Young Children’s Causal Explanations Are Biased by Post-Action Associative Information

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In a series of 4 experiments, we tested children’s understanding that the causes of their actions must necessarily be attributed to information known prior to (i.e., “pre-action” information), rather than after (i.e., “post-action” information), the completion of their actions. For example, children were shown a dog, asked to get some cheese to feed the dog, and then returned to discover a mouse. In Experiment 1, the majority of 3-, 4-, and 5-year-olds claimed that they had gotten the cheese to feed the mouse. In Experiments 2 and 3, we ruled out the possibilities that (1) children had forgotten the critical “pre-action” information (e.g., “dog”), and (2) children had merely attributed the cause of their action to the most recent item (e.g., “dog”) that they had seen. Finally, in Experiment 4, we determined that 7-year-olds, but not 6-year-olds, correctly attributed the cause of their action to the pre-action information, suggesting that this is the age at which children are no longer influenced by associative post-action information when explaining the causes of their actions. These results are discussed in terms of their relevance for causal reasoning, action explanation, and memory.

Keywords: cognitive development, explanations, causal reasoning, memory, theory of mind

Causal reasoning is argued to be a “developmental primitive” (Wellman & Gelman, 1998) and an important “building block” for cognition (Goswami, 1998). Indeed, by 6 months of age, infants are believed to have some understanding of mechanical causation (e.g., Leslie, 1982) and, by the preschool years, children show considerable understanding of physical (e.g., Bullock & Gelman, 1979; Das Gupta & Bryant, 1989; Kun, 1978; Rankin & McCormack, 2013), biological (e.g., Gelman & Wellman, 1991), and psychological (e.g., Bartsch & Wellman, 1989; Hickling & Wellman, 2001; Wellman & Bartsch, 1988) causality, with these abilities improving between 3 and 4 years of age (e.g., Buchanan & Sobel, 2011; Bullock, 1985; Das Gupta & Bryant, 1989).

Integral to a mature concept of physical causality is an understanding of Hume’s (1748, as cited in Goswami, 2008) principles of priority, covariation, and temporal contiguity. In this article, we are particularly interested in the priority principle, or the understanding that causes precede their effects (Goswami, 2008). From a young age children appear to reason according to this principle (e.g., Bullock & Gelman, 1979; Rankin & McCormack, 2013). For example, a classic study by Bullock and Gelman explored preschoolers’ understanding of the priority principle by using a “jack-in-the-box” apparatus—a long opaque box with one opening at each end and a large opening in the middle where the jack appeared. One puppet dropped a marble down the hole at one end before the jack jumped, whereas another puppet dropped a marble down the hole at the other end after he had jumped. Even 3-year-olds tended to correctly respond that the first marble had made the jack jump.

In this type of experiment, children’s reasoning is about objects in the physical world. Yet, an important issue to consider is whether children’s reasoning about aspects of the psychological world also abides by the priority principle. More specifically, do children assume that the causes of their own actions must also be events/information that preceded the actions themselves, or are there particular contexts that lead them to abandon this principle?

Consider the following example: A child is asked to get some cheese to feed a dog. When the child returns with the cheese, he discovers that the dog has disappeared and a mouse has replaced it! Were the child then asked why he went to get the cheese, would he explain his action by (correctly) referring to the dog or (incorrectly) referring to the mouse? To our knowledge, this question has not been explored, yet its answer has important implications for children’s causal reasoning, explanatory competence, and memory. In what follows, we discuss findings from several different areas of cognitive development that are relevant to answering this question. These findings all highlight contexts in which causally irrelevant information influences children’s reasoning about a prior intention/belief.

The first set of findings is in the area of children’s understanding of prior intentions and suggests that children do not always use the priority principle when reasoning about their own actions (e.g., Bradmetz & Amiotte-Suchet, 2001; Gopnik & Slaughter, 1991; Russell, Hill, & Franco, 2001).
(1991) asked children to draw a red ball. Once children had drawn the outline of the ball, the experimenter showed them an apple and told them that their drawing looked like the apple. She then asked children whether they could draw an apple instead. After children had done so, the experimenter asked them what their original intention had been. Almost half of the 3-year-olds incorrectly responded “apple,” whereas almost all of the 4-year-olds responded “ball.”

Similarly, Russell et al. (2001) assessed preschoolers’ understanding that one can be mistaken (or have “false ideas”) about the goal of a current action (or as Searle, 1983, refers to it, “intentions-in-action”) by using a “transparent intentions” task. In the false-belief version of the task, children were presented with a plastic transparency on which an incomplete drawing (e.g., boy’s head missing an ear) appeared. They were then asked to complete the drawing (i.e., draw the ear) and, once they had, they were shown that what they had drawn had unexpectedly completed another drawing (i.e., the handle of a cup). Children were then asked whether they had intended to draw an ear or a handle and whether they had thought they were drawing an ear or a handle. In the true-belief version of the task, children were given only one transparency (e.g., a drawing of an incomplete cup). After having drawn the missing feature (i.e., handle), the transparency was placed on top of the other one (showing the boy’s face) after which the same questions as in the false-belief version were asked. Thus, in both cases, children had to ignore outcome knowledge to correctly reason about their prior intention. Interestingly, 3- and 4-year-olds performed differently in the false- and true-belief versions of the task. However, overall, 4-year-olds were better than 3-year-olds at reporting their past intentions (i.e., what they had “meant” to do). Russell et al. (2001) argue that young preschoolers have difficulty reporting a past mental state (e.g., intention to complete the drawing of the boy) when it conflicts with current information (e.g., the ear they drew is now the handle of a cup).

