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Research into young children's counterfactual thinking is equivocal about how children's counterfactual responses to causal events may be affected by the length of the causal inference required. This study examined the causal length effect in 3- and 4-year-old children (N=87). Children participated in two counterfactual inference tasks involving causally-related sequences of events. One task entailed counterfactual emotional judgements about the experience of characters in stories, whereas the other task entailed a counterfactual inference about a potential alternative outcome to a physical event. Children at each age level were randomly assigned to answer test questions that required a long, medium, or short counterfactual inference. Four-year-olds outperformed 3-year-olds in both tasks, but this age difference was mediated by children's language ability. More striking was the complete absence of difference among causal length conditions in both tasks. Our results support other studies that question the nature of the causal length effect in children's counterfactual reasoning. We discuss the possibility that children's developing understanding of temporal versus causal relationships may account for discrepant findings regarding the causal length effect.

Keywords

Preschool, children, counterfactual, inferences, causal, length, effect, revisited

Disciplines

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Preschool Children's Counterfactual Inferences: The Causal Length Effect Revisited

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Abstract

Research into young children's counterfactual thinking is equivocal about how children's counterfactual responses to causal events may be affected by the length of the causal inference required. This study examined the causal length effect in 3- and 4-year-old children ($N=87$). Children participated in two counterfactual inference tasks involving causally-related sequences of events. One task entailed counterfactual emotional judgements about the experience of characters in stories, whereas the other task entailed a counterfactual inference about a potential alternative outcome to a physical event. Children at each age level were randomly assigned to answer test questions that required a long, medium, or short counterfactual inference. Four-year-olds outperformed 3-year-olds in both tasks, but this age difference was mediated by children's language ability. More striking was the complete absence of difference among causal length conditions in both tasks. Our results support other studies that question the nature of the causal length effect in children's counterfactual reasoning. We discuss the possibility that children's developing understanding of temporal versus causal relationships may account for discrepant findings regarding the causal length effect.

Introduction

Thoughts of "what if" or "if only" are known as counterfactual thoughts, which posit alternatives to reality and involve mentally mutating some factual antecedent and making an assessment of the associated outcome of such an alteration (Roeser & Olson, 1995). The concept of mutability is central to how easily one can think counterfactually about an event (McGill & Tenbrunsel, 2000). A related concept is the well-established *causal order effect* (Segura, Fernandez-Berrocal, & Byrne, 2002; Wells, Taylor, & Turtle, 1987) – the finding that individuals will most likely mutate the first event in a causal sequence of events. This paper is concerned with 3- to 4-year-old children's ability to think counterfactually, and whether or not the causal order effect is evident in this age group.

It is evident from an increasing body of literature that children as young as 3 years of age already have some capacity to conceptualise what might have been, with this competence for counterfactual judgement reflected in young children's causal reasoning (Harris, German,

& Mills, 1996) and linguistic expression (Bowerman, 1986); and that this capability develops rapidly during the preschool years (German & Nichols, 2003; Guajardo & Turley-Ames, 2004; Harris et al., 1996). It has further been shown that young children's counterfactual thinking ability is associated with their language development as well as their theory of mind understanding (i.e., an understanding of one's own and others' mental states) (Guajardo & Turley-Ames, 2004). Beck, Robinson, Carroll, and Apperly (2006) also concluded that 3- and 4-year-olds can perform satisfactorily in standard counterfactual tasks. However, these researchers found that it is not until children are around 5 or 6 years old that they genuinely understand that for counterfactual thinking to occur, a situation must afford multiple possibilities for different outcomes to be possible.

Within the literature on children's counterfactual thinking, there are some distinct inconsistencies between empirical findings and associated explanations regarding the cognitive mechanisms underlying the counterfactual thinking abilities in preschool aged children. For instance, German and Nichols (2003) proposed that young children's difficulty with counterfactual reasoning stems from the complexity of the inferences required by the various tasks. They argue that the length of the chain of inferences required in some counterfactual thinking tasks – and the associated demands on working memory – makes the task more complicated for younger children. To address this proposal, German and Nichols designed an experimental paradigm that involved narrative stories and required an emotional based judgement. In the narrative there were three causally related events that resulted in a specific outcome. Three inference conditions based on the narratives used were constructed. The questions referred to the position in the causal chain that was addressed. The questions were referred to as long, medium and short conditions, corresponding to the first, second and third event respectively (German & Nichols, 2003).

