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DOI:

[10.1037/cns0000235](https://doi.org/10.1037/cns0000235)

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*Document Version*

Peer reviewed version

*Citation for published version (Harvard):*

Beck, S 2020, 'The subject of children's counterfactual thoughts.', *Psychology of Consciousness: Theory, Research, and Practice*. <https://doi.org/10.1037/cns0000235>

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The subject of children's counterfactual thoughts.

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**Accepted for publication March 2020.**

### Abstract

Developmental psychologists debate when children acquire the ability to think counterfactually about what might have been. Most researchers have focussed on the reasoning structure of counterfactual thoughts, but the subject matter about which children are asked to think counterfactually has been largely neglected. I review whether children's counterfactual thinking differs across subject matter, specifically when they are asked to think about emotional, mechanistic, and temporal aspects of the world, concluding that the last is particularly important.

Adult humans use counterfactual thinking to imagine how the world could have been different. We speculate about small and large changes to reality as well as changes to events in the recent and distant past. For example, we use counterfactual thinking to express relief in the short term when we think, “If I hadn’t looked up and stopped at the crossing, I would have been knocked down just then” and also when we consider how our lives would have turned out had we studied a different subject at university many years ago. Over the last 25 years there has been growing interest in the development of counterfactual thinking, especially in when children’s competence emerges. Developmental research does not simply inform us about children’s capabilities though. By looking at young children and the developmental trajectory, we gain insight into the cognitive processes involved in counterfactual thought, and developmental researchers have made significant contributions to the broader cognitive science debate on how to define and categorise different types of thinking.

In this paper, I will review a largely overlooked aspect of children’s counterfactual thinking: the subject matter about which children are thinking. While researchers have tended to focus on children’s competence at particular ages, few researchers have examined whether the subject matter influences their performance. Yet, I will argue that by considering subject, especially temporal aspects, we will learn more about children’s counterfactual thinking. I will first review the research that has already explored whether subject matter influences children’s counterfactual thought. Then I will explore whether considering temporal aspects could help advance our understanding. Finally, I will highlight areas where the subject matter may be important, but has yet to be fully examined by developmental researchers.

First, to set the scene, we need to be aware of the current positions on the development of counterfactual thinking. Developmental psychologists began to explore children’s counterfactual thinking experimentally in the late 1990s (*pace* Kuczaj & Daly,

1979). In one such study (see also Harris, German, & Mills, 1996, that we return to below), Riggs, Peterson, Robinson, and Mitchell (1998) told children short narratives modelled on the false belief task. For example, a firefighter, Peter, is at home in bed, sick, while Sally has gone out. He receives a call telling him that there is a fire at the post office, and he leaves his bed to go and help. Children were asked a counterfactual question, “If there had been no fire, where would Peter be?” and the majority of 3- and 4-year-olds gave the wrong answer, claiming that Peter would be at the Post Office (performance on the false belief question, which asked about where Sally thought Peter was, was closely related to performance on the counterfactual question). In the time since this study, there has emerged much debate in the developmental counterfactual literature, particularly about the age at which children can do counterfactual thinking. To some extent this debate is confounded by disagreement about what constitutes genuine counterfactual thinking. There are various positions in this debate: some argue that counterfactual thinking develops in late childhood or even early adolescence (e.g. Rafetseder, Schwitalla, & Perner, 2013), others that very early developing abilities (such as pretending) reflect the same cognitive processes as counterfactual thinking (Weisberg & Gopnik, 2013), while others (arguing that counterfactual thinking is distinct from other imaginative types of thinking) suggest that there are multiple developments that occur in early and middle childhood as children gradually become able to do increasingly sophisticated thinking about what did not happen but might have (Beck & Riggs, 2014). My own position is the third, but in this paper I do not wish to simply rehearse the same arguments about what evidence there is for early or late development. Instead, I want to explore whether subject matter influences children’s counterfactual thought and suggest that considering subject matter offers new insights and also, new directions for research.