Finally, using a paradigm aimed at assessing children’s ability to explain actions that were based on a past false belief, Atance and O’Neill (2004; see also, Atance, Metcalf, & Zuijdijk, 2012; Bartsch, Campbell, & Troseth, 2007) showed children a crayon box and asked them to state what was inside. Once children responded “crayons,” they were asked to get some paper (that had been placed nearby) to draw on with the crayons. When children returned with the paper, they were shown that the box actually contained candles. Importantly, children were asked to explain why they went to get the paper. Across a number of different contexts, 3-year-olds had difficulty correctly explaining that the reason they went to get the paper was to draw on it with the crayons. In this study, children were asked to explain rather than merely identify or predict their false belief because it has been argued (e.g., Bartsch et al., 2007) that children’s explanations—more so than predictions, for example—provide an especially sensitive means of assessing children’s psychological understanding and developmental change, more broadly. Accordingly, in the current study, we also solicit children’s explanations for the causes of their actions.

An important point to glean from all of the studies discussed thus far is that 3- and 4-year-olds’ reporting of their prior intentions/false beliefs/actions is sometimes influenced by information that has only become known to them after, not before, they had acted. These findings differ somewhat from those of Bullock and Gelman (1979), for example, that show that children as young as 3 abide by the priority principle in their reasoning about the physical world. However, such “prior intention/action” tasks also require that children have an understanding of misrepresentation (e.g., recognizing that they falsely believed they were drawing the boy’s ear), as well as the ability to inhibit conflicting outcome knowledge. As such, it is not altogether surprising that 3-year-olds, and even 4-year-olds, have difficulty because it is not until around age 5 that children develop a more adult-like understanding of misrepresentation (e.g., Wellman, Cross, & Watson, 2001), along with better-developed inhibitory control skills (e.g., Zelazo & Carlson, 2012).

Yet, even at age 5 (and older), memory is nevertheless influenced by outcome knowledge, especially when this knowledge is consistent with prior intentions/actions. For example, in the Russell et al. (2001) study, a half-moon shape is equally consistent with a boy’s ear and the handle of a teacup. Similarly, in Gopnik and Slaughter (1991), a circle is just as easily turned into a ball as an apple. Thus, an interesting question is how children would perform on similar tasks when the outcome information is more strongly associated or consistent with the prior intention than the initial information upon which children acted. For example, in the “dog” and “mouse” example described earlier in this article, “cheese” is more strongly associated with “mouse” than it is with “dog.” An important area that pertains to this question is the study of memory and scripts.

Much of our knowledge is organized in scripts or schemas for familiar places, objects, people, events, and routines (Mandler, 1979). By 3 years of age, children possess script-based knowledge (e.g., what happens when you go to a birthday party; Hudson, Fivush, & Kuebli, 1992; Hudson & Shaprio, 1991), and this knowledge is critical in organizing their memory for past events. Although relying on script information can benefit one’s memory (i.e., script-typical information can be easier to remember), it can also incur costs (Bower, Black, & Turner, 1979; Myles-Worsley, Cromer, & Dodd, 1986; Ornstein et al., 1998). For example, in a study of memory for scripts, Bower et al. found that information that was implied by the script but not explicitly stated interfered in recall and caused false alarms in recognition tests. Why might these findings be relevant for children’s explanations for the causes of their actions? Given that scripts can bias both adults’ and children’s recall of past events, it is possible that when outcome information is consistent with a script for action (e.g., feeding cheese to a mouse) but not with the actual cause for action (e.g., feeding cheese to a dog), action explanations may be inaccurate.

In summary, the research reviewed thus far suggests that 3-year-olds tend to abide by the priority principle when making judgments about the physical world (e.g., which marble caused the jack to jump; Bullock & Gelman, 1979; Rankin & McCormack, 2013). However, when reasoning about intentional action, for example, 3-year-olds will often change/misstate their prior intention to fit with an outcome that is associated with their action (e.g., Gopnik & Slaughter, 1991), seemingly “violating” the priority principle. More broadly, the knowledge that children have about the world (e.g., scripts) can often bias their memory for past events. Returning to the “dog-mouse” scenario described earlier, research suggests that 3-year-olds (and also possibly 4-year-olds) should have difficulty with this scenario because the belief upon which their intention was based (i.e., dog present) was unexpectedly changed
(i.e., mouse present). However, it is unclear how older children (i.e., 5-year-olds) would perform in this context. Although they should be adept at reporting their prior intention (i.e., “to feed the dog”), the association that they hold between “cheese” and “mouse” (or, the script “feeding cheese to a mouse”) is stronger than the association between “cheese” and “dog.” As such, it is possible that this associative knowledge will compete with (and possibly override) 5-year-olds’ understanding of the priority principle and/or false belief, for example, thus leading them to explain their action by stating that they had intended to feed cheese to the mouse rather than to the dog. Assessing how children explain their actions in this type of context is important because a sophisticated understanding of causal explanation must include the recognition that, under no circumstances, can information presented after one acted explain the cause of one’s action.

In a series of three experiments, we tested 3-, 4-, and 5-year-olds’ understanding that the causes of their actions must necessarily be attributed to information known prior to (i.e., “pre-action” information), rather than after (i.e., “post-action” information), the completion of their actions. All three experiments entailed variations of the “dog-mouse” scenario described earlier. Despite several manipulations to reduce verbal and memorial demands in Experiments 2–3, all three age groups had difficulty correctly explaining the cause of their action. Thus, in one final experiment, we tested 6- and 7-year-olds using the same tasks as in Experiment 1 to pinpoint when in development children’s explanations for the causes of their actions are no longer influenced by “associative” post-action information.