To illustrate, consider the Flower story used in German and Nichols (2003, p. 517): "*Here is Mrs Rosy. She's just planted her new flower and she is very happy with it. She calls her husband from the house to come*

and have a look. When Mr Rosy opens the door to come into the garden, the dog escapes from the kitchen. The dog runs around the garden. Look, he jumps on the flower and squashes it! Now the flower is all flat and Mrs Rosy is sad." The questions for the three conditions were as follows, "What if the dog hadn't squashed the flower, would Mrs Rosy be happy or sad?"; "What if the dog hadn't escaped from the house, would Mrs Rosy be happy or sad?"; and "What if Mrs Rosy hadn't called her husband, would Mrs Rosy be happy or sad?" for the short, medium and long conditions, respectively.

Consistent with their prediction, German and Nichols (2003) found that 3- and 4-year-old children performed significantly better in the short condition than in the medium and long conditions. These researchers speculated that young children's difficulty with medium and long chain counterfactual inferences may be attributed to their still developing executive functions, specifically working memory and inhibitory control.

Beck et al. (2006) attempted to explain the findings of German and Nichols (2003) based on the difference between standard and open counterfactuals. The suggestion followed that the long causal chain requires one to think back to a situation where multiple possibilities could have occurred. It was proposed that children have difficulty with this, because it requires thinking about both the actual and counterfactual events as possibilities. Conversely the short inference condition could be correctly answered. By imagining an alternative outcome without relating that outcome to the current world, it was still possible to answer the short counterfactual inference question correctly. However, Beck et al. did not fully articulate why the same strategy could not be used in dealing with medium and long causal chain questions.

Interestingly too, in a replication of German and Nichols' (2003) study, Chan and Hahn (2007) found completely conflicting results with only two minor additions: the word 'now' was added to the experimental task questions (e.g., "what if the dog hadn't squashed the flower, would Mrs Rosy be happy or sad now?"; and the between subjects design was changed to a within subjects design in terms of counterfactual condition. With a sample of 3- and 4-year-olds, Chan and Hahn found that children performed better in the medium and long inference conditions and poorly in the short inference condition – the inverse of German and Nichols' findings. This pattern was replicated even when their data were reanalyzed by reintroducing a between subjects design, taking into account only the first inference chain condition received by each child. Measurement of both inhibitory control and working memory were included, and found to be implicated in the short inference condition but not in the medium and long conditions as was suggested by German and Nichols (2003). Likewise, Beck, Riggs and Gorniak

(2007) used the same experimental paradigm, and found results consistent with Chan and Hahn (2007). Beck et al. concluded that the long chain condition was not correlated to executive functions while the short condition was. Findings from these latter studies suggest that children as young as 3 or 4 years of age may already be sensitive to the causal order effect, and this sensitivity is reflected in their greater ease of drawing long chain counterfactual inferences.

In examining the impact of inference length it may be possible to ascertain whether or not the causal order effect is present and robust in 3- and 4-year-old children. If the causal order effect is present children should mutate the first event and hence perform better in the long inference length condition. In addition, the recent research legacy has involved an experimental paradigm that involves emotional based judgements regarding story-based task stimuli. An extension of this paradigm allowing an investigation of counterfactual judgements about physical events regarding stimuli presented via a more visual medium may remove the influence of young children's developing theory of mind, thus providing a more careful scrutiny of children's counterfactual thinking abilities.

The present study had two general aims. Firstly, it aimed to replicate the inference length findings of Chan and Hahn (2007), and in doing so, ascertain the causal order effect in children. Secondly, this study sought to extend the causal length experimental paradigm to examine young children's counterfactual judgements about physical events. In accordance with the findings of Beck et al. (2007) and Chan and Hahn (2007), we hypothesized that for story-based tasks and a task based on observing a physical event, children would perform better in the long inference condition than in the medium and short conditions. We also expected that age and language ability would be related to children's counterfactual thinking task performance.