### **Domain-specific counterfactual thinking: emotional subject matter**

While developmental researchers have largely neglected the question of subject matter, there have been some studies that addressed this topic. The focus has been on emotional subject matter, probably for two reasons: 1) the theory of mind literature (which has close ties to work on children's counterfactual thinking) suggests that children understand simple emotions before they understand other mental states like belief (Hadwin & Perner, 1991) and 2) research with adults shows that they are particularly likely to think counterfactually in negative situations (Sanna & Turley, 1996). An early study by German (1999) showed the same pattern in children. Children who heard about a negative event appeared to be more likely to engage in counterfactual thinking than those who heard about a positive event. For example, in one story Sally chose to eat chocolate rather than a sandwich and ended up hungry (negative event). When 5-year-olds were asked what she should have done to avoid this outcome, half of them referred to the relevant unchosen option: she should have eaten the sandwich. Significantly more of them made reference to this counterfactual event than children who heard events described where the choice was irrelevant to the negative outcome (she ate white chocolate rather than brown chocolate) and when the event had a positive outcome, regardless of whether the choice was relevant or irrelevant. The lack of reference to the counterfactual in the positive versions of the task could be taken as evidence that children are more likely to think counterfactually when the content they are thinking about involves negative emotions rather than positive (See discussion below of Harris et al., 1996 and Nyhout & Ganea, 2020 who used similar methods).

A broader approach to looking at the effect of emotional subject matter on counterfactual thinking is seen in work by Sobel (2011) who compared counterfactual thinking about emotions and knowledge. His suggestion was that children's counterfactual thinking might be observed earlier in domains about which children had a good causal understanding. It is generally accepted that children understand simple emotional

consequences earlier than the knowledge-based mental states that are required to understand surprise (Hadwin & Perner, 1991). In Sobel's study, three- and four- year olds heard stories in which either an antecedent led to a character's desire being fulfilled, or the character was ignorant of an event which then surprised him. When asked counterfactual questions about these stories, children gave appropriate answers to those about the emotional experience, but not to those about the surprise. Sobel argues that it is essential for children to understand the causal structure of the situation in order to think counterfactually. This is an important point: without understanding the causal relations in a situation one cannot engage in counterfactual thinking, and it predicts that there should be domain differences in performance on counterfactual tasks based on casual knowledge. In this case, it appears that children display counterfactual thinking about emotional content before they do so about knowledge-based mental states.

However, the claim that children's counterfactual thinking about emotional subject matter is precocious is challenged by another study. Beck, Riggs, & Gorniak (2010) also contrasted children's performance on counterfactual questions about different subject matter. An advantage of this study is that the two subject conditions used the very same stories (based on those used by German & Nichols, 2003). In an example story, Tom built a sandcastle in the garden and called his dad to come and look at it. Dad opens the door to the house, and in doing so allows the dog to escape. The dog steals Tom's spade and drops it in the pond leaving Tom sad. The studies reported in this paper were designed to investigate the difference reported by German and Nichols that it was easier for 3- and 4-year-olds to answer questions about short causal chains of events rather than long (this was not replicated in the studies reported by Beck et al.). I will not go into the details of this manipulation here, but in doing so we used two different questions: emotion questions that asked about Tom's emotional experience, "What if Tom had not called his dad, would Tom be happy or sad?"

and location questions that asked about physical aspects of the story, “What if Tom had not called his dad, would the spade be in the sandpit or the pond?” There were no differences in performance on these two questions, despite them being about different domains.

Performance overall was relatively poor, with the average score being 1.05 out of 2 (note however, that individual children were approximately twice as likely to respond consistently (two wrong or two correct answers) than give one wrong and one correct answer, suggesting that on an individual level children were not simply guessing). This introduces doubt that the main determinant of counterfactual thinking success is the subject of the material being asked about. It may, of course, be that at this age children’s understanding of the causal domains of simple emotions and simple physical movements of objects are similarly poor. This seems a little surprising given the simplicity of the events: a toy being stolen and someone being sad, and a dog moving an object from one place to another. Instead, I think it is more likely that there is a domain general mechanism yet to develop that children need to think counterfactually.