**Experiment 1**

**Method**

**Participants.** The sample included 36 children: twelve 3-year-olds (6 boys; mean age = 41.4 months, range = 38 to 47 months), twelve 4-year-olds (6 boys; mean age = 52.2 months, range = 48 to 56 months), and twelve 5-year-olds (6 boys; mean age = 64.7 months, range = 60 to 71 months). Most participants were from middle-class backgrounds and were predominantly White, but the sample also included several children of Asian and African descent. Children either spoke English as their first language or were bilingual English and French speakers. Participants were recruited in a large city using advertisements in newspapers, daycares, and local retailers. Children received a small gift for their participation.

**Design and procedure.** Participants were tested individually in a laboratory playroom by a female experimenter. Prior to each testing session, materials were placed in a set of drawers next to the experimenter’s chair. Additional materials were placed in a second set of drawers in the hallway outside the testing room. Upon entering the testing room, children were introduced to Elmo (a hand puppet controlled by the experimenter). The experimenter explained to children that they would be playing games with Elmo and that Elmo would be asking them some questions. These “games” consisted of four test trials and four control trials presented in one of three randomized orders with the stipulation that the first trial was always the “crayon” control trial (see “Control trials” section, below) to serve as a warm-up for children. All testing sessions were video recorded.

**Test trials.** In the section that follows, we describe the structure of the test trials, using the *pennies trial* as an example. In all test trials, children were given a reason to perform an action (e.g., retrieve pennies from the hallway to put in a box). This “pre-action” information was plausible and consistent with the current state of the world (e.g., children were shown an open box on the table in front of them). While children retrieved the object (and were thus absent from the room), the experimenter replaced the item that was initially on the table (e.g., the box) with another item (e.g., a piggy bank). When children returned with the object, they were shown that the state of the world upon which they had initially acted had changed (e.g., the experimenter said, “Oh look, now there’s a piggy bank on the table”). Although this “post-action” information (i.e., piggy bank) was causally irrelevant to the action the children had performed, it was associated with it (i.e., pennies go in piggy banks). The piggy bank remained on the table while children were then asked the *action explanation question* by Elmo (e.g., “Why did you go get the pennies?”). If children did not respond to this question, they were immediately asked a forced-choice question (i.e., “Did you go get the pennies to put them in the box or to put them in the piggy bank?”) with the two response options counterbalanced across participants. Note that this forced-choice question was only needed in $n = 2$ instances across all four test trials in this experiment.

In addition to the pennies trial, children were administered three other test trials. In the *sponge trial*, children were shown the Elmo doll, and the experimenter then stated: “You know what? Elmo really likes sponges. There’s a sponge in the drawer in the hall, can you go get the sponge to show Elmo?” While children were absent from the room, the experimenter poured water on the table. When the children returned to the room, the experimenter stated, “Oh no! I spilled some water on the table!” The water remained on the table while children were then asked the action explanation question by Elmo: “Why did you go get the sponge?” If children did not respond to this question, they were immediately asked a forced-choice question (i.e., “Did you go get the sponge to clean up the water or to show it to Elmo?”) with the two response options counterbalanced across participants.

In the *cheese trial*, the experimenter placed a stuffed dog on the table and stated: “Look, here’s a dog. Can you go get some cheese to feed to the dog? There’s some cheese in the drawer in the hall.” While children were absent from the room, the experimenter removed the dog from the table and replaced it with a toy mouse. When the children returned to the room, the experimenter stated, “Oh look, now there’s a mouse on the table!” The mouse remained on the table while Elmo asked children the action explanation question: “Why did you go get the cheese?” If children did not respond, they were immediately asked a forced-choice question (i.e., “Did you go get the cheese to feed the mouse or to feed the dog?”) with the two response options counterbalanced across participants.

In the *glue trial*, the experimenter stated: “I know that there’s some glue in the drawer in the hall, but, I don’t know if it’s a big bottle or a small bottle of glue. Can you go get the bottle of glue for me so that I can see if it’s big or small?” While children retrieved the glue from the drawer, the experimenter placed a smiley face with one eye missing on the table (the missing “eye” was placed next to the smiley face on the table). When the children returned to the room, the experimenter stated, “Oh look, Elmo
found this smiley face and one of its eyes fell off!” The smiley face remained on the table while children were then asked the action explanation question by Elmo: “Why did you go get the glue?” If children did not respond to this question, they were immediately asked a forced-choice question (i.e., “Did you go get the glue so I could see if it was a small bottle or a big bottle or to glue the eye on the smiley face?”) with the two response options counterbalanced across participants.

**Control trials.** In addition to the test trials, four control trials were administered to obtain a baseline level of children’s explanatory competence when no post-action information was provided. For example, in one control trial (the crayon trial), children were shown a piece of paper and asked to get a crayon to color on the paper. When children returned, the paper was still on the table and children were asked the action explanation question (i.e., “Why did you go get the crayon?”). The three remaining control trials involved retrieving a stamp to put on a letter, a puzzle piece to complete a puzzle, and a picture of an animal to find out what animal it was.

Only at the end of the experimental session were children allowed to perform any of the actions (e.g., put pennies in the piggy bank), if they so desired.

**Coding and reliability.** The following categories were used to code the action explanation questions for both the test and control trials:

1. **pre-action:** Explanations that referenced the pre-action information (e.g., “To show Elmo the sponge,” “To show him,” “To put them [the pennies] in the box,” “For the dog,” “To see if it [the glue] was huge or small”) or referenced the experimenter having asked them to perform the action (e.g., “Because you asked me to”) were considered correct and received a score of 1.

2. **post-action:** Explanations that referenced the post-action information (e.g., “To clean up the water,” “To put in the piggy bank,” “For the mouse,” “To glue the eye back on the happy face”) were considered incorrect and received a score of 0.

