

# The Role of Temporal Information and Interventions in Children's Causal Structure Learning



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## Introduction

Recent evidence suggests that adults recruit temporal information when making causal structure judgements (Lagnado & Sloman, 2006). We examined whether children's causal structure judgements in learning scenarios were similarly guided by temporal information. In addition we sought to examine the degree to which children's causal learning is equivalent to an understanding of the outcome of certain types of interventions as some researchers have claimed (Schulz, Kushnir & Gopnik, 2007).

## Experiment 1

### Method

**Participants:** Sixty 6-to-7-year-olds ( $M = 83$  months;  $Range = 77 - 90$  months) and 52 adults ( $M = 30$  years,  $Range = 20 - 60$  years).

**Design and apparatus:** Participants were presented with a simple three-variable system. An initial event A was followed by two separate events B and C. There were two experimental conditions: in the synchronous condition events B and C occurred simultaneously while in the sequential condition events A, B and C occurred in a temporal sequence (see Figure 1). Our hypothesis was that participants would be more likely to judge the causal structure to be a common cause one in the synchronous condition and a causal chain structure in the sequential condition.

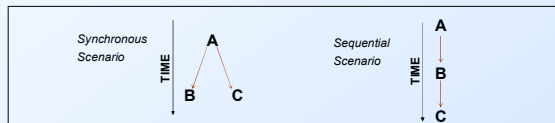


Figure 1. Synchronous and sequential Experimental conditions

Events A, B and C were 3 devices (a blue ball, a yellow square and a red bar) which rotated on the surface of a wooden toy-like box (see Figure 2a).

**Procedure:** Participants were randomly assigned to one of the two conditions. In both conditions the experimenter rotated device A for approximately 1 sec (the position of the three devices was counterbalanced across participants) after which the two other devices rotated in turn. Participants observed four experimental sequences. Figure 2b shows the temporal schedule of the two conditions

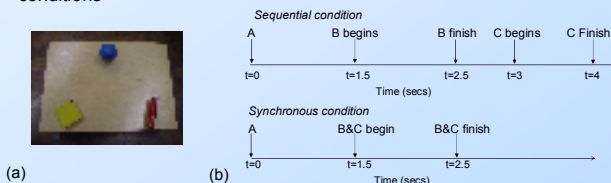


Figure 2. (a) apparatus pictured from above, (b) temporal schedule of the 2 conditions

**Causal questions:** Participants were asked two causal questions about events B and C e.g., "which one of the other two makes the blue one go?"

**Causal model choice:** They were then presented with 3 pictorial representations of the causal structure and asked to select the picture which "shows how the box actually works" (see figure 3).

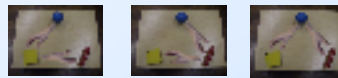


Figure 3. Causal picture models

**Intervention questions:** Finally, they were asked 2 'prevent-then-generate' intervention questions. The experimenter intervened to disable event B/C and then asked what would happen to the other device if A is activated. E.g. "If I push the blue one will the red [yellow] one still go?"

## Results

**Causal questions:** The distribution of common cause type responses (A causes B and A causes C) to causal chain responses (A causes B and B causes C) was significantly different across the two conditions for both children [ $\chi^2(1, N = 60) = 13.3, p < 0.01$ ] and adults [ $\chi^2(1, N = 52) = 13.02, p = 0.001$ ].

**Causal model choice:** Both children's and adult's choice of causal model significantly varied across the two conditions (see Figure 4).

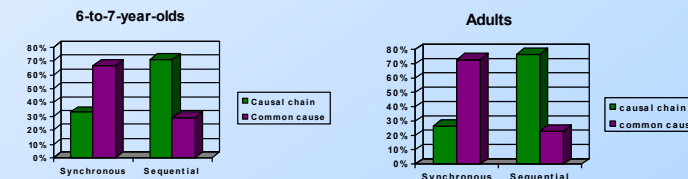


Figure 4. Causal model choice

**Intervention question responses:** Adult's responses to the intervention questions significantly varied across the two conditions,  $\chi^2(1, N = 45) = 9.25, p = 0.001$ . In total, 88% of adults gave responses which were consistent with their causal model choice. Children's responses did not vary across the two conditions,  $\chi^2(1, N = 50) = 1.36, p = 0.24$ . Just 47% gave responses consistent with their causal model choice.

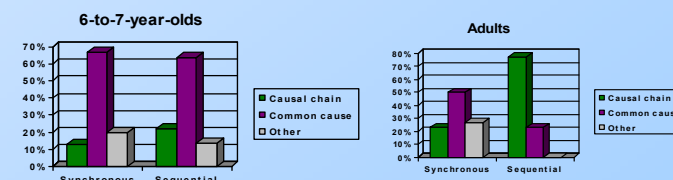


Figure 5. Intervention question responses

## Summary

Both children's and adult's causal judgements were affected by the overall temporal structure as we hypothesised. Only adults' judgements about the effect of interventions was similarly affected by the temporal structure.

## Experiment 2

Experiment 2 examined whether the use of an intervention to produce event A potentially confounded our interpretation that the overall temporal structure of the sequences influenced children's causal judgements. The two conditions were as before except that event A now occurred autonomously rather than by the experimenter's intervention.

**Participants:** Sixty 6-to-7-year-olds ( $M = 86$  months;  $Range = 79 - 92$  months).

**Procedure:** As before children were asked to select a causal model from 3 alternatives that they thought best illustrated how the box worked. They were asked the same prevent-then-generate intervention questions as in Experiment 1. They were additionally asked two generative intervention questions about the outcomes of interventions on B and C (e.g., "can you make the [blue] one go by moving one of the other two?").

## Results

**Causal model choice:** Children's choice of causal model significantly varied across the two conditions in a manner consistent with our temporal hypothesis,  $\chi^2(1, N = 58) = 15.63, p < 0.001$  (see Figure 6a).

**Prevent-then-generate intervention questions:** There was no difference in the distribution of responses across conditions  $\chi^2(1, N = 39) = 0.01, p = 0.96$  (Figure 6b).

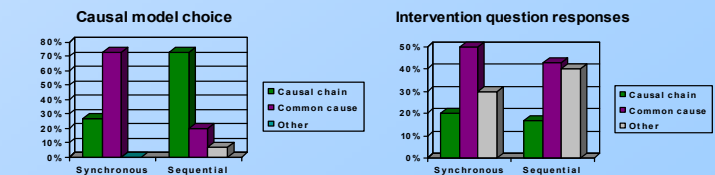


Figure 6. (a) causal model choice (b) prevent-then-generate intervention question

**Generative intervention questions:** There was no difference between the two conditions. The majority of children in both conditions gave a 'yes' response to both questions. Only 30% of children gave responses consistent with their causal model choice.

## Conclusion

Both 6-to-7-year-olds' and adults' causal structure judgements were influenced by the temporal structure of the event sequences. Children's judgements about the outcomes of both preventative and generative interventions were not similarly affected by the temporal structure. Moreover, there was low levels of consistency between children's causal and intervention judgements. These results corroborate research with adults which shows that they preferentially weight temporal order information when making causal structure judgements (Lagnado & Sloman, 2006; White, 2005). It is inconsistent with accounts of children's causal understanding which claim that causal judgements are equivalent to judgements about the effects of interventions.