Further evidence that the domain of causal knowledge cannot be the only determinant of children’s counterfactual thinking performance comes from comparisons of counterfactual thinking with a closely related type of thinking about the future, commonly called future hypothetical thinking in the developmental literature. In these studies the very same event is described. For example, in an early study (Robinson & Beck, 2000) a toy car drove from a midpoint on a road into a red garage at one end of the road. At the other end of the road was a blue garage. Three- and four- year-old children asked a counterfactual question, “What if the car had driven the other way? Which garage would it be in?” were less likely to give the correct answer (the blue garage) than children asked a future hypothetical question, “What if next time the car drives the other way? Which garage will it be in?” and performance on the latter question was near ceiling. The causal structure of the situation for both questions is the



same, but counterfactual thinking about the same subject matter was more challenging. The common interpretation of this finding (e.g. Beck et al., 2006) is that, although both future hypotheticals and counterfactuals require generation of an alternative, the future alternative is not in conflict with what is known to be true, because the future is uncertain (at least psychologically).

### **Machines and Narratives**

As I mentioned at the start of this paper, theories of the development of counterfactual thinking differ in when they attribute competence to young children. One account, promoted by Gopnik and colleagues, argues that children can think counterfactually from a very young age. For example, Buchsbaum, Bridgers, Skolnick Weisberg, and Gopnik (2012) presented evidence making a strong claim for children being able to engage in counterfactual thinking at 3 years of age. The task used a blicket detector machine (see Gopnik & Sobel, 2000). The machine activated, playing happy birthday, when a certain type of block, a 'zando', was placed on it. Once children had learnt the causal rules about how the machine worked they were asked counterfactual questions. Holding a zando, the experimenter asked "If this one were not a zando, what would happen if we put it on top of the machine?" and on a separate trial, holding a block that was not a zando, the experimenter asked "If this one were a zando, what would happen if we put it on top of the machine?" Even 3-year-olds were significantly better than chance at answering these questions correctly (not activate and activate, respectively).

The main proponents of the theory that counterfactual thinking is late developing, Rafetseder and Perner, use tasks with rather different subject matter: narrative scenes, typically involving people's actions and possibly choices. In one story (Rafetseder, Schwitalla, & Perner, 2013), a brother and a sister want to take the candy that their mother leaves on a shelf into their respective bedrooms. However, the little sister can only reach the

lower shelf but not the higher, and, because of a broken leg in a cast, the big brother can only reach the higher shelf. On a key trial the mother puts the candy on the high shelf and the brother comes along and takes it to his room. The counterfactual question is “What if the little girl had come looking for the candy instead of the boy? Where would the candy be?” The correct answer here is to say that the candy would be on the shelf, because the girl would not have been able to reach it. However, many children gave the answer that the candy would be in the girl’s room, apparently using what Rafetseder et al. call Basic Conditional Reasoning to make a simple assumption that if the girl comes the candy goes to the girl’s room and if the boy comes it goes to the boy’s room. They found that it was not until children were around 13 years old that they took into account the specific events in the narrative to reason about the counterfactual. Another study (Rafetseder & Perner, 2018), used a simpler narrative (based on a task used by Harris, German, & Mills, 1996) in which two characters walk across a floor wearing dirty shoes. In this version when asked about the state of the floor if the second character had not walked across it, the incorrect answer was to say that the floor would be clean, ignoring the fact that in the nearest possible counterfactual world the other character would still have made muddy footprints. This task proved easier than the shelf story used in previous studies, probably due to the efforts Rafetseder and Perner made to ensure that the two characters left separate, differently coloured, dirty footprints, and because the story itself is quite simple. Around 50% of a group of 4;2 – 5;4 year-olds and 70% of 5;4 – 6;0 year-olds gave the correct answers.