3. **Irrelevant Response:** Irrelevant explanations (e.g., “Because I opened the drawer,” “Because the pennies were in the hallway”) were also considered incorrect and received a score of 0.

4. **No response:** This category included such responses as “I just wanted to,” “Because,” and “I don’t know” and were also considered incorrect and received a score of 0.

All of the children’s explanations were coded by the second author. The fourth author also independently coded 100% of the testing sessions from the DVD recordings. Mean Cohen’s kappa was .94 across all variables. All disagreements were resolved through discussion.

**Results and Discussion**

Preliminary analyses revealed no effects of sex or order of trial administration and so we collapsed the data across these variables. To obtain an overall assessment of the types of explanations that children provided, we summed the action explanation codes across the entire sample for each of the four test trials ($n = 144$), and the four control trials ($n = 144$; see Table 1 for a Code × Trial breakdown). Across all age groups, 16.7% of children’s explanations on the test trials referenced the pre-action information (e.g., “to feed the dog”) and were thus scored as correct, whereas the corresponding percentage on the control trials was 84.7%.

**Table 1**

*Response Frequencies for Test and Control Trials: Experiment 1*

<table>
<thead>
<tr>
<th>Code</th>
<th>Test trials</th>
<th>Control trials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sponge</td>
<td>4 (11.1)</td>
<td>30 (83.3)</td>
</tr>
<tr>
<td>Cheese</td>
<td>11 (30.5)</td>
<td>23 (63.9)</td>
</tr>
<tr>
<td>Pennies</td>
<td>3 (8.3)</td>
<td>29 (80.6)</td>
</tr>
<tr>
<td>Glue</td>
<td>6 (16.7)</td>
<td>30 (83.3)</td>
</tr>
<tr>
<td>Pre-action (correct)</td>
<td>4 (11.1)</td>
<td>30 (83.3)</td>
</tr>
<tr>
<td>Post-action (correct)</td>
<td>31 (86.1)</td>
<td>34 (94.4)</td>
</tr>
<tr>
<td>Irrelevant (correct)</td>
<td>3 (8.3)</td>
<td>3 (8.3)</td>
</tr>
<tr>
<td>No response (correct)</td>
<td>3 (8.3)</td>
<td>2 (5.6)</td>
</tr>
<tr>
<td>Pre-action (incorrect)</td>
<td>2 (5.6)</td>
<td>2 (5.6)</td>
</tr>
<tr>
<td>Post-action (incorrect)</td>
<td>2 (5.6)</td>
<td>2 (5.6)</td>
</tr>
<tr>
<td>Irrelevant (incorrect)</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>No response (incorrect)</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>

*Note.* Numbers in parentheses represent corresponding percentages.

**Trial and age differences.** We entered children’s scores on the test trials (range = 0 to 4) and the control trials (range = 0 to 4) into a mixed analysis of variance (ANOVA), with trial type (test, control) as a within-subjects factor and age (3, 4, 5) as a between-subjects factor. Results revealed a significant main effect of trial type, $F(1, 33) = 142.76, p < .001, \eta^2_p = .81$, indicating that children explained their actions correctly significantly more often on the control trials ($M = 3.39, SD = 1.08$) than on the test trials ($M = 6.7, SD = 1.10$). No significant main effect of age or a Trial Type × Age interaction was detected (Figure 1).

Whereas children performed extremely well on the control trials, their performance on the test trials was poor. This pattern suggests that children’s ability to correctly explain the cause of their action was compromised by the associative post-action information and not by the broader capacity to generate an explanation. If so, then varying the associative strength of the post-action information (e.g., strongly vs. weakly associated with children’s action) should impact children’s performance. However, before doing so we wanted to rule out the possibility that children may have simply been unable to remember/access the initial cause of their action and thus, by default, assumed that their action was premised on a goal related to the new object (e.g., “feed the mouse”) that now appeared before them. Such a memory difficulty is different from an “associative” one. We tested this alternative interpretation in Experiment 2 by making the pre- and post-action information equally accessible to children by having photographs of each item present when the test question was asked. If children’s limitation is mainly memorial in nature, then they should perform well on the test trials. However, if children are indeed unduly influenced by the association between the new object and their action, they will continue to have difficulty with these trials.

1 Across control and test trials in Experiments 1, 2, 3, and 4, children only provided this response 5.6%, 2.1%, 2.1%, and 4.7% of the time, respectively.

2 This code does not apply to the control trials, in which the initial state of the world remained unchanged.
Experiment 2

Method

Participants. The sample included 36 children who had not participated in Experiment 1: twelve 3-year-olds (5 boys; mean age = 40.8 months, range = 36 to 47 months), twelve 4-year-olds (6 boys; mean age = 53.2 months, range = 49 to 59 months), and twelve 5-year-olds (6 boys; mean age = 65.1 month, range = 60 to 71 months). Sample characteristics, recruitment, and remuneration were the same as in Experiment 1.

Design and procedure. Participants received four test trials and four control trials presented in one of three randomized orders, with the stipulation that the first trial was always the “crayon” control trial to serve as a warm-up for children.

Test trials. The four test trials were identical to those in Experiment 1, except that the test question was presented in a forced-choice format after the second object (i.e., piggy bank, mouse, smiley face) had been removed from the table. For example, in the pennies trial, children were asked by Elmo “Did you go get the pennies so you could put them in the box or so you could put them in the piggy bank?” (order of options counterbalanced). This test question was accompanied by photographs representing the correct pre-action information (i.e., box) and incorrect post-action information (i.e., piggy bank). Note, however, that for the sponge trial, the water needed to remain on the table because wiping it up may have cued children to what was in fact the incorrect response (i.e., that they went to get the sponge to wipe up the water).

