

# Reasoning About Intentions: Counterexamples to Reasons for Actions

Csongor Juhos and Ana Cristina Quelhas  
ISPA-Instituto Universitário

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

Four experiments tested the idea that people distinguish between biconditional, conditional, and enabling intention conditionals by thinking about counterexamples. The experiments examined intention conditionals that contain different types of reasons for actions, such as beliefs, goals, obligations, and social norms, based on a corpus of 48 intention conditionals established through an extensive materials test ( $n = 136$ ). Experiment 1 ( $n = 19$ ) showed that retrieved alternative reasons suppress the *affirmation of the consequent* and *denial of the antecedent* inferences from conditional intentions, whereas retrieved disabling reasons suppress the *modus ponens* and *modus tollens* inferences from enabling intentions. Experiment 2 ( $n = 61$ ) showed that the suppression effects also occur for explicitly provided alternatives and disablers, for a large corpus of 80 intention conditionals. Experiment 3 ( $n = 60$ ) showed that the suppression effects also occur for unfamiliar content, for which participants cannot rely on prior knowledge or beliefs about probabilities. Experiment 4 ( $n = 26$ ) showed that participants retrieve alternatives and disablers readily for intentions just as they do for causal conditionals. The implications of the results for alternative accounts based on possibilities and probabilities are discussed.

*Keywords:* intentions, reasons, conditionals, disablers, counterexamples

A person's intentions encompass his or her purposes and objectives and embrace a striking array of diverse reasons for actions (e.g., Anscombe, 1963; Bratman, 1987; Davidson, 1963; Von Wright, 1983). People consider that their actions are determined primarily by their intentions (e.g., Libet, Gleason, Wright, & Pearl, 1983), and they attempt to identify intentions from a very young age (e.g., Feinfield, Lee, Flavell, Green, & Flavell, 1999; Saxe, Tenenbaum, & Carey, 2005). They assess reasons for actions not only when they attempt to plan for the future and solve problems (e.g., Sio & Ormerod, 2009) but also when they try to understand and justify the past (e.g., Davison & Feeney, 2008; McEleney & Byrne, 2006). Individuals communicate their intentions to others (e.g., Grice, 1975; Searle, 1969), and effective argumentation depends on the communication of reasons (e.g., Hahn & Oaksford, 2007; Mercier & Sperber, 2011).

People also evaluate the intentions that led to other people's actions (e.g., Cushman & Mele, 2008; Knobe, 2010), they distinguish

whether actions were intentional or unintentional (e.g., Fausey, Long, Inamori, & Boroditsky, 2010; Knobe, 2003), and their judgments of morality and legality rely on assessments of the appropriateness of their own and others' intentions (e.g., Algoe & Haidt 2009; Hart & Honore, 1959; Knobe, 2010; McCloy & Byrne, 2000). A failure to process intentions accurately contributes to psychological disorders such as schizophrenia and paranoid delusions (e.g., Hooker, Roese, & Park, 2000; Johnson-Laird, Mancini, & Gangemi, 2006; Roese, Park, Smallman, & Gibson, 2008), and it also occurs following damage to the prefrontal cortex (e.g., Young et al., 2010). Hence, understanding how people reason about intentions is relevant to understanding not only problem solving and legal argumentation but also linguistic communication, social persuasion, and moral judgment. It has implications for understanding the experience of emotional, psychological, and neuropsychological disorders, and the experience of consciousness itself.

A person's intentions are the reasons for his or her actions (e.g., Anscombe, 1963; Davidson, 1963; see also Broome, 2001), and philosophers have identified many different reasons for actions, including desires, urges, moral views, aesthetic principles, economic prejudices, public and private goals and values, obligations, prescriptive rules, social conventions such as community customs, fashions, and traditions, and communicative challenges such as orders and requests (Davidson, 1963). A broad distinction is often usefully drawn between internal reasons and external reasons (e.g., Anscombe, 1963; Bittner, 2001; Davidson, 1963; Von Wright, 1983). Internal reasons include beliefs, such as "If Paul believes the police are watching, then he stops at the red light," and goals, such as "If Mary's goal is to get her tires replaced, then she goes to the mechanic," and external reasons include obligations, such as "If Laura is required to do so by the security staff, then she leaves the nightclub," and social norms, such as "If Linda is in a church, then she speaks quietly" (e.g., Walsh & Byrne, 2007).

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Csongor Juhos and Ana Cristina Quelhas, Department of Psychological Sciences, ISPA-Instituto Universitário; Ruth M. J. Byrne, School of Psychology and Institute of Neuroscience, Trinity College Dublin, University of Dublin.

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Correspondence concerning this article should be addressed to Ruth M. J. Byrne, School of Psychology and Institute of Neuroscience, Trinity College, University of Dublin, Dublin, Ireland. E-mail: [rmbyrne@tcd.ie](mailto:rmbyrne@tcd.ie)

Intentionality is one of the core categories of mental life, along with space, time, and cause (Miller & Johnson-Laird, 1976). Psychologists have made many experimental discoveries about reasoning about space, time, and cause; however, fewer experimental studies have examined the cognitive processes that underlie conditional reasoning about intentions. It is known that people readily make some inferences from conditionals that contain obligations and permissions (e.g., Cheng & Holyoak, 1985; Cheng, Holyoak, Nisbett, & Oliver, 1986; Girotto, Gilly, Blaye, & Light, 1989; Manktelow & Over, 1991; see also Cosmides, Tooby, Fiddick, & Bryant, 2005) and from conditionals that contain social inducements such as promises and threats (e.g., Bonnefon, 2009; Egan & Byrne, 2012). They also readily create counterfactual “if only” thoughts about reason–action sequences (e.g., Walsh & Byrne, 2007; see also McCloy & Byrne, 2000; Quelhas & Byrne, 2003). But little is known about how people interpret intention conditionals that comprise a range of different sorts of reason–action sequences and about how they make inferences from them. Inferences from intention conditionals form the basic building blocks out of which people compose their judgments about the intentionality of other people’s actions, and so it is crucial to understand the conditional inferences that people make from them.

We first outline a new proposal that people reason about intention conditionals by thinking of counterexamples, and then we consider important differences and similarities between intentions and causes. Next, we report the results of four experiments testing the role of counterexamples in making inferences for a large set of over 100 intention conditionals based on familiar reason–action sequences, as well as unfamiliar ones. Finally, we consider the implications of the results for alternative views of reasoning about intentions based on possibilities and probabilities.

### Reasoning About Intention Conditionals

Our aim is to test the idea that people think about counterexamples when they understand and make inferences from intention conditionals. We suggest that people distinguish between different sorts of reason–action relations such as biconditional, conditional, and enabling intentions. The two key tenets of our proposal are (a) different sorts of intention relations are consistent with different sorts of contingencies and people retrieve different counterexamples to them and (b) different sorts of counterexamples suppress different inferences from intention relations. The distinction between biconditional, conditional, and enabling intentions applies to intention conditionals with different sorts of contents, including internal reasons such as beliefs and goals and external reasons such as obligations and social norms.

### Counterexamples to Intention Conditionals

We propose that one sort of reason–action relation is *biconditional*, for example, “If Abi believes the tooth fairy exists, then she places her tooth under her pillow.” It is consistent with several situations: “Abi believes the tooth fairy exists and she places her tooth under the pillow” (A and B), and “Abi does not believe the tooth fairy exists and she does not place her tooth under the pillow” (not-A and not-B). A biconditional reason is sufficient for the action—when the person has the reason, he or she will tend to carry out the action—and it is also necessary for the action—when the person does not have the

reason, he or she will tend not to carry out the action. The contingencies consistent with a biconditional intention relation are outlined in Table 1.

Another sort is a *conditional* intention relation, for example, “If Paul believed the police were watching, he stopped at the red light.” It is consistent with several contingencies—“Paul believed the police were watching and he stopped at the red light” (A and B), and “Paul did not believe the police were watching and he did not stop at the red light” (not-A and not-B)—but crucially, it is also consistent with the situation “Paul did not believe the police were watching and he stopped at the red light” (not-A and B), as Table 1 also illustrates. A conditional reason is sufficient for the action: When the person has the reason, he or she will tend to carry out the action. But a conditional reason is not necessary for the action—other reasons and conditions can also bring about the action, for example, Paul may not believe the police are watching, but he may wish to be a safe driver, and so he will stop at the red light anyway. We suggest that people can readily retrieve such an *alternative* reason to a conditional intention (not-A and B because alternative reason to A).

A third sort is an *enabling* intention, for example, “If Cathy believed it was going to rain, she took an umbrella.” It is consistent with several contingencies—“Cathy believed it was going to rain and she took an umbrella” (A and B), and “Cathy did not believe it was going to rain and she did not take an umbrella” (not-A and not-B)—but crucially, it is also consistent with the situation “Cathy believed it was going to rain and she did not take an umbrella” (A and not-B). An enabling reason is necessary for the action; when the person does not have the reason, he or she will tend not to carry out the action. But it is not sufficient for the action; when the person has the reason, he or she may carry out the action or may not—other reasons and conditions must also be present to bring about the action, for example, Cathy may have the belief that it is going to rain, but she may also believe that her raincoat will keep her dry, as Table 1 shows. We suggest that people can readily retrieve such a *disabling* reason to an enabling intention relation (A and not-B because disabling reason to A).