Even though Rafetseder and Perner found success at a younger age than in their previous study, there remains a dispute in the literature about whether children can engage in counterfactual thinking from 3 years if not before (e.g. Buchsbaum et al., 2012) or whether it develops at or after 5 years (e.g. Rafetseder & Perner, 2018). It could be tempting to look at this discrepancy and focus on a difference in the type of subject matter children are being

asked about. In the blicket detector task the world is very simple and deterministic; there are straightforward rules, which even very young children can learn, about which blocks activate the machine. The candy and shoes narratives are more complex and involve multiple people's actions and psychological causation (a point made by McCormack, Ho, Gribben, O'Connor, & Hoerl, 2018). At first glance, it might appear that children can think counterfactually about the simple deterministic world, but struggle to reason with the more complex narrative. One might conceive of this argument in a similar way to Sobel's claim above that there are domain specific effects on counterfactual thinking and children are able to reason about mechanistic domains before they can reason about other more complex social domains. Alternatively, one might think that the deterministic content is structurally simpler than that used by Rafetseder, and that this simplicity may make reduced domain general demands. We already know that domain general executive functions predict children's ability to think counterfactually (Beck, Riggs, & Gorniak, 2009; Burns, Riggs, & Beck, 2012; Guajardo, Parker, & Turley-Ames, 20019).

However, the difference in difficulty we see in children's counterfactual thinking, is not directly related to whether the content is deterministic or not. Two strands of evidence speak to this. First, there are narrative tasks that appear to show 3-year-olds thinking counterfactually. Second, there are mechanistic tasks that are more challenging for young children.

The format of the apparently easy narrative tasks is that children hear a very short narrative with a key choice or action and are asked why an outcome occurred (explanation question) or how it could have been prevented (prevention question). For example, Harris et al. (1996) used a story where a character chose to draw with a black pen rather than a pencil and ended up with inky fingers. In a control condition, the choice was between black and blue pens. Children's explanations and suggestions for prevention were coded for references to the

rejected option and these references were taken as evidence that children as young as 3 years old considered what might have been, i.e. that they think counterfactually.

Very recently, Nyhout and Ganea (2020) took a similar approach, but designed stories that made no reference to an alternative choice or action. Children as young as 3 also identified counterfactual outcomes. For example, in a story where Andy leaves his drawings on the porch, the wind blows them away. When asked how the negative outcome could have been prevented, children from 5 almost always referred to actions that character could have taken, e.g. 'If he draws inside'. Even 3- and 4-year-olds often made this type of response, but they were also more likely than older children to refer to uncontrollable events, such as the wind not blowing. Although these force of nature explanations are not typically offered by adults, they are valid counterfactuals: had the wind not blown, the drawings would be safe.

Although these studies may show 3-year-olds thinking counterfactually, an alternative explanation comes from Rafetseder and Perner's suggestion that children who appear to entertain counterfactuals may instead be using Basic Conditional Reasoning (BCR). In their words, "the counterfactual problems that children find to be easy can be solved by applying conditionals that express general regularities to suppositions that can be counter to fact" (Rafetseder, Schwitalla, & Perner, 2012, p391). I am not sure that we need to characterise children's thinking as explicitly involving conditionals, but it does seem possible that children might answer Harris and Nyhout's explanation and prevention questions by thinking about general regularities in the world, for example: the wind blows things away; no wind means things do not get blown away; no wind inside; pens can make your fingers inky; pencils do not make fingers inky, etc. In other words, children can use their general knowledge to describe a world where the drawing does not get blown away or fingers do not get inky. But this does not involve thinking about a counterfactual to a specific event. Rafetseder and colleagues argue that this explanation can also account for apparent success

on counterfactual conditional tasks at around 4 and BCR is often operationalised as negating the key causal relation in an event. For example, in Riggs et al. (1998), that there was a fire at the Post Office and Peter went to the Post Office, is negated: no fire, Peter does not go to the Post Office and stays put. I will return to BCR explanations below in relation to Hoerl and McCormack's theory of temporal cognition.