Method

Participants

The sample comprised 42 three-year-olds (21 girls, 21 boys, $M=42.5$ months, range = 37-47) and 45 four-year-olds (23 girls, 22 boys, $M=53.0$ months, range = 48-61). The children attended one of seven different day care centres and preschools in central and northern Sydney with families from diverse socio-demographic backgrounds, and participated upon written parental consent. All participating children had an adequate understanding of the English language (as determined at the outset of testing by their teachers). Recruitment of participants and all research activities for this study were in accordance with protocol approved by the University of Wollongong Human Research Ethics Committee.

Materials and Procedure

The same female experimenter tested all children. Testing was done individually in a single experimental session that lasted up to 30 minutes. Children of each gender within each age level were randomly assigned to one of three inference conditions: short, medium or long. Approximately equal proportions across age and gender were maintained. Each child participated in two counterfactual thinking tasks – the causal story task and the mouse trap task. The ordering of these two tasks was counterbalanced across participants.

Causal Story Task. Two narratives and accompanying illustrations were taken from Chan and Hahn (2007). These tasks were modified from the original tasks used in German and Nichols (2003) (the “*Flower Story*” and “*Balloon Story*” – see the *Introduction* section for the script of the Flower story). The four illustrations depicting key elements of each story were printed in colour on A6 individual pages and laminated.

Children were presented with both stories; the order of story presentation was counterbalanced within age and gender groups. As each story was read each individual page was placed flat on a table, from left to right. After listening to the story, two control questions followed: (1) a ‘now’ control question (e.g., “*Just now, is Mrs Rosy happy or sad?*”), and (2) a ‘before’ control question (e.g., “*Right at the beginning, was Mrs Rosy happy or sad?*”). The test questions according to condition were as follows: *Short Inference*: “*What if the dog hadn’t squashed the flower, would Mrs Rosy be happy or sad now?*”; *Medium Inference*: “*What if the dog hadn’t escaped from the house, would Mrs Rosy be happy or sad now?*”; and *Long Inference*: “*What if Mrs Rosy hadn’t called her husband, would Mrs Rosy be happy or sad now?*” Whilst asking the accompanying questions, the experimenter pointed to the page of the corresponding event.

Mouse Trap Task. Following a pilot study, a 21-second video demonstration was developed and shown to the child. In this video a puppet was playing with an apparatus based on an adaptation of the game ‘Mouse Trap’[®]. The chain of causally related events resulted in the mouse being caught under a basket. The video was shown twice. During the second viewing, four laminated colour 10 cm x 13.31 cm pictures of the three separate events and resulting outcome were placed in front of the child. This was done to reinforce the sequence of events and to provide a memory aid. When the child was questioned, the experimenter pointed to the picture that corresponded to the appropriate event.

The video included the following narrative (with each key event pointed out in parentheses): “*In this game Tom the tiger is trying to trap the yellow mouse under the basket. He pushes over the bucket and the silver ball rolls down the stairs (Event 1), the ball drops into the*

yellow tub (Event 2) and the basket slides down the pole and trips the mouse (Event 3).” Consistent with the causal story task, two control questions (‘now’ and ‘before’) were then asked. Test questions according to the child’s assigned condition followed: *Short Inference*: “*What if the basket hadn’t fallen down the pole, would the mouse be free or caught under the basket now?*”; *Medium Inference*: “*What if the ball hadn’t fallen into the yellow tub, would the mouse be free or caught under the basket now?*”; and *Long Inference*: “*What if Tom hadn’t tipped the bucket, would the mouse be free or caught under the basket now?*”

Language Task. All children were tested using the Stanford-Binet Version 5, Intelligence Scale vocabulary subtest. This test was performed after the counterfactual thinking tasks. All participants began the vocabulary test at the second start level, for ages 3 and above. Questions were continued until the child received four consecutive 0 scores.

To recapitulate, within each counterfactual thinking task, a 2 (age group: 3 vs. 4 years) x 3 (counterfactual condition: short, medium, long) between-subjects factorial design was employed, with counterfactual thinking task performance as the dependent measure. Language task performance was assessed to ascertain the contribution of language development in counterfactual thinking task performance.