### Inference Suppression for Intentions

We propose that counterexamples suppress inferences from intention conditionals, and different counterexamples suppress different inferences. An alternative reason will suppress the *denial of the antecedent* (DA) and *affirmation of the consequent* (AC) inferences. For example, when participants are given a conditional intention, such as, “If Paul believes the police are watching, then he stops at the red light” (if A then B), and the information “Paul does not believe the police were watching” (not-A), they will *not* make the DA inference “therefore he does not stop at the red light” (therefore not-B), presumably because they can retrieve an alternative reason, for example, “he wishes to be a safe driver.” Likewise, when participants are given the information “Paul stops at the red light” (B), they will *not* make the AC inference “therefore he believes the police were watching” (therefore A). Participants can retrieve several alternative reasons for the action of stopping at a red light other than Paul believing the police are watching.

In contrast, a disabling reason will suppress the *modus ponens* (MP) and *modus tollens* (MT) inferences. For example, when

Table 1  
*Examples of Intention Conditionals That Express Biconditional, Conditional, and Enabling Reasons (Illustrated for Beliefs), the Contingencies True and False for Them, and the Valid Inferences They Support*

Biconditional intention	Example	If Abi believes in the tooth fairy, then she puts her tooth under the pillow	If A, B
	Contingencies	<i>True:</i> Abi believes in tooth fairy and puts tooth under pillow Abi does not believe in tooth fairy and does not put tooth under pillow  <i>False:</i> Abi believes in tooth fairy and does not put tooth under pillow Abi does not believe in tooth fairy and puts tooth under pillow	<i>True:</i> A & B Not-A & not-B  <i>False:</i> A & not-B Not-A & B
	Inferences	MP: She believes in tooth fairy ∴ puts tooth under pillow MT: She does not put tooth under pillow ∴ does not believe in tooth fairy AC: She puts tooth under pillow ∴ believes in tooth fairy DA: She does not believe in tooth fairy ∴ does not put tooth under pillow	A ∴ B Not-A ∴ not-B  B ∴ A Not-A ∴ not-B
Conditional intention	Example	If Paul believes the police are watching, then he stops at the red light	If A, B
	Contingencies	<i>True:</i> Paul believes police are watching and stops at red light Paul does not believe police are watching and does not stop at red light Paul does not believe police are watching and stops at red light  <i>False:</i> Paul believes police are watching and does not stop at red light	<i>True:</i> A & B Not-A & not-B Not-A & B  <i>False:</i> A & not-B
	Inferences	MP: Paul believes police are watching ∴ stops at red light MT: Paul does not stop at red light ∴ does not believe police are watching	A ∴ B Not-B ∴ not-A
Enabling intention	Example	If Cathy believes it will rain, then she takes an umbrella	If A, B
	Contingencies	<i>True:</i> Cathy believes it will rain and takes umbrella Cathy does not believe it will rain and does not take umbrella Cathy believes it will rain and does not take umbrella  <i>False:</i> Cathy does not believe it will rain and takes umbrella	<i>True:</i> A & B Not-A & not-B A & not-B  <i>False:</i> Not-A & B
	Inferences	AC: Cathy takes an umbrella ∴ believes it will rain DA: Cathy does not believe it will rain ∴ does not take umbrella	B ∴ A Not-A ∴ not-B

Note. AC = affirmation of the consequent; DA = denial of the antecedent; MP = modus ponens; MT = modus tollens.

participants are given an enabling intention, such as, “If Cathy believes it is going to rain, then she brings her umbrella” (if A then B), and the information “Cathy believes it is going to rain” (A), they will *not* make the MP inference “therefore she brought an umbrella” (therefore B), presumably because they can retrieve a disabling reason, for example, “Cathy believes her raincoat will keep her dry.” Likewise, when participants are given the information “Cathy did not bring an umbrella” (not-B), they will *not* make the MT inference “therefore she did not believe it was going to rain” (therefore not-A). Participants can retrieve several disabling reasons that would lead to the opposite of the action of bringing an umbrella despite Cathy believing it is going to rain.

When participants are given a biconditional intention, for example, “If Abi believes the tooth fairy exists, then she puts her tooth under her pillow,” they will tend to make all four inferences—they will not tend to retrieve alternative reasons for the action of putting a tooth under a pillow other than Abi believing in the tooth fairy, and they will not tend to retrieve disabling reasons

that lead to the opposite of the action of putting a tooth under a pillow despite Abi believing in the tooth fairy. Of course, semantic and pragmatic factors may lead people to consider different possibilities. For example, knowledge that Abi is an older child may lead participants to retrieve an alternative reason, such as that she wishes to obtain the monetary reward that she knows her parents will put under her pillow in exchange for her tooth—their background knowledge will lead them to retrieve a counterexample for the action of putting a tooth under a pillow other than Abi believing in the tooth fairy. Alternatively, knowledge that Abi lives in abject poverty may lead participants to retrieve a disabling reason, such as that she knows her mother has no money whatsoever—their background knowledge will lead them to retrieve a counterexample that leads to the opposite of the action of putting her tooth under her pillow despite Abi believing in the tooth fairy. Content and context can have a profound impact on the interpretation of conditionals, but our suggestion is that without the additional knowledge about Abi’s age or financial circumstances, participants

will tend not to retrieve alternative or disabling reasons for the conditional.

Our aim in the experiments we report is to examine whether counterexamples, either retrieved or explicitly provided, suppress inferences from intention conditionals based on familiar and unfamiliar content. Experiment 1 tests the prediction that different counterexamples suppress different inferences from intention conditionals by examining whether the inferences people make are affected by the counterexamples they have retrieved, that is, whether they make different inferences from biconditional, conditional, and enabling intentions. Experiment 2 tests whether they make different inferences from the different sorts of intentions when counterexamples are explicitly provided to them. Experiment 3 tests whether they make different inferences from the different sorts of intentions even when they have no prior knowledge about the domain or beliefs about the probabilities or utilities of the relationship between the reason and action. Experiment 4 tests whether participants retrieve alternatives and disablers readily for intentions just as they do for causal conditionals.

After we report the results of the experiments, we consider the cognitive processes that may underlie suppression for intention conditionals. There is as yet no consensus about the cognitive processes that may underlie conditional reasoning, and no current theory of conditional reasoning offers an account of how people reason with intention conditionals. We consider potential extensions of two alternative views to explain intention conditionals, that the cognitive processes are based on the construction of possibilities (e.g., Byrne & Johnson-Laird, 2009; Johnson-Laird & Byrne, 2002) or that they are based on the calculation of probabilities (e.g., Evans & Over, 2004; Oaksford & Chater, 2007). The experiments aim to examine the suppression of inferences by counterexamples, and this aim raises questions about the similarities and differences between intention conditionals and causal conditionals.

### Intentions and Causes

The proposal that people distinguish between different sorts of biconditional, conditional, and enabling intention relations by retrieving counterexamples that suppress inferences is analogous to conclusions from findings on causal conditionals. There are important similarities—and equally important differences—between reason–action and cause–effect relations.

### Differences Between Intentions and Causes

People provide reasons for behavior they believe is intentional and causes for behavior they believe is unintentional (Malle, 1999; see also Reeder, 2009), and they tend to view intentions as causes from an early age (e.g., Muentener & Lakusta, 2011; see Wolff, 2003). But whether or not reasons can be considered to *cause* actions has been vigorously debated (e.g., Davidson, 1963; Donnellan, 1967; Smith & Jones, 1986). A person may carry out a single action—walking to the shops—for many different reasons at once—a need to buy milk, a desire to get exercise, a goal to speak again to the friendly shop-assistant—or conversely, they may carry out many actions—working long hours, taking on extra tasks, carrying out work to a high standard—for a single reason—a goal to be promoted. These many-to-one and one-to-many map-

pings of reasons to actions are uncharacteristic of causal relations, which tend to have a simpler one-to-one mapping of causes to effects (e.g., Walsh & Byrne, 2007). Accordingly, the relation between reasons and actions is less constrained than the relation between causes and effects. Effects are determined by their causes through a causal mechanism, for example, the causes of breaking a glass are determined by the causal mechanism required to break glass, whereas the reasons for breaking a glass—a wish to disturb someone, a need to express anger, or simple carelessness—may have a less fixed relationship to the action and may depend on pragmatic considerations and individual presuppositions. In this respect, cause–effect relations can be considered constrained by the nature of their effects, whereas reason–action relations are constrained by the nature of the reason. Hence, people imagine how things could have been different for cause–effect sequences differently from reason–action sequences. They think about how a cause–effect sequence could have turned out differently by imagining the cause had been different, whereas they think about how a reason–action sequence could have turned out differently by imagining the action had been different (Walsh & Byrne, 2007).