Control trials. The four control trials were identical to those in Experiment 1.

Coding and reliability.

Test trials. Children’s responses to the test question were considered correct if children pointed to/verbally labeled the photo depicting the pre-action information (e.g., on the cheese trial, the child pointed to/verbally labeled the photo of the dog). Responses were coded as incorrect if children pointed to/verbally labeled the photo depicting the post-action information (e.g., on the cheese trial, the child pointed to/verbally labeled the photo of the mouse), or responded “I don’t know.”

Control trials. These trials were coded using the same coding scheme described in Experiment 1.

All of the children’s responses were coded by the second author. The fourth author independently coded 100% of the testing sessions from the DVD recordings. Mean Cohen’s kappa was .95 across all variables. All disagreements were resolved through discussion.

Results and Discussion

Preliminary analyses revealed no effects of sex or order of trial administration and so we collapsed the data across these variables. To obtain an overall assessment of the types of responses that children provided, we summed the codes across the entire sample for each of the four test trials (n = 144), and the four control trials (n = 144; Table 2). Across all age groups, 51.4% of children’s responses on the test trials referenced the pre-action information and were scored as correct, whereas the corresponding percentage on the control trials was 75.0%.

Trial and age differences. We entered children’s scores on the test trials (range = 0 to 4) and the control trials (range = 0 to 4) into a mixed ANOVA, with trial type (test, control) as a within-subjects factor and age (3, 4, 5) as a between-subjects factor. Results revealed a significant main effect of trial type, F(1, 33) = 10.01, p = .003, ηp2 = .23, indicating that children’s responses were correct significantly more often on the control trials (M = 3.00, SD = 1.37) than on the test trials (M = 2.06, SD = 1.37). No significant main effect of age or a Trial Type × Age interaction was detected (Figure 2). Moreover, children’s performance on each of the test trials was not significantly higher than chance (all ps > .24).

Presenting the response options in a forced-choice format made the correct and incorrect responses equally accessible to children and thus reduced both verbal and memorial demands. Yet, children did not select the correct explanation for their action significantly more often than chance at any of the three ages. As such, children’s poor performance on the test trials in Experiment 1 cannot be explained in terms of memory difficulties alone. This finding supports our claim that children’s failure to correctly report the cause of their action on the test trials is at least partly influenced by post-action associative information.

Table 2

<table>
<thead>
<tr>
<th>Code</th>
<th>Post-action (correct)</th>
<th>Post-action (incorrect)</th>
<th>Points to both photos (incorrect)</th>
<th>Irrelevant (incorrect)</th>
<th>No response (incorrect)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sponge</td>
<td>21 (58.3)</td>
<td>12 (33.3)</td>
<td>3 (8.3)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Cheese</td>
<td>22 (61.1)</td>
<td>14 (38.9)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Pennies</td>
<td>16 (44.4)</td>
<td>20 (55.6)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Glue</td>
<td>15 (41.7)</td>
<td>18 (50.0)</td>
<td>1 (2.8)</td>
<td>1 (2.8)</td>
<td>1 (2.8)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test trials</th>
<th>Crayon Stamp Puzzle Picture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-action (correct)</td>
<td>26 (72.2)</td>
</tr>
<tr>
<td>Irrelevant (incorrect)</td>
<td>4 (11.1)</td>
</tr>
<tr>
<td>No response (incorrect)</td>
<td>6 (16.7)</td>
</tr>
</tbody>
</table>

Note. Numbers in parentheses represent corresponding percentages. There was one response in the Glue trial that was not codable, thus the n for this trial was 35.
However, another possibility is that children were simply attributing the cause of their action to the most recent object (e.g., “mouse”) they had seen on the table. We addressed this possibility in Experiment 3 by assigning children to one of three experimental conditions: (a) post-action associative: In this condition (as in the previous two experiments), the post-action information was more highly associated with children’s action than the pre-action information (e.g., children retrieved cheese to feed a dog but then returned to find a mouse); (b) non-associative condition: In this condition, both the pre- and post-action information were equally (un)associated with children’s action (e.g., children retrieved cheese to feed a dog but then returned to find a cat), and (c) pre-action associative condition: In this condition, the pre-action information was more highly associated with the action than the post-action information (e.g., children retrieved cheese to feed a mouse but returned to find a dog; see Figure 3 for the two trials used in each condition).

If children are simply attributing the cause of their action to the most recent object that they saw on the table, then they should perform equally poorly in all three conditions because, in each, the last object on the table was not the cause of their action. If, however, it is the associative post-action information that is driving children’s errors then they should perform significantly worse on the post-action associative condition compared with both the non-associative and pre-action associative conditions.

**Experiment 3**

**Method**

**Participants.** Participants were eighteen 3-year-olds (11 boys; mean age = 42.4 months, range = 39 to 46 months), nineteen 4-year-olds (11 boys; mean age = 53.4 months, range = 48 to 59 months), and thirteen 5-year-olds (7 boys; mean age = 65.2 months, range = 60 to 70 months). Sample characteristics, recruitment, and remuneration were the same as in Experiments 1 and 2.

**Design and procedure.** Participants were randomly assigned to one of three conditions that always entailed first receiving the crayon control trial followed by two test trials in counterbalanced order.

**Post-action associative condition.** The two test trials were identical to the pennies and cheese trials used in Experiment 1 (i.e., children received post-action information that was associated to the action they had just performed), save that a bowl was used instead of the box for the pennies trial.

