory environment, recruited from birth records; the other half were recruited from a two different preschools serving a predominantly middle-class community. Half the children were randomly assigned to the *insides* condition and the other half to the *labels* condition. There were no significant differences in age between the conditions. Fifty children were Caucasian, five children were African-American, four children Asian, one child was Hispanic, one child was of Middle Eastern descent, and five children were of mixed descent. No formal measure of SES was administered.

1.1.2. Materials

The machine was an $8'' \times 6'' \times 3''$ box made of black plastic with a white top (Fig. 2). If an object activated the machine, green LEDs wired into the top of the device illuminated and the machine placed a novel melody. The machine was designed to be activated surreptitiously via a remote held under the table, hidden from the child.

Four different sets of three blocks were used. A sample set appears in Fig. 1. A 1.3 cm (diameter) $\times$ 2.5 cm (depth) hole was drilled into each block, covered by a dowel that could be removed to reveal the insides of the block. Each set consisted of three blocks. Blocks A and AI were identical except that block AI had a small red ball hidden inside of the hole, fixed in place. This red ball was only visible when the dowel was removed and was being explicitly demonstrated to the child. The rest of the time the dowel was closed. Block BI was a different shape and color than blocks A and AI, but otherwise the same. For instance, one set consisted of two purple oval-shaped blocks (one with red inside) and a white triangular block with red inside. No block in any set was red or green. Four additional blocks were used in the warm-up phase of the experiment. They were all different in shape and color and lacked the dowels, holes, and insides.

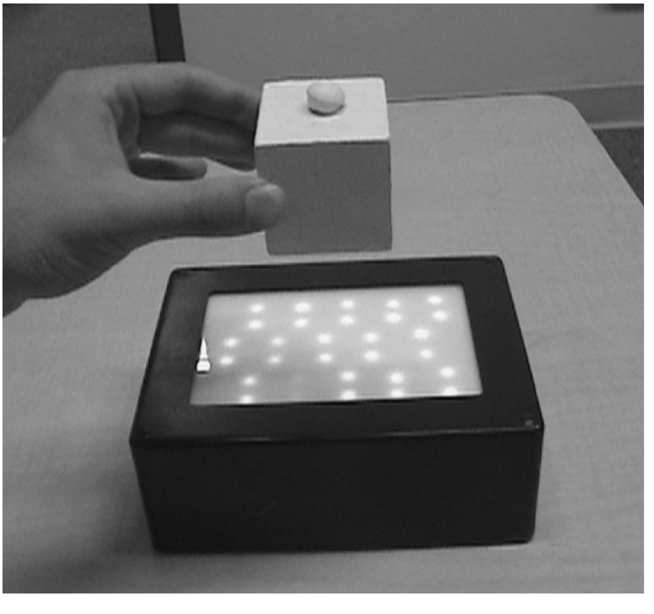

Fig. 2. The blicket detector used in the two experiments and a sample object activating the machine while held over it.

1.1.3. Procedure

Warm-up. Children were first given a warm-up activity to ensure that they would point to objects and respond to the experimenter. The four warm-up blocks were brought out, and children were asked to point to the biggest one, then the red one, then the smallest one, and then the blue one. Children who did not point correctly ($n = 1$) or who touched the blocks ($n = 1$) were asked to try again. No children failed the pretest after this second try.

Half the children were randomly assigned to the *insides* condition. This condition was a replication of a procedure used by Sobel et al. (2007, Experiment 4), except that the objects activated the machine at a distance instead of on contact. Children were introduced to the machine as follows: "This is my machine. Some things make it go, and some things don't." No reference was made to labels or mechanisms. The first set of blocks was placed on the table between the child and the machine, and the efficacy of each object was demonstrated one by one, from left to right. This was done by holding each block 4–6″ over the machine for approximately 3 s. For object A, the machine did not activate. For objects AI and BI, the machine did activate for the entire time that the block was held over the machine. This was achieved by the experimenter pressing a button on the machine's remote, which was kept hidden under the table. Each block was then demonstrated a second time with the same results. The locations of the blocks were varied so the blocks were seen in a variety of orders and locations.