The relation between reasons and actions is also less consistent over time than the relation between causes and effects (e.g., Hart & Honore, 1959), and people experience some difficulty in remembering reasons for actions and inactions (e.g., Gilovich & Medvec, 1994). Intentions and causal attributions make contributions to people’s judgments, for example, about moral matters, that are distinct one from the other (e.g., Alicke, 2000; Cushman & Young, 2011). In fact, there are far greater vagaries in the relation between reasons and actions compared to the relation between causes and their effects (e.g., Donnellan, 1967; Smith & Jones, 1986). An action can be *defined* by a reason in various ways, for example, driving home can be defined in terms of traveling in comfort, contributing to the transport economy, or polluting the planet, any of which may be intentional or not (e.g., Anscombe, 1963; see Walsh & Byrne, 2007). Likewise, an action can be *explained* by a reason in various ways, for example, taking an alternate route to collect medicine for a sick spouse can be explained by the reason that the person wished to help her spouse, but the reason itself may need to be further explained, for example, the person wished to help her spouse because she loves him, because she fears she will be criticized if she does not, or because she thinks it is her duty (e.g., Davidson, 1963; see also Walsh & Byrne, 2007).

### Similarities Between Intentions and Causes

Notwithstanding the important differences between intentions and causes, we suggest one similarity in reasoning about intentions and reasoning about causes is the role of counterexamples. A key discovery in causal reasoning is that people distinguish between different sorts of causal relations (e.g., Cummins, Lubart, Alksnis, & Rist, 1991; De Neys, Schaeken, & d’Ydewalle, 2005a; see also Cheng & Novick, 1992; Sloman, Barbey, & Hotaling, 2009). They judge distinct causal relations to be consistent with different sorts of contingencies (e.g., Egan, Frosch, & Hancock, 2008; Frosch & Byrne, 2012; Goldvarg & Johnson-Laird, 2001). For example, the simplest sort of cause is a biconditional causal relation, such as, “If the gong is hit, then it makes a sound” (if A then B) (e.g., Cheng & Novick, 1992; Cummins et al., 1991; Goldvarg & Johnson-



Laird, 2001; Schustack & Sternberg, 1981). People interpret it as consistent with several contingencies, such as “the gong is hit and it makes a sound” (A and B), and “the gong is not hit and it does not make a sound” (not-A and not-B).

Another sort of causal relation is a conditional causal relation, for example, “If the fruit is ripe, then it falls from the tree” (if A then B). People interpret it as consistent with a different set of contingencies from the biconditional cause, that is, “the fruit is ripe and it falls from the tree” (A and B); “the fruit is not ripe and it does not fall from the tree” (not-A and not-B); and crucially, “the fruit is not ripe and it falls from the tree” (not-A and B)—other causes and conditions can also bring about the effect, for example, strong winds can cause the fruit to fall from the tree (e.g., Thompson, 1994; Thompson & Byrne, 2002). People readily retrieve such an alternative cause (not-A and B because alternative cause to A; e.g., Cummins, 1995; De Neys, Schaeken, & d’Ydewalle, 2003; Markovits & Potvin, 2001; Quinn & Markovits, 2002). An alternative cause, whether retrieved or explicitly provided, suppresses the DA and the AC inferences, for example, given “the fruit was not ripe,” participants do *not* conclude, “therefore it did not fall from the tree” if they have thought about, or been told about, an alternative cause, such as “it may have been a windy day instead” (e.g., Markovits, 1984; Romain, Connell, & Braine, 1983).

A third sort of causal relation is an *enabling* one (or an *allowing* relation), for example, “If the product is advertised, then sales increase” (if A then B; e.g., Cheng & Novick, 1992; Goldvarg & Johnson-Laird, 2001). People interpret it as consistent with a different set of contingencies from a biconditional or conditional cause, such as “the product is advertised and sales increase” (A and B); “the product is not advertised and sales do not increase” (not-A and not-B); and crucially, “the product is advertised and sales do not increase” (A and not-B)—other causes and conditions must also be present to bring about the effect, for example, the ads must be effective and well placed. People readily retrieve such a disabling cause, for example, “the product is advertised and sales do not increase because the ads are no good” (A and not-B because disabling cause to A; e.g., De Neys et al., 2003; Markovits & Potvin, 2001). A disabling cause suppresses the MP and MT inferences, for example, given “the product was advertised,” participants do *not* conclude “therefore sales increased” if they have thought about, or been told about, a disabler such as “the ads may have been no good” (e.g., Byrne, 1989; Byrne, Espino, & Santamaria, 1999; Cummins et al., 1991; De Neys et al., 2003; Oaksford & Chater, 1998; Stevenson & Over, 1995). People’s ability to retrieve counterexamples depends on their working memory: It can be interrupted by secondary tasks that compete for working memory resources, and individuals with higher working memory capacity are better at retrieving, and at inhibiting, counterexamples (e.g., De Neys, 2011; De Neys, Schaeken, & d’Ydewalle, 2005b). We examine whether people similarly distinguish between different sorts of biconditional, conditional, and enabling intention relations by retrieving counterexamples that suppress inferences.

### Materials Test: A Corpus of Intention Conditionals

Intention conditionals have not been studied systematically before, and so, unlike causal conditionals, no corpus of conditionals is available for which it has been established that participants readily generate alternative and disabling reasons, and no clear

categorization exists of conditionals that contain biconditional, conditional, or enabling intentions. Our first task then was to carry out a materials test on a large set of conditionals about intentions gathered from different sources in everyday life such as newspapers, conversations, and so on.

The materials check was designed to test whether or not participants can generate counterexamples to intention relations. We tested whether they generated many alternative reasons to some reason–action relations that could be categorized as conditional intentions, whether they generated many disabling reasons to other reason–action relations that could be categorized as enabling intentions, and whether they generated few alternatives or disablers to other reason–action relations that could be categorized as biconditional intentions. The materials test also checked whether people can generate alternatives and disabling reasons to reason–action relations of different sorts, including beliefs, goals, obligations, and social norms.

## Method

**Materials and design.** We constructed a set of conditionals corresponding to four sorts of reasons—external, that is, obligations and social norms, and internal, that is, beliefs and goals. We included conditionals that contained intentions for which we expected that participants would be able to generate many alternatives, for example, “If Linda’s goal is to replace her car’s tires, then she goes to a mechanic,” such as “she has a desire to see the handsome mechanic” or “she is obliged to get her car certified for safety,” and conditionals that contained intentions for which we expected that participants would be able to generate many disablers, for example, “If Mary’s goal is to look thinner, then she has liposuction,” such as “she has a desire to be healthy instead” or “she is obliged to avoid surgery.” We also included conditionals that contained intentions for which we expected that participants would not be able to generate alternatives or disablers, for example, “If Alicia’s goal is to get her driving license, then she goes to a driving school.” We provided a preliminary categorization for these conditionals into the three sorts of reason–action relations—biconditional, conditional, and enabling—based on commonsense intuitions (see the Appendix). We included four different contents in each of these 12 categories, that is, the three sorts of reason–action relations—biconditional, conditional, and enabling—for the four sorts of reasons—two external, obligations and social norms, and two internal, beliefs and goals—resulting in a set of 48 conditionals.

Participants were assigned to the Alternatives task condition or the Disablers task condition. In each trial, they were asked to consider a different conditional, for example:

Consider the following: If Mary is required to do so by her mother, then she goes to bed at 9 o’clock.

Participants in the Alternatives condition were given a fact of the form *not-A and B*:

We know for a fact that: Mary goes to bed at 9 o’clock, but she is not required to do so to by her mother.

Participants in the Disablers condition were given a fact, this time of the form *A and not-B*:

We know for a fact that: Mary is required to do so by her mother, but she does not go to bed at 9 o'clock.

Their task was as follows (adapted from Cummins, 1995):

Please write down, with examples, as many different circumstances as you can that could make this situation possible.

**Participants and procedure.** The participants were 136 students from ISPA, Lisbon, who took part voluntarily. The participants assigned to the Alternatives condition were 54 women and nine men, average age 21 years, and the participants assigned to the Disablers condition were 60 women and 13 men, average age 22 years (and one who did not record gender). The materials were presented in a booklet that contained instructions and the 48 trials. Two independent raters coded the responses as alternatives or disablers in each condition. The results of the interrater analysis for the Alternatives condition was  $\kappa = .36$ ,  $p < .01$ , and for the Disablers condition, it was  $\kappa = .47$ ,  $p < .01$ . Disagreements were settled by discussion.