**Non-associative condition.** In this condition, pre- and post-action information were both unassociated with children’s action. For example, children retrieved pennies to put in a bowl. When children returned with the pennies, a glass had replaced the bowl and, with the glass on the table, Elmo asked them why they had retrieved the pennies (and, if necessary, the corresponding forced-choice question). In the second test trial, children retrieved cheese to feed a dog. When they returned to find that a cat had replaced the dog, with the cat on the table, they were asked by Elmo why they had retrieved the cheese and, if necessary, the corresponding forced-choice question.3 Note that the forced-choice question was only asked in n = 2 instances across all three conditions in this experiment.

**Pre-action associative condition.** In this condition, children’s action was more highly associated with the pre-action information than with the post-action information. For example, children retrieved pennies to put in a piggy bank. When they returned, a bowl had replaced the piggy bank and, with the bowl on the table, they were asked why they had retrieved the pennies and, if necessary, the corresponding forced-choice question.

**Coding and reliability.** Test trials were coded as in Experiment 1, and all of the children’s explanations were coded by the fourth author. A trained undergraduate psychology student blind to the experiment’s hypotheses independently coded 100% of the testing sessions from the DVD recordings. Mean Cohen’s kappa was .99 across all variables. All disagreements were resolved through discussion.

**Results and Discussion**

Preliminary analyses revealed no effects of sex or counterbalancing order, so we collapsed the data across these variables.

**Test trials.** To obtain an overall assessment of the types of explanations that children provided, we summed the codes for children’s explanations on the two test trials for the post-action associative, non-associative, and pre-action associative conditions (n = 34, n = 34, and n = 32, respectively; see Table 3 for a Code × Condition breakdown).

We entered children’s scores on the test trials (range = 0 to 2) into a univariate ANOVA, with condition (post-action associative, non-associative, and pre-action associative) and age (3, 4, 5) as between-subjects factors. Results revealed a significant main effect of condition, F(2, 41) = 11.16, p < .001, ηp² = .35. No significant

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3 To ensure that the pre- and post-action information were equally unassociated with the performed action, half of the children in this condition received reversed versions of the trials described in the text (i.e., they retrieved pennies to put in a glass and returned to find that a bowl had replaced the glass, and retrieved cheese to feed a cat and returned to find that a dog had replaced the cat). Analyses revealed that children’s ability to explain their actions in this condition did not differ as a function of item order.
main effect of age or an Age × Condition interaction was detected (Figure 4).

Planned contrasts (Fisher’s Least Significant Difference, LSD) revealed that, as hypothesized, children performed significantly worse on the post-action associative condition compared with both the non-associative ($p < .05$) and pre-action associative ($p < .001$) conditions. This finding supports our claim that associative post-action information significantly interferes with children’s ability to correctly explain their actions. However, the fact that children also performed significantly better in the pre-action associative condition compared with the non-associative condition ($p < .05$) suggests that children are also biased to mention the last object that they saw on the table as the cause of their action.

**Experiment 4**

In light of the finding that children’s performance on the test trials in the previous three experiments did not improve with age, the goal of Experiment 4 was to examine the performance of a group of 6- and 7-year-olds on these same trials. These age groups were chosen because previous research suggests that children’s use of scripts and categorical knowledge (e.g., gender stereotypes) becomes more flexible in early childhood (e.g., Hudson & Nelson, 1983; Martin & Ruble, 2004).

**Method**

**Participants.** The sample included 24 children: twelve 6-year-olds (6 boys; mean age = 79.0 months, range = 73 to 83 months) and twelve 7-year-olds (7 boys; mean age = 89.8 months, range = 84 to 94 months). Sample characteristics, recruitment, and remuneration were the same as in the previous experiments.

**Design and procedure.** Design and procedure were identical to Experiment 1.

**Coding and reliability.** Test and control trials were coded as in Experiment 1. Note that the forced-choice question (e.g., “Did you go get the pennies to put them in the box or to put them in the piggy bank?”) was only asked in one instance in this Experiment. All of the children’s explanations were coded by the second

<table>
<thead>
<tr>
<th>Condition</th>
<th>Trial</th>
<th>Initial Cause for Action</th>
<th>Action</th>
<th>Post-action Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Post-Action Associative</td>
<td>A</td>
<td>Put pennies in bowl</td>
<td>Retrieve pennies</td>
<td>Piggy bank on table (bowl gone)</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>Feed cheese to dog</td>
<td>Retrieve cheese</td>
<td>Mouse on table (dog gone)</td>
</tr>
<tr>
<td>2. Non-Associative</td>
<td>A</td>
<td>Put pennies in bowl</td>
<td>Retrieve pennies</td>
<td>Glass on table (bowl gone)</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>Feed cheese to dog</td>
<td>Retrieve cheese</td>
<td>Cat on table (dog gone)</td>
</tr>
<tr>
<td>3. Pre-Action Associative</td>
<td>A</td>
<td>Put pennies in piggy bank</td>
<td>Retrieve pennies</td>
<td>Bowl on table (piggy bank gone)</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>Feed cheese to mouse</td>
<td>Retrieve cheese</td>
<td>Dog on table (dog gone)</td>
</tr>
</tbody>
</table>

*Figure 3. Trials used in the post-action associative, non-associative, and pre-action associative conditions: Experiment 3. See the online article for the color version of this figure.*
Results and Discussion

Preliminary analyses revealed no effects of sex or counterbalancing order, so we collapsed the data across these variables.