After the child observed this demonstration, the experimenter pointed out the doors and opened the door on block AI. He showed the child that it contained the red ball inside and said, "This one has a little red thing inside." The experimenter then placed the door back on object AI and asked the child, "Can you point to the other one with a little red thing inside?" The child's response, either block A or BI, was recorded, and the next set of three blocks was introduced and this procedure repeated.

The other half of the children were assigned to the *labels* condition. This procedure was a replication of the *conflict*, *neutral language* condition used by Nazzi and Gopnik (2000), except that the objects activated the machine at a distance, instead of on contact. The procedure was identical to the insides condition with one key change. Instead of opening up object AI to show the red ball inside, children were told that object AI was a "blicket" and were asked to point to the other "blicket." Note that children were never told that the machine was a "blicket machine" or that "blickets make the machine go." In both conditions, the order of presentation of the sets of blocks was counterbalanced across participants.

1.2. Results

We considered the number of trials on which each child chose object A (a perceptual response) vs. the number of trials they chose object BI (a causal response). The means and distribution of object BI choices are shown in Table 1. Preliminary analyses showed that gender and the order in which children experienced the four trials had no significant effect on the distributions of responses. Further, no one set of blocks was more likely to elicit a causal response than another. As a result, we summed and averaged the number of times children chose object BI (i.e., the causal response) across the four trials to give each child a causal score.

These scores were analyzed by a 2 (age group) × 2 (condition) analysis of variance (ANOVA), which revealed a main effect of age, $F(1, 62) = 5.75$, $p < .05$, partial $\eta^2 = .085$, as well as a main effect of condition,

Table 1
Number of children making 0, 1, 2, 3, or 4 causal responses and overall mean number of causal responses in Study 1.

	Number of causal responses						
	0	1	2	3	4	Mean	SD
4-year-olds							
Insides condition ($N = 17$)	5	5	1	4	2	1.59	1.46
Labels condition ($N = 17$)	12	0	1	2	2	0.94	1.56
5-year-olds							
Insides condition ($N = 16$)	2	0	3	1	10	3.06	1.44
Labels condition ($N = 16$)	10	0	0	3	3	1.31	1.78

$F(1, 62) = 9.70$, $p < .005$, partial $\eta^2 = .135$. No significant interaction was found. In general, 5-year-olds made more causal responses than 4-year-olds, $t(64) = -2.24$, $p < .05$, Cohen's $d = 0.56$. Further, children made more causal responses in the insides condition than the labels condition, $t(64) = 2.94$, $p < .005$, Cohen's $d = 0.74$.

We wanted to consider these results using nonparametric analyses as well, since inspection of Table 1 reveals that these data potentially had a bimodal distribution. The distribution of 5-year-olds' responses in the insides condition was different from that of 4-year-olds, Mann–Whitney $U = 62.50$, $z = -2.74$, $p < .01$, $r = -0.48$. This was not the case in the labels condition, Mann–Whitney $U = 122.00$, $z = -0.60$, *ns*. Similarly, 5-year-olds' distribution of responses differed between the labels and insides condition, Mann–Whitney $U = 59.50$, $z = -2.76$, $p < .01$, $r = -0.49$. Four-year-olds' distributions showed a marginally significant difference between the insides and labels conditions, Mann–Whitney $U = 98.50$, $z = -1.70$ $p = .11$, $r = -0.29$.