## Results and Discussion

Wilcoxon signed rank tests showed that participants in the Alternatives condition generated more alternatives for some conditionals, that is, those we had preliminarily categorized as conditional intentions, compared to others, that is, those we had preliminarily categorized as biconditional ( $z = 6.90$ ,  $p < .001$ ,  $r = .62$ ) and those we had categorized as enabling ( $z = 6.85$ ,  $p < .001$ ,  $r = .61$ ), as Figure 1A shows. The raw data for this experiment and each of the subsequent ones are available at <http://reasoningandimagination.wordpress.com/>. Participants in the Disablers condition generated more disablers for some conditionals, that is, those we had preliminarily categorized as enabling, compared to others, that is, those preliminarily categorized as biconditional ( $z = 5.48$ ,  $p < .001$ ,  $r = .49$ ), although not compared to conditional intentions ( $z = .75$ ,  $p = .45$ ), as Figure 1A also shows.

The pattern for the generation of alternatives in the Alternatives condition, for the comparison of conditional to biconditional and of conditional to enabling, was observed for each type of reason—goals, beliefs, obligations, and norms—as Figure 1B shows, in each of the eight cases (all  $z$ s  $> 4.71$ ,  $ps < .01$ ,  $rs > .59$ ). The pattern for the generation of disablers in the Disablers condition was observed, as Figure 1B shows, in six of the eight cases (all  $z$ s  $> 2.97$ ,  $ps < .01$ ,  $rs > .35$ ), and the two exceptions were the comparison of enabling to biconditional for obligations ( $z = 0.71$ ,  $p = .48$ ) and norms ( $z = 1.46$ ,  $p = .15$ ).

The results of the materials test show that people distinguish between biconditional, conditional, and enabling intentions.<sup>1</sup> They retrieved alternative reasons to the conditionals we had preliminarily categorized as conditional intentions, they retrieved disabling reasons to the conditionals we had preliminarily categorized as enabling intentions, and they retrieved far fewer alternatives or disablers to the conditionals we had preliminarily categorized as biconditional intentions. They did so for a variety of reasons based on beliefs, goals, obligations, and social norms (although with some disparities for disablers to external reasons). We rely on a subset of this corpus in our first experiment to examine the generation of counterexamples to different intention conditionals and the inferences people make from them.

## Experiment 1: Inferences From Intention Conditionals

The aim of the experiment was to test whether inferences are suppressed from intention conditionals when people spontaneously retrieve counterexamples. The experiment was designed to test two predictions, first, that the DA and AC inferences will be suppressed from conditional intention relations to which participants retrieve many alternatives and few disablers, compared to biconditional and enabling intentions, and second, that the MP and MT inferences will be suppressed from enabling intentions to which participants retrieve many disablers and few alternatives, compared to biconditional and conditional intention relations.

We expect to observe a pattern wherein, for biconditional intentions, participants make all four inferences; for conditional intentions, they make the MP and MT inferences, but they make fewer of the DA and AC inferences; and for enabling intentions, they make the DA and AC inferences, but they make fewer of the MP and MT inferences. In the experiment, participants generated disablers and alternatives for biconditional, conditional, and enabling intention relations, instantiated in content corresponding to beliefs, goals, obligations, and social norms, and they evaluated the four conditional inferences for each of the intention conditionals. We expect to observe the same pattern for each of the different sorts of reasons: beliefs, goals, obligations, and social norms.

## Method

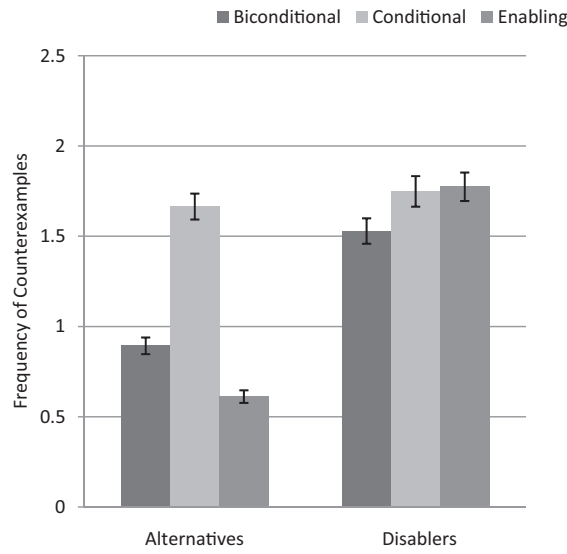
**Materials and design.** Participants acted as their own controls. Every participant was given 12 intention conditionals: One content was selected from each of the 12 categories of reasons (biconditional, conditional, and enabling intention relations, for beliefs, goals, obligations, and social norms), which had the best score for that category in the materials pretest (see the Appendix).

Participants completed both an alternative and a disabler generation task for each conditional, and 1 week later, they completed an inference task for each conditional. In the generation task, participants retrieved alternatives and disablers for each conditional in counterbalanced blocks. They were given the following instructions and an example (illustrated here for disabler generation):

Imagine you are a National Security Academy finalist. The academy trains agents for the Secret Services Agency. The task you are given is part of your admission examination. It is vital for any spy to be able to analyze fragments of information and make sense of them. We will present two fragments of information: a statement and a fact, both

<sup>1</sup> We conducted a second analysis to ensure that the results were not determined by a single content in each category, based on a reduced data set that excluded the single content in each type of reason (goal, belief, obligation, norm) for each category (biconditional, conditional, enabling) whose results deviated most (the outlier based on the standard deviation for that category), that is, 12 contents excluded from the original 48. The analysis of the remaining 36 conditionals yielded the same results: Participants in the Alternatives condition generated more alternatives for conditional intention relations ( $M = 1.70$ ,  $SD = .59$ ) compared to biconditional ( $M = .88$ ,  $SD = .39$ ,  $z = 6.85$ ,  $p < .01$ ,  $r = .86$ ) and enabling ( $M = .67$ ,  $SD = .31$ ,  $z = 6.90$ ,  $p < .01$ ,  $r = .87$ ). Participants in the Disablers condition generated more disablers for enabling ( $M = 1.62$ ,  $SD = .64$ ) compared to biconditional ( $M = 1.39$ ,  $SD = .54$ ,  $z = 4.87$ ,  $p < .01$ ,  $r = .57$ ), although this time fewer than conditional intention relations ( $M = 1.76$ ,  $SD = .74$ ,  $z = 2.59$ ,  $p < .01$ ,  $r = .30$ ).

**A**



**B**

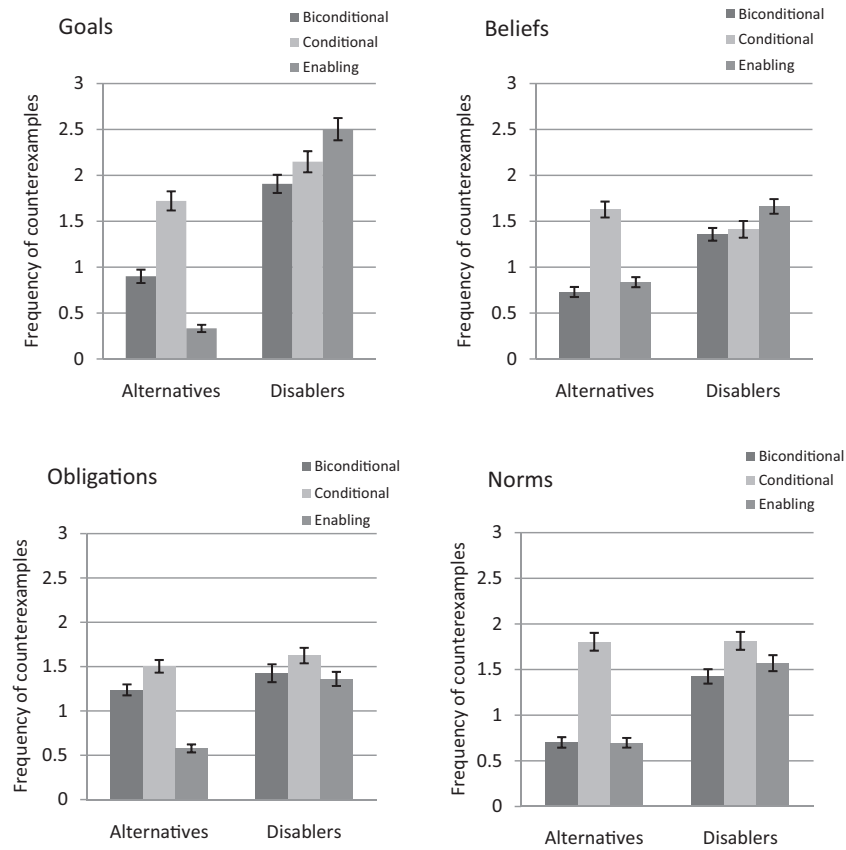


Figure 1. Mean frequency of alternatives and disablers generated for biconditional, conditional, and enabling intention conditionals in the materials test. A: For all reasons combined. B: For goals, beliefs, obligations, and norms separately. Error bars are standard error of the mean.

true. Your task is to explain how that fact could have happened. Consider, “If Joe goes to the theatre, then he buys a ticket.” It happens that “Joe goes to the theatre and he does not buy a ticket.” What do you think? How is this possible? Write down as many explanations as you can think of.