Trials and age differences. We entered children’s scores on the test trials (range = 0 to 4) and the control trials (range = 0 to 4) into a mixed ANOVA, with trial type (test, control) as a within-subjects factor and age (6, 7) as a between-subjects factor. Results revealed a significant main effect of trial type, $F(1, 22) = 33.8, p < .001, \eta_p^2 = .61$, indicating that children explained their actions correctly more often on the control trials ($M = 3.96, SD = .20$) than on the test trials ($M = 2.33, SD = 1.61$). However, this time, a significant main effect of age was also detected, $F(1, 22) = 12.46, p = .002, \eta_p^2 = .36$: 7-year-olds ($M = 3.63, SD = .67$) performed significantly better than 6-year-olds ($M = 2.67, SD = .67$). However, these main effects were qualified by a significant Trial Type $\times$ Age interaction, $F(1, 22) = 9.80, p = .005, \eta_p^2 = .31$ (Figure 5).

To follow up on this significant interaction, we conducted two one-way ANOVAs with age (6, 7) as the between-subjects factor. The first ANOVA, with test trial scores (range = 0 to 4) as the dependent variable, revealed that 7-year-olds ($M = 3.25, SD = 1.14$) performed significantly better than 6-year-olds ($M = 1.42, SD = 1.51$), $F(1, 22) = 11.33, p = .003, \eta_p^2 = .34$ (see Table 4 for response frequencies on each of the test trials). The second ANOVA, with control trial scores as the dependent variable, indicated that 6-year-olds’ ($M = 3.92, SD = .29$) and 7-year-olds’ ($M = 4.00, SD = .00$) performance on the control trials was not significantly different. These results thus suggest that there is an important developmental shift that occurs in the early school years in children’s ability to override post-action associative information to consider the (correct) cause of their action.

General Discussion

Understanding that causes precede their effects or, the “priority principle,” is critical to a mature concept of causality. Children seem to grasp this principle by 3 years of age as it pertains to the physical world. But, do children also apply it in their reasoning about the psychological world and, more specifically, to identify the causes of their own actions? To address this question, we designed a task in which children were given a plausible cause to perform an action (e.g., get some cheese to feed a dog) but, after doing so, discovered that the “physical evidence” of this cause (i.e., the dog) had disappeared and a new, causally irrelevant, but highly associative, object (a mouse) had replaced it. Children were then asked to explain/identify the cause of their action.

Table 4
Response Frequencies on Test Trials: Experiment 4

<table>
<thead>
<tr>
<th>Code</th>
<th>Sponge</th>
<th>Cheese</th>
<th>Pennies</th>
<th>Glue</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-year-olds</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-action (correct)</td>
<td>5 (41.7)</td>
<td>6 (50.0)</td>
<td>4 (33.3)</td>
<td>2 (16.7)</td>
</tr>
<tr>
<td>Post-action (incorrect)</td>
<td>7 (58.3)</td>
<td>6 (50.0)</td>
<td>8 (66.7)</td>
<td>10 (83.3)</td>
</tr>
<tr>
<td>Irrelevant (incorrect)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>No response (incorrect)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>7-year-olds</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-action (correct)</td>
<td>8 (66.7)</td>
<td>11 (91.7)</td>
<td>10 (75.5)</td>
<td>10 (83.3)</td>
</tr>
<tr>
<td>Post-action (incorrect)</td>
<td>4 (33.3)</td>
<td>1 (8.3)</td>
<td>1 (8.3)</td>
<td>2 (16.7)</td>
</tr>
<tr>
<td>Irrelevant (incorrect)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>No response (incorrect)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>1 (8.3)</td>
<td>0 (0.0)</td>
</tr>
</tbody>
</table>

Note. Numbers in parentheses represent corresponding percentages.
Our results were relatively straightforward. When children were presented with post-action information (e.g., mouse) that was highly associated with their action (e.g., getting cheese), they incorrectly used it to explain their action (e.g., “I went to get the cheese to feed the mouse”; Experiments 1, 2, and 3). One possibility that we subsequently explored in Experiment 2 was that children failed our tasks because they simply could not remember/ access the initial information (e.g., dog) that led to their action. If so, we reasoned that simultaneously providing them with photographs of both the pre- and post-action information (e.g., “dog” and “mouse”) would improve their performance. However, results indicated that none of the three age groups chose the correct pre-action information as the cause of their action at higher than chance levels.

A different possibility is that children attributed the cause of their action to the last piece of information with which they had been presented, regardless of whether or not they remembered the initial information. We tested this possibility in Experiment 3 by randomly assigning children to three different conditions. The post-action associative condition was identical in structure to the test trials that children received in Experiment 1. We also included a pre-action associative condition in which the pre-action information (e.g., “mouse”) was more highly associated with children’s action (e.g., “get cheese”) than the post-action information (e.g., “dog”). Finally, we included a non-associative condition in which both the pre- (“dog”) and post-action (e.g., “cat”) information were not associated with children’s actions. If children simply attribute the cause of their action to the last piece of information with which they are presented, then we would expect them to have equal difficulty with all three of these conditions because, for each, the last piece of information represents the incorrect cause. However, children performed significantly worse in the post-action associative condition than they did in either the pre-action or non-associative conditions (Figure 4). The results of these three experiments thus converge to support the claim that associative post-action information substantially interferes with preschoolers’ ability to correctly explain/identify the causes of their actions.

