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# Counterfactual Thinking: From Logic to Morality

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**Ruth M. J. Byrne**
Trinity College Dublin, University of Dublin, Ireland

**Abstract**

People create counterfactual alternatives to reality when they imagine how things would have turned out differently "if only. . . ." They understand counterfactuals by constructing models that correspond to the conjecture, and to the presupposed facts. The dual meaning of counterfactuals leads people to make more inferences from them compared to ordinary conditionals. People create counterfactuals by changing an aspect of reality that has been represented explicitly in their models, and they zoom in on a "fault line," such as an exceptional event. However, knowledge can modulate what is represented in models and so the fault lines can shift. Counterfactuals permeate much of mental life, including judgments about morality, such as blame or praise, and assessments of emotions, such as regret or relief.

**Keywords**

counterfactuals, reasoning, imagination, conditionals, morality

The writer Garrison Keillor, in "Donald Trump Is Four Centuries Too Late," suggests that the 17th century, with its divine right of kings, suppression of parliament, privileged sexual aggression, and vituperation, would have suited Mr. Trump. Keillor reflects on Defoe's transition from his earlier view of politics that "All men would be tyrants if they could" to his later *Robinson Crusoe* novel about a peaceful hermit on a desert island and concludes about Trump: "It would have been better if, instead of running for president and wasting everyone's time, he'd just sat down and written a novel" (Keillor, 2016). Thoughts about how things could have turned out differently "if only . . ." can seem irresistible, especially after bad events (e.g., Kahneman & Tversky, 1982b). The ability to create counterfactual alternatives to reality emerges early in life and continues to develop throughout childhood (e.g., Beck, Robinson, Carroll, & Apperly, 2006); its loss is devastating in cases of brain injury (e.g., Gomez Beldarrain, Garcia-Monco, Astigarraga, Gonzalez, & Grafman, 2005), perhaps because counterfactual thoughts serve so many diverse purposes (e.g., Byrne, 2016). They are often used to explain the past, to excuse or defend past actions (e.g., Markman, Mizoguchi, & McMullen, 2008), in part by identifying causes of outcomes or reasons for actions (e.g., McCloy & Byrne, 2002; Walsh & Byrne, 2007), and they are useful for preparing a blueprint for a plan to prevent bad things from happening again (e.g., Epstude & Roese, 2008). The comparison of how an event actually turned out to how it might have turned out differently underpins moral judgments such as blame or praise (e.g., Malle, Guglielmo, & Monroe, 2014), as well as emotional experiences such as regret or relief (e.g., Kahneman & Miller, 1986). Two issues have preoccupied contemporary research on counterfactual thinking: (a) How does the mind compute counterfactuals, that is, what sorts of mental representations and cognitive processes underlie reasoning about them? and (b) Why does the mind compute counterfactuals, that is, what sorts of counterfactuals do people create and what are their functions?

## How People Reason About Counterfactuals

The mind appears to compute a counterfactual such as "if Ruby had been at the beach then Pearl would have been in the park" by constructing a mental representation that refers not only to the conjecture, "Ruby was

**Corresponding Author:**
Ruth M. J. Byrne, School of Psychology and Institute of Neuroscience, Trinity College Dublin, University of Dublin, Ireland
E-mail: rmbyrne@tcd.ie

at the beach and Pearl was in the park," but also to the presupposed facts, "Ruby was not at the beach and Pearl was not in the park" (e.g., Byrne, 2005). This "counterfactual dual meaning" idea has led to several discoveries, perhaps most notably, the counterfactual inference effect.

## *The counterfactual inference effect*

When participants in experiments are told, "if Ruby had been at the beach then Pearl would have been in the park" and then they are told, in fact, "Pearl was not in the park," most of them conclude "Ruby was not at the beach" (e.g., Byrne & Tasso, 1999; Thompson & Byrne, 2002). They make this *modus tollens* inference about twice as often from the counterfactual compared to an ordinary conditional, "if Ruby was at the beach then Pearl was in the park." When they are told instead, in fact, "Ruby was at the beach," they readily make the *modus ponens* inference "Pearl was in the park," from the counterfactual just as often as from the ordinary conditional. Inferences that refer to the presupposed facts—Ruby was not at the beach and Pearl was not in the park—are made much more readily from the counterfactual than the ordinary conditional, and inferences that refer to the conjecture—Ruby was at the beach and Pearl was in the park—are made just as readily from the counterfactual as from the ordinary conditional, as Figure 1 shows.