For the inference task, each of the 12 conditionals was presented with the premises for an MP (A), MT (not-B), AC (B), or DA (not-A) inference, resulting in 48 distinct trials. The participants’ task was to choose a conclusion from a set of three conclusions, for example, for MP, the choices were (a) B, (b) not-B, or (c) B may or may not be the case. They were given the following instructions:

Today’s task continues the theme of an imaginary application to the Secret Services Agency. This time you will find out if your total score gives you access to the agency. Once again we will show you two fragments of information: a statement and a fact, both true. But this time your task is to think about what conclusion you can draw from the information. We will give you three possible conclusions each time, and you should choose one of them.

**Participants and procedure.** The participants were a new set of 19 students from ISPA who participated in return for course credits. They were 19 women, average age 19 years. In the generation task, the materials were presented using E-Prime software to control the duration of presentation, and the participants wrote their responses in a booklet. The 12 conditionals were presented on screen, each for 1.5 min. During this time, on each trial in the Alternatives condition, they were given the fact “A and not-B,” and they had to write down, with examples, as many different circumstances as they could that would make the situation possible. The 12 conditionals were then presented again, each for 1.5 min. During this time, on each trial in the Disablers condition, they were given the fact “not-A and B,” and they had to write down, with examples, as many different circumstances as they could that would make the situation possible. Half the participants completed the Alternatives generation task first, and the other half completed the Disablers generation task first. At the end of each 1.5 min for each conditional, the participants were told, via headphones, that a new trial was starting. The conditionals were presented in a different randomized order for each participant in each block. The results of the interrater analysis were  $\kappa = .535$ ,  $p < .001$ .

For the inference task, participants were presented 1 week later with the 48 trials individually on a computer screen, the procedure was self-paced, and participants chose their conclusion from a set of three conclusions via a keypress. The trials were presented in a different randomized order for each participant.

## Results and Discussion

Wilcoxon signed ranks tests showed that participants made fewer MP inferences from enabling intentions compared to biconditional ones ( $z = 3.83$ ,  $p < .001$ ,  $r = .88$ ) or conditional ones ( $z = 3.86$ ,  $p < .001$ ,  $r = .89$ ), and they made fewer MT inferences from enabling intentions compared to biconditional ones ( $z = 3.49$ ,  $p < .001$ ,  $r = .80$ ) or conditional ones ( $z = 3.36$ ,  $p < .001$ ,  $r = .77$ ), as Figure 2A shows.

Second, McNemar tests showed that this pattern of the suppression of MP and MT for enabling intentions held in each of the eight cases for enabling intentions compared to biconditional ones, as Figure 2B shows ( $N = 19$  in all cases, all  $ps < .003$ ), and it held

in each of the eight cases for enabling intentions compared to conditional ones (all  $ps < .01$ ).

Participants made fewer AC inferences from conditional intentions compared to biconditional ones ( $z = 2.94$ ,  $p < .003$ ,  $r = .67$ ) or enabling ones ( $z = 3.14$ ,  $p < .002$ ,  $r = .72$ ) and fewer DA inferences from conditional intentions compared to biconditional ones ( $z = 2.17$ ,  $p < .03$ ,  $r = .50$ ) and (marginally) compared to enabling ones ( $z = 1.71$ ,  $p = .086$ ,  $r = .39$ ), as Figure 2A shows.

Fourth, McNemar tests showed that this pattern of the suppression of the DA and AC inferences for conditional intentions held in six of the eight cases for conditional intentions compared to biconditional ones, as Figure 2B shows ( $N = 19$  for all cases, all  $ps < .046$ ), and the exceptions were DA for beliefs ( $p < .055$ ) and norms ( $p < .09$ ). This pattern also held in five of the eight cases for conditional intentions compared to enabling ones (all  $ps < .033$ ), and the exceptions were DA for goals ( $p < .133$ ), obligations ( $p < .194$ ), and norms ( $p < .344$ ).

Finally, Wilcoxon tests showed that in the generation task, participants generated more alternative reasons for conditional intentions ( $M = 1.99$ ,  $SD = 1.28$ ) compared to biconditional ones ( $M = .84$ ,  $SD = .67$ ,  $z = 3.491$ ,  $p < .001$ ,  $r = .80$ ) and enabling ones ( $M = 1.42$ ,  $SD = .90$ ,  $z = 2.632$ ,  $p < .008$ ,  $r = .60$ ). They generated more disabling reasons for enabling intentions ( $M = 1.67$ ,  $SD = 1.03$ ) compared to biconditional ones ( $M = .59$ ,  $SD = .62$ ,  $z = 3.75$ ,  $p < .001$ ,  $r = .86$ ) and conditional ones ( $M = .93$ ,  $SD = .66$ ,  $z = 3.55$ ,  $p < .001$ ,  $r = .81$ ). These results replicate the materials pretest.

The experiment shows that participants make different inferences from biconditional, conditional, and enabling intention conditionals. Participants generated many alternatives and few disablers to conditional intentions, and so the DA and AC inferences were suppressed, and the MP and MT inferences were not. Participants generated many disablers and few alternatives to enabling intentions, and so the MP and MT inferences were suppressed, and the DA and AC inferences were not. Participants generated few disablers and few alternatives to biconditional intentions, and none of the four inferences were suppressed. Our next experiment aims to replicate the finding for the larger corpus of 48 intention conditionals from the materials pretest and to extend it to inferences from conditional arguments for which participants are provided with explicit alternative or disabling reasons, rather than ones for which they have retrieved alternatives or disablers.

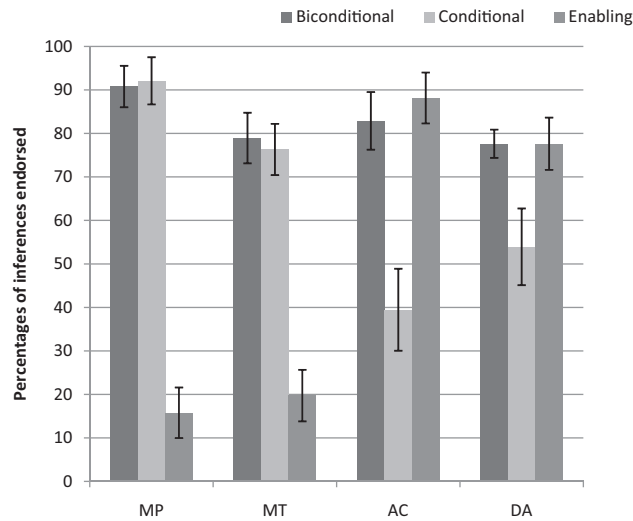
## Experiment 2: Explicit Counterexamples

The aim of the experiment was to test whether inferences are suppressed from intention conditionals when people are explicitly provided with counterexamples, that is, not only when they spontaneously retrieve counterexamples as Experiment 1 showed. The suppression of inferences by retrieved counterexamples implicates an individual’s knowledge about the nature of the relationship between a reason and an action. But even if an individual does not know of counterexamples to an intention relation, we expect that the provision of explicit counterexamples will be enough to suppress inferences. The experiment tested the prediction that the DA and AC inferences will be suppressed from conditional intentions when participants have been given a second conditional with an explicit alternative antecedent that leads to the same consequent, for example,

If Isabel’s goal is to replace her car tires, then she goes to a mechanic.



**A**



**B**

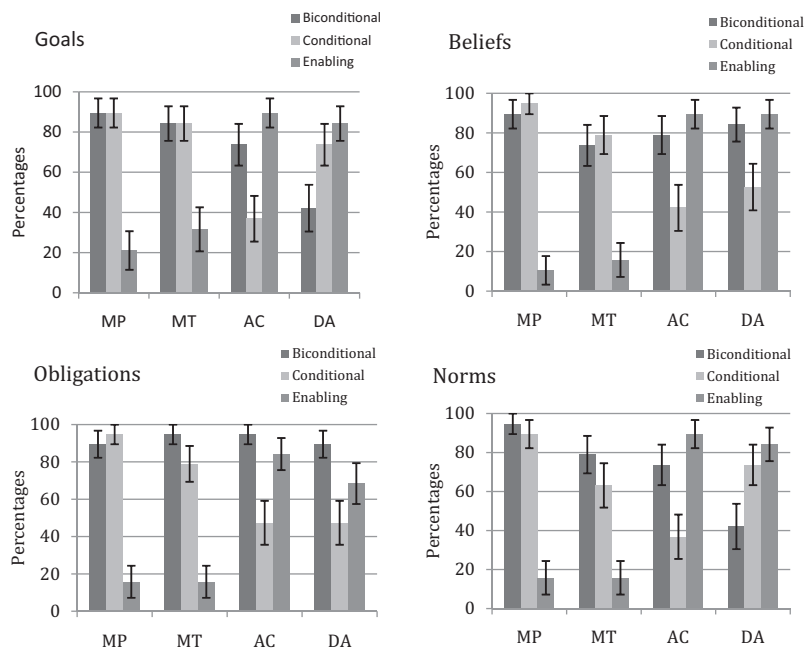


Figure 2. Percentages of MP, MT, DA, and AC inferences endorsed for biconditional, conditional, and enabling intentions in Experiment 1 with retrieved counterexamples. A: For all reasons combined. B: For goals, beliefs, obligations, and norms separately. Error bars are standard error of the mean. AC = affirmation of the consequent; DA = denial of the antecedent; MP = modus ponens; MT = modus tollens.