One striking aspect of our results is that the 5-year-olds in our experiments performed no better than the 3-year-olds. We believe that one of the reasons that we did not detect significant age-related differences is because the younger (i.e., 3-year-olds) and older (i.e., 4- to 6-year-olds) children were failing our tasks for different reasons. Specifically, the primary source of difficulty for the 3-year-olds may have centered on understanding false beliefs. That is, to succeed, children may have needed to acknowledge that they had falsely believed, or “expected,” that the dog, for example, would be present when they returned. This difficulty, combined with limitations in executive functioning, most notably inhibitory control, may have led younger children to err on our tasks. As such, a future direction of research is to run our task alongside tasks of executive functioning and theory of mind. Because children’s performance on such tasks improves quite dramatically between ages 3 and 5 (e.g., Bernstein, Atance, Meltzoff, & Loftus, 2007; Bernstein, Erdfelder, Meltzoff, Peria, & Loftus, 2011), such an improvement could account for the poor performance of the older preschoolers (and the 6-year-olds in Experiment 4). Rather, we believe that what may have led older children to err is the fact that their script-based knowledge is becoming more developed during the preschool (and early school) years and is more readily drawn upon in their reasoning (e.g., Hudson & Nelson, 1983). Similarly, according to fuzzy-trace theory (e.g., Brainerd & Reyna, 2002) memory representations fall on a continuum from more literal/ verbatim to more gist-like, or “fuzzy.” Whereas younger children tend to rely more heavily on verbatim traces compared with gist-like traces, the opposite is true of older children and adults. Accordingly, older children may have been more likely to “fall prey” to the association between “mouse” and “cheese” thus leading them to falsely claim that they went to get the cheese to feed the mouse.

Such an associative account has been proposed by Howe and his colleagues (e.g., Howe & Wilkinson, 2011) in the realm of false memories and, more specifically, that an associative activation of concepts in an individual’s knowledge base is ultimately responsible for memory errors in children and adults. In the context of our study then, because “cheese” is more highly associated with “mouse” than with “dog,” for example, when children are asked to explain why they went to get the cheese, the concept of “mouse” is activated thus leading them to incorrectly attribute it as the cause of their action. If so, then children with better associative knowledge (e.g., “mice eat cheese”) should actually perform worse on our task. Yet given that the 7-year-olds in our study should have the strongest associative knowledge of all, this account cannot explain why they were practically at ceiling on our task (Figure 5).

One possibility is that children’s script-based knowledge—though presumably still improving—may lead to less memory bias at this stage in development. This is consistent with research that suggests that children’s use of scripts in structuring their recall becomes more flexible around age 7 (e.g., Hudson & Nelson, 1983). It is also around this age that children become more flexible in their gender stereotypes (e.g., Martin & Ruble, 2004; Trautner et al., 2005). Alternatively, it may be that the processes that children draw upon to formulate their responses/explanations change with development. Although at first glance our results appear inconsistent with the notion that older children rely more heavily on gist-like memory representations (which would in turn lead to incorrect responses on our task), it is important to note that both gist-like and verbatim processing improve with age (Brainerd & Reyna, 2002). As such, older children’s improved verbatim
recall, at least in the context of our task, may ultimately allow them to reject the possibility that they retrieved the cheese to feed the mouse because they clearly remember getting the cheese to feed the dog. Nonetheless, it is possible that after longer delays (e.g., several days/weeks) the relative weighting of gist-like over verbatim memory traces increases which would result in even 7-year-olds (and possibly older children/adults) claiming that they got the cheese to feed the mouse. This prediction is consistent with fuzzy-trace theory’s claim that verbatim traces decay more rapidly over time than gist traces (or the memory for meaning) and will thus become less accessible (see also Hudson & Nelson, 1983, and Ornstein et al., 1998, for the argument that children’s recall becomes more schematic over time).

Conclusion

By age 3, children tend to abide by the priority principle as it pertains to the physical world (e.g., Bullock & Gelman, 1979). In contrast, our experiments support the idea that when young children are asked to reason about the psychological world—and about the causes of their own actions, in particular—there are contexts in which they appear to abandon this principle. More specifically, when post-action information (e.g., “mouse”) is more highly associated with children’s action (“get cheese”) than was the pre-action information (“dog”), children younger than age 7 err. These incorrect causal attributions cannot solely be explained by limitations in memory (Experiment 2), or by a tendency to attribute the cause of one’s action to the last piece of information presented (Experiment 3). Whether children would make a similar error in other domains of causal reasoning (e.g., biological) remains to be determined but is an interesting area for future research. We have argued that a number of factors (e.g., inhibitory control, associative knowledge) likely contribute to the errors that children make. Although the precise mechanisms through which these factors interact with age remain to be determined, our findings nevertheless shed light on the sorts of contexts that influence young children’s memory, causal reasoning, and action explanation.

References


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Call for Nominations

The Publications and Communications (P&C) Board of the American Psychological Association has opened nominations for the editorships of Developmental Psychology and the Journal of Consulting and Clinical Psychology for the years 2017–2022. Jacquelynne S. Eccles, PhD, and Arthur M. Nezu, PhD, respectively, are the incumbent editors.

Candidates should be members of APA and should be available to start receiving manuscripts in early 2016 to prepare for issues published in 2017. Please note that the P&C Board encourages participation by members of underrepresented groups in the publication process and would particularly welcome such nominees. Self-nominations are also encouraged.

Search chairs have been appointed as follows:

- Developmental Psychology, Suzanne Corkin, PhD, and Mark Sobell, PhD
- Journal of Consulting and Clinical Psychology, Neal Schmitt, PhD, and Annette LaGreca, PhD

Candidates should be nominated by accessing APA’s EditorQuest site on the Web. Using your Web browser, go to http://editorquest.apa.org. On the Home menu on the left, find “Guests.” Next, click on the link “Submit a Nomination,” enter your nominee’s information, and click “Submit.”

Prepared statements of one page or less in support of a nominee can also be submitted by e-mail to Sarah Wiederkehr, P&C Board Search Liaison, at swiederkehr@apa.org.

Deadline for accepting nominations is January 7, 2015, when reviews will begin.