Finally, we considered whether each group's responses differed from chance performance. Chi-squared goodness-of-fit tests revealed that both 4- and 5-year-olds' responses differed from chance in the insides condition, $\chi^2(4, N = 17) = 20.10$, $p < .001$ for the 4-year-olds and $\chi^2(4, N = 16) = 89.75$, $p < .001$, for the 5-year-olds. Four- and 5-year-olds' responses also differed from chance in the labels condition, $\chi^2(4, N = 17) = 123.40$, $p < .001$ for the 4-year-olds and $\chi^2(4, N = 16) = 95.25$, $p < .001$, for the 5-year-olds. We also performed multinomial analyses on 4- and 5-year-olds' responses (separately) in both the insides and labels conditions. These analyses showed that responses were different from chance levels in both conditions for both age groups, all p-values $< .001$.

1.3. Discussion

Previous findings suggested that when causal properties of objects acted on contact, 4-year-olds registered a relation between the objects' causal properties and their labels and insides even when those properties conflicted with objects' perceptual appearance. Nazzi and Gopnik (2000) found that 4-year-olds in their *conflict-neutral language* condition (identical to the present procedure, except for the nature of the causal relation) made causal responses 54% of the time, compared to the 25% level of response made by 3-year-olds. Similarly, Sobel et al. (2007) showed that 4-year-olds made causal responses on 72% of their trials (identical to the present insides condition, except for the nature of the causal relation), compared to a 40% level of response made by 3-year-olds. Here, both 4- and 5-year-olds' responses in the labels condition when the causal properties of the objects acted at a distance were more similar to Nazzi and Gopnik's 3-year-olds' responses when the causal properties acted on contact. In these cases, children were more likely to respond based on the objects' external perceptual similarity. Inferences about insides were different: the developmental difference between 4- and 5-year-olds here concerning causality-at-a-distance is analogous to the developmental difference observed by Sobel et al. (2007) between 3- and 4-year-olds when those same causal properties act on contact. Five-year-olds also appeared to respond differently in the labels and insides conditions, suggesting that their inferences in these conditions are mediated by separate processes. We will return to this possibility in the General Discussion.

Why did children not respond to causal properties that act at a distance in a similar manner to causal properties that act on contact? One possibility is that children did not register that the machine's activation was caused by the objects because of the distance between the object and the machine. If this were the case, children might have been easily swayed by the other compelling piece of information presented to them—the perceptual similarity among the objects. Study 2 was designed to consider this possibility. We specifically focused on only a group of 4-year-olds in this experiment, as the data from the 5-year-olds in the insides condition suggest that these older children did recognize some relation between the objects' spatial location and their relation to the machine.

2. Study 2

Study 2 replicated the labels and insides conditions of Study 1 with a new group of 4-year-olds, eliminating the perceptual conflict. Children were shown three perceptually different blocks on each trial; each was held over the machine, which activated for two out of three of the objects. After this demonstration, one of the objects that was associated with the machine's activation was either labeled a "blicket" (in the labels condition) or was revealed to contain an internal part (in the insides condition), and the children were asked which other object of the remaining two shared this property. If children failed to register that the blocks caused the machine to activate when they were held over it, their responses should be at chance levels. This would suggest that 4-year-olds did not register the same efficacy in Study 1 and responded on the basis of the objects' perceptual similarity, which is a consistent predictor of category membership (Landau, Smith, & Jones, 1988) and by extension, insides (Gelman & Wellman, 1991). If performance differed from chance, it would suggest that the results of Study 1 were not due simply to younger children failing to register or use the causal properties of the objects.

2.1. Methods

2.1.1. Participants

The sample included thirty-two 4-year-olds (16 girls, *M* = 54 months, range 47–62 months), recruited from birth records and three preschools each serving the same predominantly middle-class community. One additional child was tested, but excluded because of experimenter error. Children were randomly assigned to one of the two conditions: labels (*n* = 16) or insides (*n* = 16). There was no significant differences between the means across conditions; 25 children were Caucasian, 3 children were Asian, 1 child was Hispanic, 2 children were of Middle Eastern descent, and 1 child was of mixed descent. No formal measure of SES was administered.