If Isabel’s goal is to get her car serviced, then she goes to a mechanic.

The experiment also tested the prediction that the MP and MT inferences will be suppressed from enabling intentions when participants have been given a second conditional with an explicit disabling antecedent that leads to the opposite consequent (follow-

ing the method of Geiger & Oberauer, 2007; Markovits, Lortie Forgues, & Brunet, 2010):

If Mario’s goal is to look thinner, then he has liposuction.

If Mario’s goal is to be in good shape, then he does not have liposuction.

The experiment also aims to generalize the results of the previous experiment to a larger corpus of intention conditionals. The materials rely on 80 intention conditionals, comprising the original corpus of 48 intention conditionals from the materials pretest as the first conditional in a pair, accompanied by 32 new intention conditionals with alternative and disabling reasons as the second conditional in a pair (see the Appendix).

## Method

**Materials and design.** The materials consisted of the full set of 48 conditionals from the pretest, including the 12 conditionals used in the previous experiment, as the first conditional in a pair, and 32 new intention conditionals with alternative and disabling reasons as the second conditional in a pair. Participants were assigned to one of three groups—biconditional intentions, conditional intentions, or enabling intentions—and so, each participant received 16 of the original 48 conditionals as the first conditional in a pair, comprising four instances of each of the four types of reasons: beliefs, goals, obligations, and social norms. Each conditional pair was accompanied by four inferences—MP, MT, DA, and AC—and thus, each participant completed 64 inferences (16 conditionals  $\times$  4 inferences).

The 16 conditionals in the conditional intention condition were each accompanied by a second conditional that contained an alternative antecedent that led to the same consequent, and the 16 conditionals in the enabling intention condition were each accompanied by a second conditional that contained a disabling antecedent that led to the opposite consequent (see the Appendix). The 16 conditionals in the biconditional condition were presented without an accompanying second conditional. Participants were given the following instructions:

Imagine that scientists have recently discovered that thinking about certain aspects of daily life discloses brain activities never before recorded. A team of scientists was assembled to create the materials for a research program based on the discoveries made. Since all the work was done under great pressure, it is necessary to verify whether everything is correct. In the following pages you will be presented with aspects of daily life that will be part of their research. The aspects will always be followed by four situations and conclusions. Your task is to assess whether those conclusions follow logically from the information available.

As in the previous experiment, their task was to choose a conclusion from a set of three conclusions.

**Participants and procedure.** The participants were a new set of 61 students from ISPA who participated in return for course credits. They were 44 women and 17 men, with an average age of 20 years. They were assigned at random to one of the three conditions, biconditional intentions ( $n = 22$ ), conditional intentions ( $n = 19$ ), and enabling intentions ( $n = 20$ ). The materials were presented in a booklet, and each conditional was presented on a separate page with its four inferences.

## Results and Discussion

Mann-Whitney  $U$  tests showed that as predicted, participants made fewer AC inferences from conditional intentions compared to biconditional ones ( $U = 118.0$ ,  $W = 308.0$ ,  $p < .02$ ,  $r = .37$ ) or enabling ones ( $U = 53.0$ ,  $W = 243.0$ ,  $p < .001$ ,  $r = .62$ ) and

fewer DA inferences from conditional intentions compared to biconditional ones ( $U = 110.0$ ,  $W = 300.0$ ,  $p < .009$ ,  $r = .41$ ) or enabling ones ( $U = 68.0$ ,  $W = 258.0$ ,  $p < .001$ ,  $r = .55$ ), as Figure 3 shows.

Participants made fewer MP inferences from enabling intentions compared to conditional ones ( $U = 22.0$ ,  $W = 232.0$ ,  $p < .001$ ,  $r = .78$ ) but not to biconditional ones ( $U = 162.0$ ,  $W = 372.0$ ,  $p < .14$ ,  $r = .23$ ) and fewer MT inferences from enabling intentions compared to conditional ones ( $U = 115.0$ ,  $W = 325.00$ ,  $p < .04$ ,  $r = .34$ ) or to biconditional ones ( $U = 79.5$ ,  $W = 289.5$ ,  $p < .001$ ,  $r = .55$ ), as Figure 3 also shows.

The experiment replicates the finding that participants make different inferences from biconditional, conditional, and enabling intentions for the larger corpus of 48 intention conditionals and for the explicit provision of counterexamples in 32 new intention conditionals containing alternative or disabling reasons. The results show that inferences are suppressed from intention conditionals not only when individuals can retrieve a counterexample from their own knowledge about the reason–action relation, as Experiment 1 showed, but also when they are explicitly told about a counterexample to the reason–action relation. Experiments 1 and 2 show that inferences are suppressed by counterexamples, for familiar reason–action relations, about which participants have prior knowledge and beliefs, including beliefs about the likelihood of the reason or the action or about the likelihood of the relationship of the two. Our next experiment aims to extend the finding to unfamiliar intention conditionals.

### Experiment 3: Unfamiliar Content

The aim of the experiment was to test whether inferences are suppressed from intention conditionals for unfamiliar content when people cannot rely on their background knowledge or on their beliefs about the probability of the events or their relation-

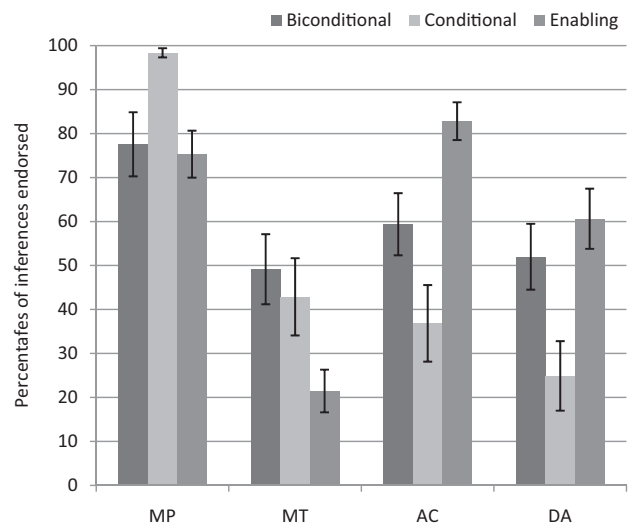


Figure 3. Percentages of MP, MT, DA, and AC inferences endorsed for biconditional, conditional, and enabling intention conditionals in Experiment 2 with explicitly provided counterexamples. Error bars are standard error of the mean. AC = affirmation of the consequent; DA = denial of the antecedent; MP = modus ponens; MT = modus tollens.

ship. We examined whether the explicit provision of a counterexample to a reason–action relation is sufficient to suppress an inference, for unfamiliar reasons and unfamiliar actions and unfamiliar reason–action relationships, when an individual cannot rely on his or her knowledge to estimate the likelihood of the reasons or actions. We used nonsense words set in a fantasy alien context (adapted from Geiger & Oberauer, 2007; Markovits et al., 2010), for example,

If a Floop believes he has Xly in his blood, then he initiates Midosis.

We conveyed intentions based on beliefs, such as the example above, as well as goals, for example,

If a Squik’s goal is to call Thardon, then he rubs himself against the Plok,

and social norms, for example,

If a Lipp respects the social norm of smoking Ara, then he puts on a Silig,

and obligations, for example,

If a Nool is required to belong to the Voolii, then he changes his skin.

The experiment tests the prediction that the DA and AC inferences will be suppressed from conditional intentions to which participants have been given a second conditional with an explicit alternative reason that leads to the same action, for example,

If a Floop believes he has Xly in his blood, then he initiates Midosis.

If a Floop believes he has Zhaa in his blood, then he initiates Midosis.

The experiment also tests the prediction that the MP and MT inferences will be suppressed from enabling intention conditionals to which participants have been given a second conditional with an explicit disabling reason that leads to the opposite action, for example,

If a Floop believes he has Xly in his blood, then he initiates Midosis.

But if additionally a Floop believes he has Zhaa in his blood, then he does not initiate Midosis.