## *Dual possibilities for counterfactuals*

The discovery that people make more inferences from a counterfactual than an ordinary conditional provides an important clue about how the mind computes counterfactuals (e.g., Byrne, 2016). People may construct mental models, iconic mental representations of possibilities that capture the way the world would be if an assertion were true (e.g., Byrne & Johnson-Laird, 2009; Johnson-Laird & Byrne, 2002). They construct a model of the possibility corresponding to the counterfactual conjecture and one corresponding to the presupposed facts, and they annotate the possibilities to indicate their epistemic status:

Counterfactual: Ruby at beach and Pearl in park
Facts: Ruby not at beach and Pearl not in park
. . .

(The three dots indicate that there may be other possibilities that they have not yet thought about). In contrast, they tend to think about just a single possibility initially when they understand an ordinary conditional, such as, "if Ruby was at the beach then Pearl was in the park."

Ruby at the beach and Pearl in the park
. . .

(e.g., Johnson-Laird & Byrne, 2002). They can "flesh out" these models to be more explicit if need be, but at the outset they tend to think about few possibilities as a result of working memory limitations.

A different explanation is that people understand counterfactuals by thinking about the conjecture, and they include numerical values in their model to represent the strength of their prior beliefs in the counterfactual, as well as their prior beliefs about the presupposed facts, such as,

Ruby at the beach and Pearl in the park .71

(e.g., Evans, 2007, p. 74; see also Sloman & Lagnado, 2005). However, the counterfactual inference effect has been found for many different sorts of content, including counterfactuals for which participants have no prior beliefs, such as those about shapes on a blackboard, or the locations of people in places, as well as for familiar content, and it appears to be a very widespread phenomenon in reasoning, as Table 1 shows.

## *Counterfactual dual meaning effects*

The dual meaning idea, that people think not only about the conjecture but also about the presupposed facts when they understand a counterfactual, is also supported by evidence from online measures of comprehension and recordings of brain activity. For example, when participants read a story in which Tim's friend says to him on the way to the fruit market, "If there had been apples then there would have been carrots," they are "primed" to read subsequent assertions that fit with their expectations. Later in the story when the fruit seller tells Tim and his friend, "there are no apples and there are no carrots," they read the conjunction more quickly compared to when they were primed by an ordinary conditional, "if there are apples then there are carrots" (e.g., Santamaria, Espino, & Byrne, 2005). And when later in the story the fruit seller says instead, "there are apples and there are carrots," they read the conjunction just as quickly whether it is primed by the counterfactual or the ordinary conditional. The counterfactual primes them to read both the conjunction corresponding to the presupposed facts and the one corresponding to the