2.1.2. Materials and procedure

Materials and procedures were the same as in Study 1 with one change. In each set, the three blocks were all the same shape but different colors. For instance, one set contained an orange cube, a yellow cube, and a white cube. Rather than having to choose between a block that looked the same and a block that had similar causal properties, children had to choose between an object that had a similar causal property and a distracter. This procedure does not test children's ability to override a perceptual conflict, but rather their ability to recognize that the particular causal property children observed is relevant for categorization or inferences about insides.

2.2. Results and discussion

The means and distributions of children's responses are shown in Table 2. Preliminary analyses showed no effects of gender, order, or block sets. There was no significant difference between means across conditions, $t(30) = -1.23$, *ns*., nor was there a significant difference in the distribution of responses between the two conditions, Mann–Whitney $U = 96.00$, $z = -1.28$, *ns*. Chi-squared goodness-of-fit tests revealed that 4-year-olds in both the insides and labels conditions responded differently than chance expectations, $\chi^2(4, N = 16) = 18.50$ and 69.67, respectively, both p-values $\leq .001$. Multinomial analysis on responses in both conditions also showed that responses were different from chance levels, both p-values $< .001$.

We compared the results of Study 2 to 4-year-olds' responses in the analogous condition in Study 1 via a 2 (Experiment) × 2 (Condition) ANOVA. This analysis revealed only a main effect of experiment—in general, 4-year-olds made more causal responses in Study 2 than Study 1, $F(1, 62) = 23.55$, $p < .001$, partial $\eta^2 = .28$. For both the insides and labels conditions, 4-year-olds were more likely to make causal

Table 2
Number of children making 0, 1, 2, 3, or 4 causal responses and overall mean number of causal responses in Study 2.

	Number of causal responses						
	0	1	2	3	4	Mean	SD
Insides condition (*N* = 16)	0	4	3	4	5	2.62	1.20
Labels condition (*N* = 16)	0	1	5	1	9	3.12	1.09

responses in Study 2 than in the conflict procedure used in Study 1, $t(31) = -2.22$, $p < .05$, Cohen's $d = .80$, for the insides condition and $t(31) = -4.64$, $p < .01$, Cohen's $d = 1.67$ for the labels condition. Nonparametric analyses were consistent with these results: the distributions of responses across the two studies were different for both the insides and labels conditions, Mann–Whitney $U = 78.50$ and 39.50, $z = -2.12$ and 3.60 respectively, both p-values $< .05$, $r = .37$ and .63 respectively.

These data suggest that when objects demonstrate causal efficacy that acts at a distance and perceptual similarity does not bias children toward a particular inference, 4-year-olds can relate those causal properties to those objects' labels or internal parts. This conclusion is consistent with studies showing similar results for contact causality (Gopnik & Sobel, 2000; Nazzi & Gopnik, 2000). These data suggest that young children are capable of integrating information across a spatial divide—in both conditions 4-year-olds clearly related the causality-at-a-distance to an inference about the objects. Taken with the results of Study 1, these data suggest that when this type of causal property conflicts with perceptual similarity, 4-year-olds use perceptual similarity not because they fail to register to the causal efficacy of the objects, but because they potentially believe perceptual similarity is a better guide to objects' category membership or insides than a causal property that acts at a distance.

3. General discussion

There is strong evidence that young children and infants register contact causality in their perception of events, often discriminating it from events that act at a distance (Kushnir & Gopnik, 2007; Leslie & Keeble, 1987; Oakes & Cohen, 1990). There is also strong evidence that 4-year-olds use causal properties that act on contact to make inferences about objects' category membership and internal properties (Gopnik & Sobel, 2000; Nazzi & Gopnik, 2000; Sobel et al., 2007). The present data suggest that although 4-year-olds register the presence of causality-at-a-distance, they find it less compelling as the basis for making inferences about objects' labels or insides than contact causality. When an alternative basis for this inference is present, specifically, the objects' external perceptual features, children are likely to use that alternative. There does appear to be some difference in the developmental trajectory of these inferences. Although 4-year-olds did not use causal properties at a distance to guide inferences over perceptual similarity about either insides or category membership, 5-year-olds did use distance causality to make inferences about objects' insides.

