



Counterfactual Reasoning: Sharpening Conceptual Distinctions in Developmental Studies

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ABSTRACT—Counterfactual reasoning (CFR)—mentally representing what the world would be like now if things had been different in the past—is an important aspect of human cognition and the focus of research in areas such as philosophy, social psychology, and clinical psychology. More recently, it has also gained broad interest in cognitive developmental psychology, mainly focusing on the question of how this kind of reasoning can be characterized. Studies have been inconsistent in identifying when children can use CFR. In this article, we present theoretical positions that may account for this inconsistency and evaluate them in the light of research on counterfactual emotions.

KEYWORDS—counterfactual reasoning; basic conditional reasoning; counterfactual emotions; developmental studies

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COUNTERFACTUAL REASONING IN EVERYDAY LIFE

Counterfactual reasoning (CFR) involves mentally representing how the world would be now if things had been different in the past. In everyday discourse, we express counterfactual thoughts in the form of conditional statements; for example: “If p , then q ” or “If we had not been interested in counterfactuals, then we would not be writing this paper.” Using conditionals, we indicate that the true nature of the antecedent p is suppositional and that q should be assessed within that context (Evans, Over, & Handley, 2005). In our example, the counterfactual supposition p considers a world in which we were not interested in counterfactuals. At this point, the conclusion q —that we would not be writing this paper—is not drawn randomly; we retain as many features of the past as possible and change only those that are causally dependent on the counterfactual supposition (Edgington, 2011). For instance, as a consequence, we would not have read papers on counterfactuals, nor would we have run studies to investigate counterfactuals; hence, we would not have had anything to write about. Modeling a counterfactual world in this manner has been referred to as the nearest possible world constraint (Lewis, 1973). With CFR, we refer to this constraint that “involves a change in some features of the actual world in addition to those required by the truth of the antecedent of the counterfactual, while other such features are left unchanged” (Woodward, 2011, p. 21).

CFR IN VARIOUS DISCIPLINES

CFR has received attention in philosophy, social psychology, and clinical psychology. Intuitively—and many philosophers defend this position—CFR is closely related to our understanding of causality. For example, to counterfactually suppose that “if a piece of metal had not burst its tire, the Concorde would not have crashed” supports our understanding that the piece of metal caused the Concorde to crash (for a review, see Hoerl, McCormack, & Beck, 2011).

In contrast, social psychologists have focused on counterfactual emotions such as regret, relief, remorse, blame, and disappointment. Regret plays a key role in shaping our decision making (for a review, see Joseph-Williams, Edwards, & Elwyn, 2011) and serves as a corrective to improve behavior (Epstude & Roese, 2008). For example, people who anticipate regret over missing their train leave early to prevent feeling regret (with the beneficial side effect of not missing their train). Although CFR is a feature of normal cognition, clinical psychology has linked it to pathological processes such as depression (Markman & Weary, 1998), social anxiety (Kocovski, Endler, Rector, & Flett, 2005), procrastination (Sirois, 2004), Parkinson's disease (McNamara, Durso, Brown, & Lynch, 2003), and schizophrenia (Hooker, Roese, & Park, 2000).

More recently, CFR has become a hot topic in cognitive developmental psychology. Children's ability to engage in reasoning with counterfactual conditionals seems to be related to their ability to infer another person's false belief (Guajardo, Parker, & Turley-Ames, 2009; Guajardo & Turley-Ames, 2004; Riggs, Peterson, Robinson, & Mitchell, 1998; but see Perner, Sprung, & Steinkogler, 2004), an important step toward social understanding. Children diagnosed with autism have problems with false belief tasks, as well as with counterfactual conditionals (Grant, Riggs, & Boucher, 2004; Scott, Baron-Cohen, & Leslie, 1999). Counterfactuals also seem to play a role in attributing moral emotions: Four- to 8-year-olds attributed more negative emotions to the violator of a moral norm when a counterfactual course of action was presented beforehand (e.g., "How would Tim feel if he had not taken the chocolate?") than when no such counterfactual prompt was given (Gummerum, Cribbett, Nicolau, & Uren, 2013). In light of these important developmental links, we need to better understand how to characterize CFR.

DEVELOPMENTAL STUDIES OF CFR: STATE OF THE ART

The developmental context allows us to understand what happens in the mind when we apply CFR. For example, if we claim that for CFR, children need to understand that they should change only features of reality that are causally dependent on the counterfactual supposition, we should expect children who lack this understanding to produce a different answer. When can we be *sure* that an answer to a counterfactual question—produced by a child—is reached using CFR? We argue that these are answers (a) that most adults would agree on *and* (b) that cannot be produced by any reasoning strategy other than CFR.

Very young children seem to be able to fulfil the first criterion. For example, in a study, 3-year-olds were shown Carol, a puppet, coming home and not taking her dirty shoes off, leaving footprints on the clean floor. When asked counterfactually, "If Carol had taken her dirty shoes off, would the floor be clean or

dirty?" most 3-year-olds answered "clean" (Harris, German, & Mills, 1996). Most adults draw the same inference (Rafetseder, Schwitalla, & Perner, 2013).