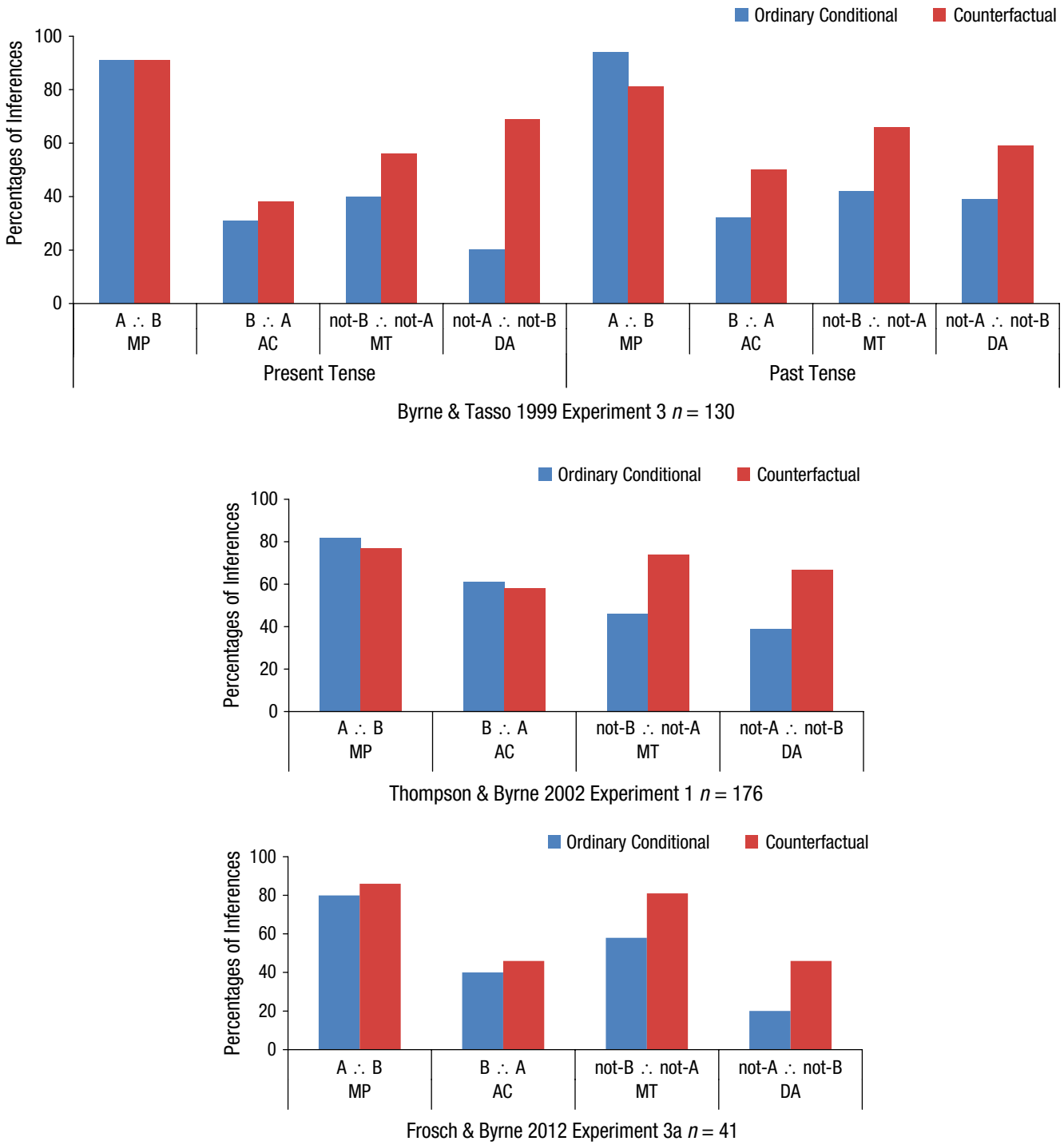


**Fig. 1.** Examples of the counterfactual inference effect, showing more inferences from counterfactuals of the form "if A had been then B would have been" than ordinary conditionals, "if A then B." Participants make more inferences that refer to the presupposed facts, not-A and not-B, from the counterfactual compared to the ordinary conditional, and they make as many inferences that refer to the conjecture, A and B, from both conditionals. The graphs are based on data reported in Byrne and Tasso (1999), Thompson and Byrne (2002), and Frosch and Byrne (2012). Error bars have not been included based on the data provided in the articles.
Key: MP = modus ponens (if A then B, A therefore B); AC = affirmation of the consequent (if A then B, B therefore A); MT = modus tollens (if A then B, not-B therefore not-A); DA = denial of the antecedent (if A then B, not-A therefore not-B).