What accounts for the difference in children's inferences about distance causality as opposed to contact? One possibility is that children simply have had more experience with causal relations that act on contact than those that act at a distance and this exposure facilitates their recognition of the objects' causal properties. Shultz (1982), for example, found that children could reason about the mechanisms behind causal relations that acted at a distance, but he often provided children with structured exposure to the stimuli prior to test. Further, detailed inspection of these data suggests that 2–4-year-olds struggled to understand these causal relations, unlike children 5 years old and older. More generally, Berzonsky (1971) demonstrated children's causal reasoning improves when they are more familiar with the domain in question; contact causality is clearly more familiar and accessible to children at earlier ages.

However, we suspect a stronger argument can be made. Children interpret the correlational information they observe in conjunction with their existent understanding of causal mechanisms. Study 2 suggests that 4-year-olds register the relation between the object's spatial location and the machine's response. However, they might discount this information when it does not conform to their understanding of causal mechanisms. Study 1 suggests that they do discount it when a plausible alternative (i.e., external perceptual similarity) is present.

Support for this hypothesis comes from a recent investigation by Sobel and Munro (2009), who replicated the Sobel et al. (2007, Experiment 4) procedure (i.e., the basis for the "insides" condition in Experiment 1) with groups of 3-year-olds, manipulating the way in which children construed the relation between the objects and the machine. When children construed the relation between object and activation as an agent "liking" an object as opposed to an object activating a machine, 3-year-olds were more likely to infer that objects with causal efficacy shared common insides. This may be attributable to desire being a mental state that children reason about at very early ages (Repacholi & Gopnik, 1997), including inferences about non-obvious properties of the objects of desires.

These findings suggest two further experiments. First, because most psychological causality acts at a distance, 4-year-olds might make more causal responses in these experiments if they construe the data they observe as indicating such a causal mechanism (i.e., an agent's desires), much in the same way 3-year-olds' inferences about contact causality were affected. Second, it should be possible to train preschoolers that objects can activate the machine at a distance because of a particular mechanism, if they are exposed to information about that mechanism. Data from Bonawitz, Fischer, & Schulz (2008) support this hypothesis. They found that 3-year-olds who failed to appreciate a particular unfamiliar causal mechanism could be trained simply by being exposed to information about that mechanism. Children given this exposure were more likely to recognize the relevance of this mechanism information when interpreting ambiguous evidence. If 3-year-olds can be trained in this manner, we suspect 4-year-olds (and potentially younger children) could be trained about causality-at-a-distance.

This account allows us to speculate about why 5-year-olds made more causal responses on the insides condition than the labels condition in Study 1. The test question in the insides condition might offer an additional piece of information about the mechanism that relates the object's spatial location to the machine—that the internal part is a potential mechanism for the object's causal property. In the labels condition, this information is not present. If children recognize this information (as 4-year-olds do in the case of contact causality; Sobel et al., 2007), they may find the inference about insides easier than the inference about category membership. Here, 5-year-olds were more likely to use distance causality in the insides than labels condition in Study 1. Further investigations should consider whether the nature of the test question in the insides condition contributed to children's inferences.

To conclude, there is ample evidence that suggests children treat contact causality differently from causality-at-a-distance. Similar to conclusions drawn by Kushnir and Gopnik (2007), the present studies suggest that children register the correlational information inherent in causal relations that act at a distance. But when that correlational information is pitted against other properties of objects that reliably predict category membership – such as external perceptual features – children are less likely to use the causal information than in analogous procedures in which the causal relation acts on contact. Children may simply be more familiar with contact causality than causal relations that act at a distance, but we suspect a stronger conclusion can be drawn: children use their existing knowledge of how causal relations work (i.e., their theories about causal mechanisms) to interpret their observations of correlational information.

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