Results

Participants’ language scores (3-year-olds: $M = 19.19$, $SD = 3.87$; 4-year-olds: $M = 22.76$, $SD = 3.81$) were translated into standardized age equivalents. Overall the actual age equivalents of the sample ($M = 36.37$ months, $SD = 6.17$) were unexpectedly much lower than the actual age of the children ($M = 48.05$ months, $SD = 6.84$).

Causal Stories Task

For each story, the counterfactual question was scored in a binary code with 1 for a correct response and 0 for an incorrect response. A combined score was computed from the counterfactual responses on the flower and balloon stories. This was done following a significant correlation found between scores on both stories, $r = .594$, $p < .01$. Further, analysis of the stories individually found the same pattern of results as the combined analysis detailed here. For the children’s response to be included in this analysis, we required that they adequately comprehended the stories by answering both the ‘before’ and ‘now’ control questions correctly for both stories. This requirement resulted in a sample size of $N = 78$. The means of the combined score can be seen in Table 1.

We conducted a 2 (age group) x 3 (counterfactual condition) factorial ANCOVA on children’s performance in the causal stories task, with the raw language score included as a covariate. Language score

was significantly related to mean combined scores on this task, $F(1,71)=6.39$, $p=.014$. After controlling for language scores, no significant interaction effect was found between age group and counterfactual condition, $F(2,71)=.31$, $p=.732$. Inspection of the means in Table 1 showed a tendency for performance in the medium inference condition to be worse than that in either the short or long inference conditions. However, there was no statistically significant main effect of counterfactual condition¹, $F(2,71)=1.41$, $p=.252$, or age group, $F(1,71)=2.01$, $p=.160$.

Table 1: Mean Scores in Counterfactual Thinking Tasks

Condition/ Age Group	Task			
	Causal stories		Mouse trap	
	<i>n</i>	<i>M</i> (<i>SD</i>)	<i>n</i>	<i>M</i> (<i>SD</i>)
Short				
3 years	14	0.86 (.86)	10	0.60 (.52)
4 years	15	1.47 (.64)	14	0.79 (.43)
Medium				
3 years	12	0.58 (.67)	10	0.30 (.48)
4 years	13	1.08 (.86)	10	0.70 (.48)
Long				
3 years	10	0.90 (.99)	6	0.67 (.52)
4 years	14	1.29 (.73)	13	0.85 (.38)

Mouse Trap Task

The results of the mouse trap task revealed similar findings. Children were excluded from the analysis if they failed to answer both control questions correctly, resulting in $N=63$. The scores were assigned similarly to the causal stories task; children received a score of 1 for the correct response and 0 for an incorrect response. The mean scores are shown in Table 1.

The same analysis that was performed with respect to the causal stories task was repeated here. The ANCOVA revealed that language score was not significantly related to the mean scores on this task, $F(1,56)=.69$, $p=.410$. Furthermore, within this analysis, there was no significant interaction between counterfactual condition and age group, $F(2,56)=.14$, $p=.868$. The main effects were also nonsignificant, $F(2,56)=1.61$, $p=.210$, and $F(1,56)=2.52$, $p=.118$ for counterfactual condition and age group, respectively.

The results of the two tests investigating the causal order effect in both emotional based judgments (causal stories task) and judgements based on physical events (mouse trap task) revealed no significant effect of counterfactual condition. However, it is also evident that there is an age-related difference in counterfactual thinking task performance. In the causal stories task this

is shown to be accounted for by language ability as measured by a standardised vocabulary subtest.

Discussion

As expected, our results indicated that age had an influence on counterfactual performance in both tasks. Further, this age effect was accounted for by the children's language scores. These findings are consistent with previous studies (e.g., German & Nichols, 2003; Guajardo & Turley-Ames, 2004). However, we also obtained unexpectedly low age equivalents of the language scores in our sample. This finding might be due to the language test being administered as the final task in the testing session. So fatigue and lack of attention might in part contribute towards the lower scores in our sample. Within the current sample, however, we have provided further evidence that language development contributes substantially to age-related improvements in young children's counterfactual thinking competence, as has been suggested by previous research (e.g., Beck et al., 2006, 2007; Guajardo & Turley-Ames, 2004).