**Table 1.** Examples of Tasks Used to Test the Counterfactual Inference Effect and Counterfactual Dual Meaning Effects

| Task | Example of content | Example of task |
|---|---|---|
| **Inference conclusion evaluation** (e.g., Egan, Garcia-Madruga, & Byrne, 2009; Frosch & Byrne, 2012; Moreno-Rios, Garcia-Madruga, & Byrne, 2008) | If the butter had been heated then it would have melted.<br>*Past tense causal content example* | *Modus tollens example*<br>The butter did not melt.<br>Therefore,<br>(a) It was not heated<br>(b) It was heated<br>(c) It may or may not have been heated |
| **Inference conclusion production** (e.g., Byrne & Tasso, 1999) | If Linda were in Dublin then Cathy would be in Galway.<br>*Present tense subjunctive example* | *Modus tollens example*<br>Cathy was not in Galway.<br>What, if anything, follows? |
| **Consistency truth table judgment** (e.g., Byrne & Egan, 2004; Egan et al., 2009; Thompson & Byrne, 2002) | The animal would have been warm-blooded only if it had been a mammal.<br>*Only if form example* | *False antecedent/consequent example*<br>Judge whether the possibility is consistent or inconsistent:<br>The animal was not warm-blooded and it was not a mammal |
| **Implications judgment** (e.g., Byrne & Egan, 2004; Thompson & Byrne, 2002) | If I were to win the lottery tomorrow then I would buy a yacht.<br>*Future tense subjunctive (prefactual) example* | What do you think is implied?<br>(a) I will win the lottery tomorrow<br>(b) I will not win the lottery tomorrow<br>(c) I will buy a yacht<br>(d) I will not buy a yacht<br>(e) Nothing is implied |
| **Verifying and falsifying judgment** (e.g., Byrne & Tasso, 1999) | If there had not been a circle on the blackboard, there would not have been a triangle.<br>*Negated antecedent/consequent example* | What two shapes would best fit the description?<br>What two shapes would definitely go against it? |
| **Memory** (e.g., Fillenbaum, 1974) | If he had left on time he would have caught the plane. | Surprise memory task—identify whether sentences were presented earlier, e.g.,<br>He did not leave on time<br>He did not catch the plane |
| **Immediate inference** (e.g., Egan & Byrne, 2012) | Jason's mother said to him: If you had hit your sister I would have grounded you.<br>*Threats content example* | What do you think happened?<br>(a) Jason definitely hit his sister<br>(b) Jason probably hit his sister<br>(c) Nothing follows<br>(d) Jason probably did not hit his sister<br>(e) Jason definitely did not hit his sister |
| **Paraphrase** (e.g., Frosch & Byrne, 2012) | If water had been poured on the campfire, then the campfire would have gone out. | Rephrase the sentence accurately, try to keep its meaning as much as possible, but without using the word "IF." |
| **Inference latency** (e.g., Quelhas & Byrne, 2003) | If the nurse had cleaned up the blood then she must have had to wear rubber gloves.<br>*Deontic content with modal example* | Time to choose conclusion, as recorded from presentation of conclusion on screen to selection of response. |
| **Counterfactual reading times** (e.g., Moreno-Rios et al., 2008) | Even if Luis had pressed the button, the machine would have started<br>*Even if form (semifactual) example* | Time to read the conditional, controlled by the participant's key press. |
| **Online priming** (e.g., De Vega, Urrutia, & Riffo, 2007; Santamaria, Espino, & Byrne, 2005) | Miguel was going to a flower shop with his sister. She told him that in this shop, if there had been roses then there would have been lilies. When they arrived at the shop, the salesman said to them, there were no roses and there were no lilies. | *Negated antecedent/consequent example*<br>Time to read target conjunctions, controlled by participant's key press to read conjunction: There were no roses and there were no lilies. |
| **Eye tracking** (e.g., Ferguson & Sanford, 2008) | If cats were vegetarians they would be cheaper for owners to look after. Families could feed their cat a bowl of carrots and it would gobble it down happily. | Eye gaze and fixations recorded for target words (e.g., carrots). |
| **Event-related potentials** (ERPs; e.g., Nieuwland & Martin, 2012) | If NASA had not developed its Apollo Project, the first country to land on the moon would have been Russia/America. | Recording of brain activity, e.g., N400, for reading true and false counterfactuals. |
| **Functional magnetic resonance imaging** (e.g., Kulakova, Aichhorn, Schurz, Kronbichler, & Perner, 2013) | The motor is switched off today. If the motor had been switched on today would it have burned fuel? | Recording of brain activity in target brain regions while reading or listening to counterfactuals. |

conjecture, supporting the idea that people mentally represent both possibilities from the outset.