However, 3- to 5-year-olds (and even older children) have problems answering in accordance with CFR when one controls for false positives, provided by simpler reasoning strategies that lead to the same answer as CFR (Rafetseder, Cristi-Vargas, & Perner, 2010; Rafetseder & Perner, 2010; Rafetseder et al., 2013). For example, in a study like the one just described, children saw Carol and Max dirtying a clean floor. When asked, "If Carol had taken her dirty shoes off, would the floor be clean or dirty?" adolescents and adults agreed that the floor would be "dirty"; it would have been dirtied by Max. However, 5-year-olds answered this way in only 18% of the cases, and 7- to 10-year-olds in only about 50% of the cases (Rafetseder et al., 2013); they did not preserve the real course of events as closely as possible (i.e., they did not consider that Max dirtied the clean floor independently of Carol).

In the next section, we consider several theoretical positions that address why younger children fail to adhere to CFR.

THEORETICAL POSITIONS

Some argue that the difference between younger and older children reflects developmental improvements in executive functioning, specifically in inhibitory control, cognitive flexibility, and working memory. Some counterfactual tasks put fewer executive demands on children's cognitive systems than others, allowing them to solve some tasks earlier than others. Support for this notion comes from various studies (inhibitory control: Beck, Riggs, & Gorniak, 2009; cognitive flexibility: Burns, Riggs, & Beck, 2012; working memory: Guajardo et al., 2009). In the earlier example with Carol and Max, children whose working memory is not yet fully developed might have just forgotten to consider Max's dirty footprints.

However, consider two counterarguments: (a) Children find tasks that require an understanding of the nearest possible world constraint more difficult than tasks that do not require this understanding, even when the tasks are similar in structure, length, and complexity, suggesting comparable demands of executive functioning (Rafetseder et al., 2010), and (b) children who understand the nearest possible world constraint do not differ in their executive functioning capacities from children who do not yet have this understanding (Pohn & Ramsdorf, 2013). Together, these suggest that effective executive functioning abilities are not sufficient to answer counterfactual questions and that tasks similar in executive functioning demands can vary in difficulty.

A different strand of research assumes that young children, unlike older children and adults, (a) do not engage automatically in CFR or (b) have their CFR triggered by different events, compared to older children's and adults' CFR (Beck, Weisberg, Burns, & Riggs, 2013). The first explanation is sup-

ported by the fact that young children answer counterfactual questions correctly before they experience regret (Beck & Crilly, 2009); young children may have not automatically applied CFR on tasks that induce regret. The second explanation is supported by a study (Guttentag & Ferrell, 2004) in which 7-year-olds and adults usually believed Person A, who acted atypically, will feel worse about a negative outcome than Person B, who acted typically. Five-year-olds, in contrast, thought that the two people would feel equally bad. However, the second explanation does not account for performance differences between conditions that seem to have the same triggers (e.g., if Carol had taken her shoes off) but that differ in their demand for whether children have to adhere to the nearest possible world constraint.

Our study provides yet another explanation for the developmental discrepancy (Rafetseder & Perner, 2010; Rafetseder et al., 2010; Rafetseder et al., 2013). Counterfactual tasks that are passed early in life can be solved by simpler reasoning strategies, referred to as basic conditional reasoning (BCR), whereas those that are passed later can be solved only by CFR.

FORMAL CHARACTERIZATION OF CFR AND BCR

Children's problem with counterfactual tasks lies in their lack of understanding the nearest possible world constraint (Perner & Rafetseder, 2011; Rafetseder et al., 2010; Rafetseder et al., 2013): One should assume that the counterfactual world is exactly like the real world except for those facts that are incompatible with the counterfactual assumption (antecedent). In particular, one should change only facts that depend logically or causally on the counterfactual assumption.

To illustrate this difference (Rafetseder et al., 2010, Study 1), consider a mother who sometimes placed candy on the top shelf and sometimes placed it on the bottom shelf. Her tall son could reach both shelves, but his little sister could reach only the bottom shelf. In the condition in which only CFR gave the correct answer, the mother placed the candy on the top shelf and the boy took it to his room. Adults and 6-year-olds differed in their answer to the counterfactual questions: "What if the little girl had come instead of the boy? Where would the candy be?" Most of the children said the candy would have ended up in the girl's room (BCR), whereas all adults agreed that it would have stayed on the top shelf (CFR). To answer the counterfactual question correctly, one has to consider where the mother had placed the candy (on the top shelf). In contrast, the 6-year-olds did not consider this information, thereby violating the nearest possible world constraint.

When the mother put the candy on the bottom shelf and the boy came to get it, children were asked where the candy would be if the girl had come instead. This time, BCR (not relating to what really happened) led the children to the same answer as CFR, namely, "girl's room." Even the youngest children were able to answer the counterfactual questions correctly without having to use CFR.