On the other hand, a simple, rule-based task with mechanistic content has proved relatively difficult for children to handle. McCormack et al.'s (2018) study used a simple physical scenario: children saw a box with two runways: a short red runway and a long yellow runway. Both runways ended at a common point where a toy pig was sat and if a disc (described as a 'bird') travelled all the way down a runway it would knock the pig over. However, pegs could be inserted along the runways to prevent the birds reaching the pig. In each trial a red and a yellow bird were rolled down the runway. On key, doubly-determined trials neither bird was impeded by a peg and so either could have cause the pig to fall. In fact the red one was the cause, because its path was shorter. The counterfactual question "If I had not rolled the red bird that time would the pig have fallen down?" was correctly answered with "yes", because the yellow bird would still have reached the pig. This type of doubly-determined trial is of particular interest because it cannot be solved using a simple application of BCR "no cause (red bird), no effect (pig knocked over)" (see Rafetseder & Perner, 2018). Children aged 6 and above answered doubly-determined questions correctly, but 4- and 5-year-olds were not above chance when answering the doubly-determined questions, even though they gave the correct answer to singly-determined trials where only the red disc could have knocked over the pig, because the yellow's path was blocked by a peg.

In a subsequent study, Nyhout and Ganea (2019) also used doubly-determined scenarios (named over-determined in their paper, but for simplicity I will continue to use McCormack's terminology). However, they were concerned that the causal structure in

McCormack's task may have been too complex for younger children to understand and so they use the simpler world of the blinket detector (like Buchsbaum et al., 2012) for their study. The relation between cause and effect was simply that one type of block made the machine activate (causal blocks) and the other type did not (inert blocks). In doubly-determined trials two causal blocks (e.g. a red and green) were placed on the machine, which activated, and children were asked "If she had not put the red one on the box, would the light still have switched on?" Counterfactual reasoning should lead you to say "yes" to this question, because the scenario you imagine still involves the green causal block being placed on the machine, whereas BCR should result in the answer "no" (no red (causal) block, no activation). More 4 and 5 year olds gave the correct pattern of responses than was expected by chance, suggesting that even these young children were able to think counterfactually.

One possibility is that children are able to engage in counterfactual thinking on Nyhout and Ganea's simpler blinket detector task, but they struggle with McCormack's task, falling back on BCR. However, the pattern of results reported by McCormack et al. does not fit what BCR would predict. Children were less likely to say the pig would not have been knocked over had the red bird not been rolled on doubly-determined trials than on singly determined trials, even though BCR predicts the same answer to both questions.

It is certainly possible that the difference in complexity of the scenarios used in McCormack and Nyhout's tasks led to the difference in success being reported at 6 and 4 years respectively. But a different explanation has been proposed by Beck and Rafetseder (2019) using Hoerl and McCormack's (2019) dual systems theory of temporal cognition. Hoerl and McCormack argue that there are two systems for thinking about time. The temporal updating system allows one to incorporate new information about the world, but has only one model of reality. In contrast, the temporal reasoning system allows one to think about different events in time and represent the relations between them. The temporal

updating system is basic and present in many species, while the temporal reasoning system is more sophisticated and, according to Hoerl and McCormack, may be restricted to humans, probably over the age of 4 or 5 years. Someone with only a temporal updating system cannot think about events in time they simply have a current world model that they are able to update.