Similar counterfactual dual meaning effects have been identified using techniques such as memory recall and online comprehension, eye tracking, and measures of brain activity such as event-related potentials (ERPs) and functional magnetic resonance imaging (fMRI; e.g., Ferguson & Sanford, 2008; Kulakova, Aichhorn, Schurz, Kronbichler, & Perner, 2013; Nieuwland & Martin, 2012), as Table 1 shows.

## How People Create Counterfactuals

There are remarkable regularities in what the mind computes when it creates counterfactual alternatives to reality (e.g., Byrne, 2016). People zoom in on pivotal joints that appear to reflect "fault lines" in the representation of reality (e.g., Kahneman & Tversky, 1982b). It is important to note that these fault lines can shift: What the mind computes when it creates counterfactuals depends on what is explicitly represented, as modulated by knowledge.

### *Counterfactual fault line effects*

One of the first studies of how people create counterfactuals gave participants a story about a car accident that occurred when Mr. Jones left his office at his regular time; he sometimes left early to do home chores (Kahneman & Tversky, 1982b). He did not drive home by his regular route; he drove along the shore to enjoy the view. Other participants were told instead that Mr. Jones left the office earlier than usual; he drove home along his regular route. All participants were told that the accident occurred at an intersection when a truck charged into Mr. Jones's car. They were told his family often thought "if only . . ." and they were asked to continue this thought. Participants tended to create a counterfactual by changing whatever was unusual, returning it to normal: Participants who were told that Mr. Jones had gone home by an unusual route tended to say "if only he had gone home by his usual route"; those who were told that he had left at an unusual time tended to say, "if only he had gone home at his usual time." Notably, they did not create a counterfactual that changed the most improbable event—two cars being in exactly the same place at exactly the same time (e.g., Kahneman & Tversky, 1982b).

There are many such fault lines in the mental representation of reality (Kahneman & Tversky, 1982b). They correspond to junctures that have been mentally represented explicitly, such as exceptions, actions, controllable decisions, and recent events, as Table 2 shows. People tend to imagine how things might have turned out differently by changing aspects of reality that they have mentally represented explicitly.

### *Counterfactual fault line shifts*

A telling discovery is that counterfactual fault lines can shift (e.g., Byrne, 2005). For example, participants were told about a television game show in which two individuals, Alicia and Mark, are each given a shuffled deck of cards, and each draws a card from their own deck. If the two cards they draw are the same color (i.e., both from black suits or both from red suits), each individual wins €1,000. However, if the two cards are not the same color, neither wins anything. Alicia goes first and draws a red card from her deck. Mark goes next and draws a black card from his deck. Thus, the outcome is that neither individual wins anything. Participants tended to complete the sentence "Alicia and Mark could each have won €1,000 if only one of them had drawn a different card, for instance if . . ." by saying "if only Mark had drawn a red card," that is, they tended to focus on the most recent event (e.g., Byrne, Segura, Culhane, Tasso, & Berrocal, 2000; Miller & Gunasegaram, 1990). However, the temporal order effect can be eliminated. For example, participants were told instead that Alicia goes first and draws a black card from her deck. At this point, the game show host has to stop the game because of a technical difficulty; after a few minutes, the problem is solved and the game is restarted. Alicia goes first again and this time the card that she draws is a red card. Mark goes next and the card that he draws is a black card. Participants tended to say "if only Alicia had drawn a black card" as often as they said "if only Mark had drawn a red card" (e.g., Byrne et al., 2000). In another version of the game, in which the players had to pick different colored cards, participants were given an illustration that mentioned one color, such as, "If one or the other but not both draws a card from a red suit, each individual wins €1,000." The temporal order effect was reversed when they were told that Alicia drew black and Mark drew black and they both lost. Participants tended to say "if only Alicia had drawn a red card" more often than they said "if only Mark had drawn a red card" (e.g., Walsh & Byrne, 2004).

The tendency to zoom in on each of the "fault lines" can be shifted, as Table 2 shows. The discovery shows that knowledge modulates the counterfactuals that people create; people change the aspects of reality that have been explicitly represented in their models.