A formal description of how younger and older children approach counterfactual tasks (Leahy, Rafetseder, & Perner, 2013) assumes that older children and adults understand that the counterfactual antecedent is meant to contradict what actually happened in the last episode to which the question refers. And it assumes that they reason about what would be the case if that episode had taken place except for the changes stipulated by the counterfactual assumption (and changes made necessary by logical consequences). In contrast, younger children simply treat the antecedent as the description of a new episode in the story: If (at some time) the girl comes in search of candy, she will bring it to her room. In doing so, they are not faced with a contradiction. Some children understand this constraint at age 6, whereas others do so at older ages (Rafetseder & Perner, 2010; Rafetseder et al., 2010; Rafetseder et al., 2013).

WHEN DO CHILDREN FEEL COUNTERFACTUAL EMOTIONS?

Additional insights concerning children's CFR abilities come from their ability to experience counterfactual emotions—which involve comparing what is the case with what could have been the case. If things could have been better, one might feel regret; if things could have been worse, one might feel relief. Counterfactual emotion tasks do not hinge on verbal counterfactual questions and therefore might detect early CFR abilities more accurately.

Only a few studies have reported signs of counterfactual emotions in 5- to 6-year-olds (Weisberg & Beck, 2010, 2012, Study 2) or younger (Weisberg & Beck, 2012, Study 1). Other studies have found counterfactual emotions later, in 6- to 7-year-olds (Amsel & Smalley, 2000; Burns et al., 2012; Guttentag & Ferrell, 2004; O'Connor, McCormack, & Feeney, 2012) or older children (Ferrell, Guttentag, & Gredlein, 2009), with progressive development during late childhood and adolescence (Habib et al., 2012; Rafetseder & Perner, 2012).

To detect when children feel negative counterfactual emotions, researchers give them the choice between two boxes. After the children choose, the box is opened and children receive a prize (e.g., a sticker), then see the contents of the box they did not choose. This box contains either the same amount of stickers (baseline condition) or more stickers (worse off condition). Subsequently, children are asked to rate how happy they feel with the prize they got. Children who rate themselves less happy in the worse off condition than in the baseline condition are considered to have experienced regret.

However, this paradigm is liable to alternative explanations, including that children's pattern of answers might be because of the contrast effect (Kühberger, Großbichler, & Wimmer, 2011); that is, a prize appears better or worse depending on what it is compared to. One sticker is evaluated as less positive in view of four stickers (worse off condition) than in view of one sticker (baseline condition).

Two studies are not liable to this effect: More 5- to 8-year-old children rated their prize lower in the worse off condition when they were allowed to actively choose between two options than when it was decided with a die or by the experimenter (Weisberg & Beck, 2012). The contrast effect would predict that children rate their prize lower regardless of how it was decided.

However, a second study casts doubt on children experiencing regret before they are 6–7 years old (O'Connor, McCormack, & Feeney, 2013). Children were given the standard baseline and worse off conditions on consecutive days. On the second day, they were asked to choose the box they had chosen the previous day without paying for the choice, or to switch to the other box and pay one token. It was hypothesized that children would more likely switch adaptively (i.e., stick to the original choice in the baseline condition, but switch in the worse off condition) when they had experienced regret on the first day. In other words, they were expected to take corrective action to avoid feeling bad again. Of those who felt worse in the worse off condition on the first day, no 5-year-old but two thirds of the 7-year-olds and almost all of the 9-year-olds adaptively switched. Presumably, the 5-year-olds in this study did not experience regret.

SUMMARY AND FINAL THOUGHTS

In this article, we argue that 6-year-olds are only beginning to develop a full-fledged understanding of CFR and that younger children treat the counterfactual question as a description of a new episode (BCR) rather than a change to one that has actually happened (CFR). However, this change in conceptual understanding is crucial for children to be able to experience true counterfactual emotions. The precise emergence of counterfactual emotions is difficult to pinpoint and still open for debate, but children may not experience negative counterfactual emotions before age 6.

Children's ability to reason with false belief may be based on their ability to reason with counterfactual conditionals (Riggs et al., 1998). If the world were as it is perceived by an agent ("Peter's wife sees him staying sick in bed and does not hear of either the fire or see him go to fight the fire"), then it would be as the agent believes it to be ("Peter would be still in bed"). Children who can answer a counterfactual question ("Where would Peter be, if there had been no fire?") using BCR will also answer correctly the question about Peter's wife's belief ("Where does his wife think he is?"). If a child who is faced with a more intricate scenario needs CFR to answer the counterfactual question correctly, then children will have the same difficulty (or even more) answering the question about an agent's belief until they are 6 or older.

One could also expect a parallel development between CFR and scientific reasoning abilities. A fundamental element in scientific reasoning is differentiating variables that are causally

relevant for the observed outcome from variables that are not. For example, to determine whether the piece of metal was the only causally relevant factor for the Concorde to crash, one would need to manipulate this factor while holding all other independent variables constant. This amounts to the nearest possible world constraint.

Thus, our model of CFR provides a novel insight into how children understand counterfactuals and makes clear predictions about when children are able to experience counterfactual emotions, draw conclusions within other people's perspectives, and show elaborate scientific reasoning skills.

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