In Nyhout and Ganea's blicket detector task, one might take correct answers to the doubly-determined counterfactual question as showing that children are thinking back in time to the point when two causal blocks (red and green) were placed on the machine, and entertaining a counterfactual antecedent that the red block was not included in that past event. However, Beck and Rafetseder (2019) suggested that children may be able to give the correct answer to the Nyhout and Ganea blicket detector question using only the temporal updating system: i.e. by updating their current world model in which there are two causal blocks on the machine to a model in which one of these blocks is removed. This update could be conceived in one of two ways (see Figure): 1) children could consider what would happen if the red block were removed now from the blicket detector, if we 'added' new information to the model. This resembles future hypothetical thinking, which we know is relatively easy for children as young as 3<sup>1</sup>. Alternatively, 2) children could imagine an alternative world disconnected from this world, that duplicates the current state of affairs, and 'cancel' the red block in this model. This would be different from what I have previously taken to be counterfactual thinking, because it is about an imagined world, not the real past world, and because it involves working with a static model of the world, rather than using mental time travel to speculate about what might have been. However, if future work suggests that this is

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<sup>1</sup> It is important to note that Nyhout and Ganea made efforts to avoid children using the 1<sup>st</sup> strategy: the blicket detector event was presented on a video and before the counterfactual question was asked the video was paused and the screen blanked. However, the temporal updating system can handle things outside of current sensory scope, as long as they remain part of the current world model (see Hoerl & McCormack, 2019). It is at least possible that children treat the blicket detector event as ongoing, even if it is no longer visible.

a strategy children can use, careful thought would be needed to decide whether this should be thought of as an atemporal type of counterfactual thinking.

Beck and Rafetseder (2019) argue that because the event is completed in McCormack's birds and pig task, one needs to use temporal reasoning to think back in time to the beginning of this specific event and that this is what 6-year-olds are doing. However, the results reported by McCormack do not straightforwardly fit with the argument that 4-year-olds are using temporal updating. Four-year-olds are confronted by the pig lying knocked over by the red bird. If they add to the current model and imagine not rolling the red disc now, it makes no difference, because the pig cannot get back up again on this trial. If the temporal updating system can work by cancelling the red bird, then it is still the case that the child cannot rerun the events of the trial without using mental time travel, and so it is unclear what answer cancelling should give. In McCormack et al.'s (2018) study 4-year-olds were around 50% on these doubly-determined trials. Perhaps this does reflect an inability to find an answer, reflecting the temporal updating system's inability to represent events in time, but it is clear that more work is needed to understand how children are handling these tasks.

There seem to be several possible explanations for the difference in performance on various tasks and it is clear that substantial further research is needed to evaluate them. Tasks vary in complexity, whether the content is mechanistic or a narrative, and whether mental time travel is involved. It is possible that we will find that multiple factors affect children's counterfactual thinking, a position taken by Nyhout & Ganea (2019b). Or it may be that some factors are more important than others, or even that we decide that under some circumstances children are not actually engaging in counterfactual thinking, but are using different strategies to reach what appear to be the correct answers to counterfactual questions.

### **Episodic and Semantic Counterfactuals**



In the section above, I suggested that the temporal nature of the event one is thinking counterfactually about might be critical in the emergence of counterfactual thinking. Interestingly, another aspect of subject matter, also related to temporal cognition, may be relevant to the development of counterfactual thought. Researchers working on the neurological basis of counterfactual thinking have suggested that the processes involved in episodic and semantic counterfactual thinking differ. Episodic counterfactuals are those about one's real life autobiographical experiences (e.g. If I had worked harder, I would not have failed the exam), while semantic counterfactuals concern facts about the world (e.g. If kangaroos did not have tails, they would fall over). Episodic counterfactual thinking engages the default network more than counterfactual thoughts about semantic facts and involves mental time travel (Parikh et al., 2018).

Although it has not been labelled as such, we can see this distinction in the developmental literature. Researchers such as Harris and Riggs examined children's counterfactual thoughts about events they had observed (e.g. Peter going to the Post Office to put out a fire), while other researchers focussed on reasoning with alternatives to rules of facts about the world, called reasoning with false syllogisms or counter-to-fact reasoning in the developmental literature (e.g. Dias & Harris, 1988). These tasks ask children to reason with a known to be false premise such as "All fish live in trees." They then hear, "Tot is a fish. Does Tot live in the water?" Children are more likely to give the correct answer (here, "No, Tot lives in a tree") at age 6 rather than 4, with the younger children performing near floor.