## Moral Judgments

Moral norms can affect the counterfactuals that people create. For example, participants read about Steven

**Table 2.** Examples of Counterfactual Fault Lines and Fault Line Shifts

| Fault line example | Typical sentence completion | Fault line shift example | Typical completion |
|---|---|---|---|
| **Exceptionality effect**<br>Mr. Jones leaves work earlier than usual; he drives home by his usual route (or he leaves work at his usual time; he drives home by an unusual route). A truck charges through an intersection and he is killed (e.g., Kahneman & Tversky, 1982b) | If only he had left at his usual time/driven home by his usual route<br>Exception changed to normal: 39%<br>Normal changed to exception: 8% | Laura places a medium bet, she usually places a small one; it is matched by a player who matches small and medium bets and one who matches small, medium, and large bets; Laura has better cards than the large-bet player but not the medium-bet one; she loses (e.g., Dixon & Byrne, 2011) | If only she had placed a large bet: 67%.<br>(Exception changed to more exceptional) |
| **Action effect**<br>Jenny owns shares in company A. She considered switching to stock in company B, but she decided against it. She now finds out that she would have been better off by $1,200 if she had switched. Lisa owned shares in company B. She switched to stock in company A. She now finds out that she would have been better off by $1,200 if she had stayed (e.g., Byrne & McEleney, 2000; Kahneman & Tversky, 1982a) | Who feels more regret?<br>Lisa: 92%.<br>(Actor)<br>Who feels worse at the end of the first year?<br>Lisa: 88%.<br>(Actor)<br>Who feels worse after 10 years?<br>Lisa: 86%.<br>(Actor) | Linda and Cathy are enrolled at the same university. Both are only moderately satisfied and both consider transferring to another university. Linda opts to stay where she is, and Cathy decides to transfer. Linda still doesn't like where she is and wishes she had transferred, and Cathy doesn't like her new environment and wishes she had stayed (e.g., Gilovich & Medvec, 1995) | Who regrets her decision more upon learning that it was a mistake?<br>Cathy: 76%.<br>(Actor)<br>Who regrets her decision more in the long run?<br>Linda: 63%.<br>(Nonactor) |
| **Controllability effect** Example 1<br>Steven is delayed by three minor misfortunes outside his control, the maneuvers of a lorry, a tree trunk on the road, a flock of sheep, and one controllable event, an intentional decision, calling into a bar for a beer; he arrives home to find his wife has died of a heart attack (e.g., Girotto, Legrenzi, & Rizzo, 1991; McEleney & Byrne, 2006) | Most frequent response:<br>If only he hadn't called into the bar for a beer: 25%.<br>(Controllable decision) | Steven is delayed by three controllable events, a socially appropriate one, (calling to visit his elderly parents), an inappropriate one in the context of the delay, (calling to a restaurant), a neutral one, (calling to a shop), and an uncontrollable one, (a traffic jam); he arrives home to find his wife has died (e.g., McCloy & Byrne, 2000) | Least frequent response:<br>If only he hadn't called to visit his elderly parents: 12%<br>(Controllable decision) |
| **Controllability effect** Example 2<br>Participants read about Paul who takes part in a game, chooses between two envelopes that contain hard or easy sums, obtains a hard sum, tries to calculate it in 30 seconds, and fails (e.g., Girotto, Ferrante, Pighin, & Gonzalez, 2007) | If only he had chosen the other envelope: 76%.<br>(Controllable decision) | Participants take part in a game (or observe a confederate taking part). They choose between two envelopes, obtain a hard sum, try to calculate in 30 seconds, and fail (e.g., Girotto et al., 2007; Pighin, Byrne, Ferrante, Gonzalez, & Girotto, 2011) | If only I had had more time/had had pen and paper: 69%.<br>(Factors outside participants' control) |
| **Temporal order effect**<br>Alicia and Mark each draw cards; if the two cards are the same color (both red or both black), each wins €1,000. Alicia goes first and draws a red card; Mark goes next and draws a black card; neither wins anything (e.g., Miller & Gunasegaram, 1990; Segura, Fernandez-Berrocal, & Byrne, 2002) | If only Mark had drawn a red card: 90%.<br>(Most recent event) | Alicia and Mark are on a game show with the same rules. Alicia goes first and picks a black card. The game show host has to stop the game because of a technical difficulty. After it is solved, Alicia goes first again, and draws a red card. Mark goes next and draws a black card; neither wins anything (e.g., Byrne, Segura, Culhane, Tasso, & Berrocal, 2000; Walsh & Byrne, 2004) | If only Alicia had drawn a black card: 44%.<br>(Earlier event) |