We ensured that knowledge of familiar reason–action sequences in everyday life and their probabilities could not be relied on by the assignment at random of a reason to the antecedent of the conditional (e.g., a Floop believes he has Xly in his blood) and an action to the consequent of the conditional (e.g., he initiates Midosis). We also assigned a content to an intention as a belief, goal, social norm, or obligation at random and created two sets based on two different random assignments, for example, Set A assigned the Midosis content as a belief, for example, “If a Floop believes he has Xly in his blood, then he initiates Midosis,” whereas Set B assigned it as an obligation, for example, “If a Floop is required to have Xly in his blood, then he initiates Midosis.”

As a further strong control, we assigned a single reason, for example, “If a Floop believes he has Zhaa in his blood . . . ,” to be an alternative reason or a disabling reason simply based on whether it was described as leading to the same action as the first conditional, for example, “If a Floop believes he has Zhaa in his

blood, then he initiates Midosis,” or the opposite action, for example, “But if additionally a Floop believes he has Zhaa in his blood, then he does not initiate Midosis” (see the Appendix for the full set of conditionals used in the experiment, adapted from Geiger & Oberauer, 2007; Markovits et al., 2010).

## Method

**Materials and design.** The materials consisted of 24 conditionals. There were eight conditionals presented as the first conditional in a pair, comprising two instances of each of the four types of reasons: beliefs, goals, obligations, and social norms. Each one was accompanied by four inferences—MP, MT, DA, and AC—and thus, each participant completed 32 inferences (see the Appendix). The eight conditionals in the conditional intention condition were each accompanied by a second conditional that contained an alternative antecedent that led to the same consequent, and the eight conditionals in the enabling intention condition were each accompanied by a second conditional that contained a disabling antecedent that led to the opposite consequent. The conditionals in the biconditional condition were presented without a second accompanying conditional. The conditionals were assigned to the content at random and referred to as beliefs, goals, social norms, or obligations in two ways at random to make two sets; half of the participants received one set and the other half the other set. Participants were given the following instructions (adapted from Markovits et al., 2010):

Imagine the following scenario. Scientists have recently discovered life on a planet named Kronus. A team of scientists was sent there to run several tests. The scientists found environments and beings never seen before. This news was understandably met with great enthusiasm on Earth and debates on the topic led people to numerous conclusions. Over the next pages, you will be presented with the discoveries made by the scientists, each one followed by four situations and their respective conclusions. Your task is to assess whether the conclusions follow logically from the presented discoveries. Since on Kronus everything is different, you may find certain terms to be unfamiliar. That is of little importance. What is important is to focus on the conclusions and assess whether they follow logically.

As in the previous experiment, the participants’ task was to choose a conclusion from a set of three conclusions. The design was the same as the previous experiment.

**Participants and procedure.** The participants were a new set of 60 students from ISPA who participated in return for course credits. They were 46 women and 14 men, with an average age of 25 years. They were assigned at random to one of three conditions: biconditional intentions, conditional intentions, and enabling intentions ( $n = 20$  in each). Participants in the enabling intentions condition received arguments of the form “If A, then B; but if additionally disabler C, then not-B” (following Geiger & Oberauer, 2007; Markovits et al., 2010). These participants replaced an earlier set of 20 participants who were given conditionals of the form “If A, then B; if disabler C, then not-B,” to more closely match the form of arguments used in previous research. The materials were presented in a booklet, and each conditional was presented on a separate page with its four inferences.

## Results and Discussion

Mann-Whitney  $U$  tests showed that as predicted, participants made fewer AC inferences from conditional intentions compared to biconditional ones ( $U = 108.5$ ,  $W = 318.5$ ,  $p < .01$ ,  $r = .40$ ) or enabling ones ( $U = 45.0$ ,  $W = 255.0$ ,  $p < .001$ ,  $r = .68$ ) and fewer DA inferences from conditional intentions compared to biconditional ones ( $U = 79.5$ ,  $W = 289.5$ ,  $p < .001$ ,  $r = .52$ ) or enabling ones ( $U = 101.0$ ,  $W = 311.0$ ,  $p < .007$ ,  $r = .43$ ), as Figure 4 shows.

Participants made fewer MP inferences from enabling intention conditionals compared to biconditional ones ( $U = 135.0$ ,  $W = 345.0$ ,  $p < .03$ ,  $r = .34$ ) but not from conditional ones ( $U = 153.0$ ,  $W = 363.5$ ,  $p < .14$ ,  $r = .23$ ), as Figure 4 shows. They made fewer MT inferences from enabling intentions compared to biconditional ones ( $U = 121.5$ ,  $W = 331.5$ ,  $p < .03$ ,  $r = .34$ ), although the difference is not significant for the comparison to conditional ones ( $U = 151.5$ ,  $W = 361.5$ ,  $p < .18$ ,  $r = .21$ ), as Figure 4 shows.

The experiment shows that participants make different inferences from biconditional, conditional, and enabling intention conditionals, when they are explicitly told about a counterexample to the reason–action relation, for unfamiliar content. Participants had no prior knowledge about the likelihood of the reason or the action or about the probability of the relationship between them. The experiment shows that all that is required for the suppression of an inference from an intention conditional is information about a counterexample, that is, an alternative reason that leads to the same action or a disabling reason that leads to the opposite action; no knowledge or belief about the reason or action or probable explanation for their relationship is required. The final experiment examines whether participants can retrieve alternative and disabling reasons to famil-

iar intention relations as readily as they retrieve alternative and disabling causes to causal relations.

## Experiment 4: Alternative and Disabling Reasons and Causes

The aim of the experiment was to assess whether people distinguish biconditional, conditional, and enabling intentions as readily as they distinguish biconditional, conditional, and enabling causal conditionals. We expected that, despite the differences between intentions and causes, participants should be able to retrieve alternative and disabling reasons readily for an action, just as they can retrieve alternative and disabling causes readily for an effect.

## Method

**Materials and design.** Participants assigned to the Alternatives condition were given the alternatives generation task described earlier for Experiment 1, and participants in the Disablers condition were given the disablers generation task. Every participant was given 12 intention conditionals (the conditionals used in Experiment 1). They were also given 12 causal conditionals corresponding to biconditional, conditional, and enabling causes, derived from materials used in the literature (Cummins, 1995; De Neys et al., 2003), making a total of 24 trials (see the Appendix). The materials were presented in a different randomized order for each participant.

**Participants and procedure.** The participants were a new set of 26 students from ISPA who volunteered in return for course credits, 12 women in the Alternatives condition and 14 in the Disablers condition. Their average age was 22 years. The materials were presented using SurveyGizmo, which presented instructions and the 24 trials on individual PCs. The participants were given the Alternatives or Disablers tasks as before, with the additional context in their instructions:

Imagine you are a finalist at the National Security Academy. The academy trains agents for the Secret Services Agency. The task you are given is part of your admission exam and at the end you will be given your score. It is vital for any spy to be able to evaluate to what extent two situations are related. This task tests your sharpness on this.

The results of the interrater analysis for their generation of alternatives was  $\kappa = .41$ ,  $p < .01$ , and for disablers was  $\kappa = .47$ ,  $p < .01$ .

## Results and Discussion

Wilcoxon tests showed that the pattern for intention conditionals replicated the results of the materials test: Participants in the Alternatives condition generated more alternatives for conditional intentions compared to biconditional ones ( $z = 3.06$ ,  $p < .01$ ,  $r = .63$ ) and enabling ones ( $z = 2.94$ ,  $p < .01$ ,  $r = .60$ ), as Figure 5 shows. Likewise, participants in the Disablers condition generated more disablers for enabling intentions compared to biconditional ones ( $z = 3.31$ ,  $p < .001$ ,  $r = .63$ ) and this time also more compared to conditional ones ( $z = 3.21$ ,  $p < .001$ ,  $r = .61$ ).

The pattern for causal conditionals replicated earlier research (Cummins, 1995; De Neys et al., 2005a): Participants in the Alternatives condition generated more alternatives for conditional causes compared to biconditional ones ( $z = 2.95$ ,  $p < .01$ ,  $r = .60$ ) and

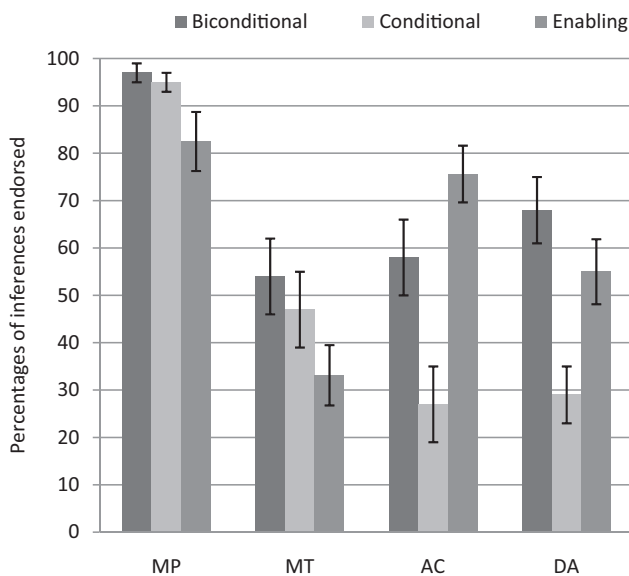


Figure 4. Percentages of MP, MT, DA, and AC inferences endorsed for biconditional, conditional, and enabling intention conditionals in Experiment 3 with unfamiliar content. Error bars are standard error of the mean. AC = affirmation of the consequent; DA = denial of the antecedent; MP = modus ponens; MT = modus tollens.