Although developmental researchers have tended not to directly compare these two ways of thinking about imagined false premises, closer examination of the parallel literatures suggests that the distinction may tell us more about the processes involved in counterfactual thinking, as it has done in the neuroscience literature. One opportunity for this is when we

review studies that tried to improve children's counterfactual thinking by engaging their aptitude for imagination. Dias and Harris (1988) used a fantasy manipulation with their counter-to-fact syllogisms (semantic counterfactuals). Some children were simply given the syllogism to reason with, and others were told "Let's pretend that I am in another planet". Four- and six-year-olds were more likely to give the correct answer in the fantasy context.

In a separate study of what we can call children's episodic counterfactual thinking described by Robinson and Beck (2000), children saw a narrative acted out with dolls. A key event in the story moved an object from one location to another, for example, Jenny left a picture on a garden table and the wind blew it up into a tree. Three- and four-year-olds' performance was unaffected by whether the experimenter asked "Pretend the wind didn't blow..." or simply used the conditional "If the wind didn't blow..." Around half the children responded that the picture would be on the table in each condition.

Granted, the Dias and Harris manipulation may have done more to engage children with a fantasy context than the change of wording in the Robinson and Beck study. But another possibility is that putting the material in a fantasy context helps counterfactual thinking about semantic content, but does not affect episodic counterfactuals. Why might this be? Episodic counterfactual scenarios involve thinking about the specific event one has witnessed. In this sense they are intrinsically tied to reality and specific past events. Jumping off into a fantasy world may not be a good approach to try to generate appropriate counterfactuals. On the other hand, reasoning about false syllogisms does not require one to think about any specific events in the world. The neuroscience literature suggests that there are different pathways involved in episodic and semantic counterfactual thinking. Perhaps episodic counterfactual thinking is immune to fantasy context in a way that semantic counterfactual thinking is not.

Perhaps there are ways in which fantasy manipulations might affect children's episodic counterfactual thinking. One possibility is that a fantasy manipulation could separate the event about which one is speculating from its place in time<sup>2</sup>. The thinker would now be thinking about an imagined possibility, but not one that stands in for a specific event in the experienced past. As episodic counterfactual thinking is necessarily retrospective (de Brigard & Parikh, 2019), targeting events that happened in one's own past, this separation may permit atemporal counterfactual thinking described above. Thus, fantasy manipulations might facilitate responses to episodic counterfactual questions by stopping them being episodic. A different possibility is that episodic counterfactual thinking might be influenced by the plausibility of the counterfactual antecedent (see de Brigard & Parikh, 2019, for discussion of modality and counterfactual thinking). In the effective manipulation used by Dias and Harris, children are asked to imagine being on another planet. Could similar psychological distancing help the child to entertain an episodic counterfactual alternative? It seems that if we asked children to think about a real event, but transport it to another planet then the child is no longer thinking about that specific episode, although it would be interesting to know if this manipulation helped them to consider alternatives. A different strategy could be to use more fantasy-based antecedents: rather than Peter, the firefighter, leaving his home to put out a fire, what if Peter were taken up on an alien spaceship?

It is worth noting that borrowing the concept of episodic counterfactual thinking from the neuroscience literature highlights a further limitation in developmental research. The tasks described above as episodic are about narrative, fictional events that the child observes, but does not participate in. In the neuroscience studies the events underlying episodic counterfactuals are ones that each individual participant has personally experienced: in studies, participants complete a 'possible experiences' questionnaire in which they generate

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<sup>2</sup> I thank Angela Nyhout for this interesting suggestion.