Contrary to our hypothesis that a causal order effect would be present in 3- and 4-year-old children, in the causal stories task, which assessed children's counterfactual performance in an emotional based judgement using a story medium, we found no significant difference between the conditions of inference length. The combined score of counterfactual thinking performance on the two stories indicated that counterfactual ability was not significantly affected by inference length or the point in the causal chain that was referred to.

In terms of the discrepancy presented within the literature, this finding adds further complications to the theory associated with counterfactual reasoning about causal chains. The causal stories task essentially involved a replication of the paradigm used in German and Nichols (2003), who instead found that short counterfactual inference questions were significantly easier for young children to answer correctly than longer chain inferences. German and Nichols suggested that this effect may be attributed to an influence of working memory and inhibitory control. Following this, Chan and Hahn's (2007) findings also indicated a significant difference among causal length conditions, but in contrast found that performance was significantly better in the medium and long inference conditions. Further, working memory and inhibitory control were only implicated in the short inference condition. Beck et al. (2007) also found that children's performance was better in the long inference condition than in the short inference condition. Moreover, their findings indicated that there was no impact of working memory or inhibitory control in the long inference condition.

We proposed that those findings which have not been adequately explained by the influence of working memory or inhibitory control may be better explained

¹ Effect size was examined for mean differences between conditions using Cohen's *d*: Between short and medium conditions = .42; between short and long conditions = .06; between medium and long conditions = .25.

in terms of a causal order effect. However, the findings presented here do not allow any firm conclusions to be made regarding children's counterfactual performance at varying points in the causal chain.

Extending the experimental paradigm to include a task that required counterfactual judgement about a visually presented physical event, the novel mouse trap task was used. However, similar results were found: there was no significant difference with respect to inference length condition. This finding further suggests that the causal order effect in preschool aged children is not robust. The different medium and kind of judgement did not result in substantially different findings.

In both tasks there was a nonsignificant trend that performance was poorer in the medium condition than in either the short or long condition. This raises the speculation that our observed findings, as well as discrepant findings in the literature on 3- and 4-year-olds' counterfactual thinking about causal sequences of events, may in fact reflect a combination of the causal order effect and another well-established order effect in adults' counterfactual thinking – the *temporal order effect*. This effect refers to the finding that when events are perceived as being temporally but not causally related, counterfactual alterations will generally be focused on the most recent event (Segura et al., 2002).

In the counterfactual tasks used in the present study and in other studies to assess children's counterfactual thinking about causal sequences of events, it was intended that participants would view the link between adjacent events in the sequence as causal in nature. However, none of the studies in the literature has explicitly ascertained if the event referred to in the test questions is indeed interpreted as the direct cause in the chain of events. For example, in the Flower story the long inference condition is as follows, "*What if Mrs Rosy hadn't called her husband, would Mrs Rosy be happy or sad now?*" It must be considered if Mrs Rosy calling her husband is actually interpreted as the cause of the dog escaping from the house, which then caused the flower to be squashed. The events in the stories may not be viewed as a coherent causal chain as intended.

Given that the events in both the causal stories task and the physical task were described as occurring across time, there was a temporal element to each scenario. Hence children who interpreted the scenarios as only temporal in nature might more readily mutate the final element (thereby showing better performance in the short inference condition), whereas children who interpreted the scenario as causal in nature would perform better in the long inference condition. Thus rather than the causal order being absent in preschool aged children, it is possible that children at this age are already sensitive to both the causal order and temporal order of events in their counterfactual thinking. Differences in interpreting the scenarios within the same sample might result in both order effects being at play but becoming negligible when only aggregated

data were considered. Future research should systematically explore this possibility.

In summary, this study adds to the growing body of research on children's counterfactual thinking about causal events, and raises further questions regarding the presence and nature of the causal length effect. Before we can conclude that the causal order effect is absent in preschool aged children, we concur with Beck et al. (2007) that a careful re-evaluation of tasks that purport to assess specific aspects of children's developing counterfactual thinking ability – and how they are interpreted by children – is needed.

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