who did not arrive home in time to save his sick wife. He was delayed by the maneuvers of a lorry, a flock of sheep, and a fallen tree trunk, and by his own intentional decision to have a beer in a bar (e.g., Girotto, Legrenzi, & Rizzo, 1991). When they were asked how things could have turned out differently, they tended to say, "If only he hadn't called into the bar for a beer." They focus on controllable events even in their spontaneous counterfactual thoughts (e.g., McEleney & Byrne, 2006). It is important to note, however, that they tend to focus on controllable events that are socially or morally inappropriate in the context of the bad outcome, such as calling into a bar in the context of a sick wife waiting at home. They do not focus on controllable events when they are morally appropriate, such as calling to visit elderly parents (e.g., McCloy & Byrne, 2000). Similarly, people do not tend to imagine a counterfactual alternative to an individual's action when their reason for the action was a moral one, such as an obligation (e.g., Walsh & Byrne, 2007).

Conversely, counterfactual alternatives impact moral thoughts about blame and responsibility, as well as emotional experiences such as guilt or regret. Morality and emotion tend to follow the same fault lines as counterfactual thoughts. For example, in the game in which Alicia and Mark fail to win €1,000 when Alicia picked a red card and Mark picked a black card, participants not only say "if only Mark had picked a red card," they also judge that Mark will experience more guilt than Alicia, and that Alicia will blame Mark more than Mark will blame her (e.g., Byrne et al., 2000; Miller & Gunasegaram, 1990). Moral and emotional fault lines sometimes shift: In the version of the game in which participants say "if only Alicia had drawn a black card" as often as they say "if only Mark had drawn a red card," their tendency to judge that Mark will experience more guilt than Alicia is eliminated, although their tendency to judge that Alicia will blame Mark more than Mark will blame her remains the same (e.g., Byrne et al., 2000).

The relationship between counterfactuals and emotions or moral judgments is not always straightforward (e.g., Walsh & Byrne, 2004). One illustration is that judgments of blame and responsibility, like judgments of cause, often focus on strong causes of an outcome—for example, participants tend to blame a drunk driver who injured a boy—whereas their counterfactual thoughts instead focus on background enablers of the outcome—for example, they imagine the boy would not have been injured if his father had collected him as he was supposed to (e.g., McCloy & Byrne, 2002; N'gbala & Branscombe, 1995). Nonetheless, participants' ascriptions of blame to an attacker are higher when they hear a counterfactual in which changes to the victim's behavior did not change the outcome, whereas they are lower when they hear a counterfactual in which changes to the victim's behavior changed the outcome (e.g., Branscombe, Owen, Garstka, & Coleman, 1996; Parkinson & Byrne, 2017). Counterfactuals appear to affect blame by assessing whether the actor could have done something differently to prevent the outcome, as well as whether the actor should have done something differently to prevent it (e.g., Malle et al., 2014).

## Conclusions

The creation of counterfactual alternatives to reality is a commonplace tendency that helps people to explain the past and prepare for the future. Counterfactuals' dual meaning ensures that people construct a model not only of the conjecture but also of the presupposed facts. People create counterfactuals by changing aspects of reality that they have mentally represented explicitly, and these fault lines can shift guided by knowledge. Emotion and moral judgments tend to follow the same fault lines as counterfactual thoughts. People's mental lives are vastly enriched by the ability to create alternatives to reality.

### Recommended Reading

Byrne, R. M. J. (2016). (See References). A review of important discoveries and current explanations of counterfactual thinking and reasoning.

Kahneman, D., & Tversky, A. (1982). (See References). A very readable, short chapter that pioneered the study of counterfactual thinking.

Nickerson, R. (2015). *Conditional reasoning*. Oxford, England: Oxford University Press. A comprehensive book on conditional reasoning with excellent overviews of the study of counterfactuals in logic and psychology.

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