autobiographical events in response to cues such as ‘You were in a snowball fight’ (e.g. Parikh et al., 2018). These then become cues to engage in episodic counterfactual thought. In the developmental literature, children almost always have a 3<sup>rd</sup> person rather than a 1<sup>st</sup> person perspective on the event about which they are asked to think counterfactually. Presumably these 3<sup>rd</sup> person experiences still form episodic memories (rather than semantic) but the child is removed from the experience itself. In the developmental literature the term ‘real world counterfactuals’ have been used to describe thoughts about specific events that happened in the world (even in a fictional dolls’ world) as compared to more generic fact-based counterfactuals. But there is a mismatch between the way counterfactuals are conceived in the neuroscience and developmental literatures: in the neuroscience literature episodic refers specifically to first person autobiographical events, in the developmental literature real world counterfactuals involve both 1<sup>st</sup> person autobiographical and 3<sup>rd</sup> person events. This distinction requires attention by developmental researchers, because studies have shown that adults’ counterfactual thinking differs when they participated in a game (actor condition) or merely read about someone in that situation (reader condition. Girotto, Ferrante, Pighin, & Gonzalez, 2007). Although, in line with the suggestion above that children watching a scenario played out with dolls may engage in episodic counterfactual thinking, adult participants who observed an actor produced the same counterfactuals as the actor, while a reader’s counterfactuals differed (Pighin, Byrne, Ferrante, Gonzalez, & Girotto, 2011).

One domain that has looked at events where the child was personally involved, and thus can be said to look at episodic counterfactuals under the neuroscience definition, is the development of regret. Regret is a counterfactual emotion, as one makes a comparison between what happened as a result of a choice one made and what would have happened had a different choice been made. For example, a child chooses between two boxes, winning the sticker contained within the box she chose. However, she then learns that the unchosen box

contained eight stickers. From around the age of 6, children express negative emotion in this situation, which has been interpreted as them making a comparison between reality “I won a sticker” and a counterfactual “If I had chosen the other box, I would have won eight stickers” (Weisberg & Beck, 2010). The experience of regret seems to require the comparison of the counterfactual with reality (supported by evidence that children who have better attentional flexibility are more likely to experience regret, Burns, Riggs, & Beck, 2012).

Weisberg & Beck (2010) contrasted first and third person versions of the regret task described above. Children either played the game themselves choosing between the two boxes or they observed while a toy played the game. Children reported their own experience of regret at a younger age than they recognised that the toy would feel a similar emotion (n.b. they were prepared to play the game, reporting the toy’s emotions about reality, so their lack of attributing regret was not due to a reluctance to credit the toy with emotional experience). Thus, it appears that within the domain of regret at least, children may find it easier to engage in counterfactual thinking about their own first person experiences rather than those they witnessed as a third person.

Is it the case that the distinction between episodic and semantic counterfactuals maps onto the distinction drawn above about counterfactuals that require temporal reasoning and those that need only a temporal updating system? Certainly episodic counterfactuals which concern thinking about specific events one has experienced in the past (and which are now over) will require temporal reasoning. But semantic counterfactuals seem to be atemporal facts about the world. However, these could still be handled by a temporal updating system. A fact, such as ‘kangaroos have tails’ is taken to be true in the current world model, and in order to form a counterfactual one can (temporarily) update this model with the new information, ‘kangaroos don’t have tails’.

## **Conclusions**

Overall, I have reviewed evidence on the influence of subject matter on children's counterfactual thinking. Although there are some suggestions that children find it easier to think counterfactually about emotional or mechanistic subject matter, there is counter evidence in both these domains to suggest that the specific subject matter is not the key predictor of success. Studies with very closely-matched subject matter are missing from the literature, however, and would make an important contribution to our understanding. However, I argue that considering the temporal content of the event is particularly important and has been largely neglected: with counterfactual thinking about events in the past that require temporal reasoning being particularly challenging for children. Further research on temporal aspects of counterfactual thinking in children may highlight the importance of the distinction between episodic and semantic counterfactual thinking.

### **Acknowledgements**

I would like to thank Angela Nyhout and another anonymous reviewer for their comments on this paper, resulting, I hope, in substantial improvement to the original draft.

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Figure: Possible routes to generating alternatives through counterfactual thinking or temporal updating (adding or cancelling).