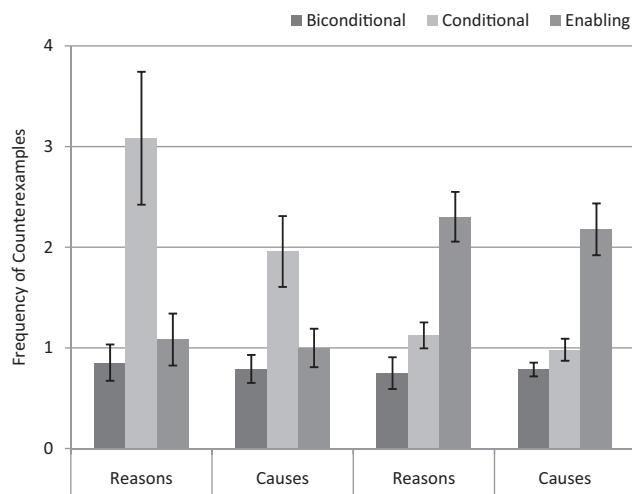


Figure 5. Mean frequency of alternatives and disablers generated for biconditional, conditional, and enabling intentions, and causes in Experiment 4. Error bars are standard error of the mean.

enabling ones ( $z = 2.75, p < .01, r = .56$ ). Participants in the Disablers condition generated more disablers for enabling causes compared to biconditional ones ( $z = 3.19, p < .001, r = .60$ ) and conditional ones ( $z = 2.95, p < .01, r = .56$ ).

The results show that participants create counterexamples readily for intention conditionals. The experiment reveals that people can retrieve alternative reasons to a reason–action sequence as readily as they retrieve alternative causes to a cause–effect sequence and can retrieve disabling reasons as readily as they retrieve disabling causes. The results indicate that despite the many differences between reasons and causes and the much greater vagaries in the reason–action relation compared to the cause–effect relation, there are similarities in the ease with which counterexamples can be retrieved between them.

### General Discussion

People come to subtly different interpretations for different sorts of intention conditionals by retrieving counterexamples to reasons for actions. Participants interpret some intentions to be conditional, for example, “If Alicia’s goal is to read her e-mails, then she turns on her computer,” and they readily retrieve alternative reasons to them, for example, “she wants to write an essay instead,” as the four experiments have shown. Alternative reasons suppress the DA and AC inferences for familiar and unfamiliar reason–action sequences. Participants interpret other intentions to be enabling, for example, “If Laura’s goal is to talk to her boyfriend, then she telephones him,” and they readily retrieve disabling reasons to them, for example, “she calls in to his house instead.” Disabling reasons suppress the MP and MT inferences for familiar and unfamiliar reason–action sequences. Participants interpret other intentions as biconditional, for example, “If Mark’s goal is to get good grades, then he studies hard”; they do not tend to retrieve alternative or disabling reasons to them, and so they make all four inferences for familiar and unfamiliar contents. These effects occur regardless of whether the intentions concern internal reasons such as people’s beliefs or goals or external reasons such as obligations or social norms.

A person may have many reasons for carrying out a single action (e.g., Anscombe, 1963; Davidson, 1963), but the nuanced view of intentions that people form is not akin to a tautology in which all four possibilities may occur. The three interpretations we have examined—biconditional, conditional, and enabling—appear to be common interpretations that participants readily reach. However, we expect that there may be other interpretations available too, for example, “If you want to see *Vertigo*, then it’s on TV tonight,” may evoke a *relevance* interpretation, akin to “If you want to see *Vertigo* or not, it’s on TV tonight” (see Johnson-Laird & Byrne, 2002, p. 662).

### Alternative Views of Reasoning

People may understand an intention conditional such as “If Paul believes the police are watching, then he stops at the red light,” by envisaging the *possibilities* with which it is consistent. People think about as few possibilities as they can because of the constraints of working memory (e.g., Barrouillet, Gauffroy, & Lecas, 2008; Goodwin & Johnson-Laird, 2005; Johnson-Laird & Byrne, 2002). They construct a single *initial* possibility, for example, “Paul believes the police are watching and he stops at the red light,” but their interpretation differs from a simple conjunction because they make a mental note that there may be alternatives, and the representation can be fleshed out to envisage more possibilities (e.g., Johnson-Laird & Byrne, 1991; Johnson-Laird, Byrne, & Schaeken, 1992). They represent only true possibilities, not possibilities ruled out as false, for example, “Paul believes the police are watching and he does *not* stop at the red light” (e.g., Barrouillet & Lecas, 1999; Espino & Byrne, 2012; Espino, Santamaria, & Byrne, 2009). Hence, their mental representations differ from entries in a truth table, and they think about possibilities, not about truth (Wittgenstein, 1953). Children develop the ability to reason about possibilities earlier than the ability to reason about the truth of an assertion (e.g., Gauffroy & Barrouillet, 2011). People list different true possibilities when they think about different sorts of relations (Goldvarg & Johnson-Laird, 2001), and they are primed to read some possibilities quickly (Frosch & Byrne, 2012).

Some inferences such as MP may be made on the basis of the initial possibility, whereas others such as MT require effortful processes, such as the construction of alternative possibilities (e.g., Espino & Byrne, 2013; Johnson-Laird, 2006; Orenes & Johnson-Laird, 2012; Stanovich, 1999). Counterexamples suppress inferences by making readily available a possibility that contradicts a putative conclusion (e.g., Byrne, 1989; Byrne et al., 1999). The process of semantic and pragmatic modulation is crucial to the interpretative process underlying the construction of models, that is, content and context can eliminate potential possibilities from consideration (e.g., Byrne & Johnson-Laird, 2009; Quelhas, Johnson-Laird, & Juhos 2010). For example, the assertion “If Abi believes the tooth fairy exists, then she places her tooth under her pillow,” tends to be interpreted as a biconditional. Participants do not retrieve alternatives or disablers, and they make all four inferences from it. However, the inferences could be suppressed by manipulating presuppositions, for example, about whether Abi is an older child, in which case another conditional with an alternative antecedent may be assumed, “If Abi believes she will get some money from the

‘tooth fairy,’ she places her tooth under her pillow.” The alternative will suppress the AC and DA inferences.

Belief in one conditional may decrease as belief in a second conditional increases, for example, it may be increasingly probable that Abi does not believe the tooth fairy exists as she gets older. The change can be captured by tagging the models with probabilities. Models represent the intension or meaning of an assertion as well as its extension or the situations to which it refers, and so, they can contain information to represent pragmatic or epistemic elements of beliefs, such as their counterfactuality (e.g., Byrne, 2005, 2007). Models may be tagged, for example, with numerical probabilities (e.g., Johnson-Laird, Legrenzi, Girotto, Legrenzi, & Caverni, 1999) or utilities (e.g., Devetag, Legrenzi, & Warglien 2000). It explains how people distinguish between likely possibilities, for example, “If Abi puts her tooth under her pillow, she gets 1 euro,” and unlikely possibilities, for example, “If Abi puts her tooth under her pillow, she gets 1 million euro,” by incorporating probabilities into models (e.g., Barrouillet et al., 2008; Gauffroy & Barrouillet, 2009). A computer simulation of the theory simulates how people infer the subjective probabilities of unique events in a nonextensional way and how people infer subjective numerical probabilities from nonnumerical evidence (e.g., Khemlani, Lotstein, & Johnson-Laird, 2012).

Of course, reasoners may not make any of the inferences when they do not believe the conditional to be true or to be probable. Even if Abi believes in the tooth fairy, her action of putting her tooth under her pillow may depend on expected utilities, such as the size of the reward. “If Abi believes she will get 1 euro from the tooth fairy, she places her tooth under her pillow,” may be believable and probable, and individuals may make the four inferences. But if the utility is very low, for example, “If Abi believes she will get 1 cent from the tooth fairy, she places her tooth under her pillow”, reasoners may not believe the truth of the conditional and instead may believe “If Abi believes she will get 1 cent from the tooth fairy, she does not place her tooth under her pillow.”

An alternative view is that people understand a conditional “if A, then B,” by adding the *if* part, A, to their beliefs and calculating the probability of the *then* part, B (Evans, 2007; Evans & Over, 2004; Oaksford & Chater, 2007). They think about true antecedents only (A) on this account, and they do not think about their belief in the negated *if* clause (not-A) or whether or not the *then* clause follows in such circumstances (e.g., Handley, Evans, & Thompson, 2006; Over, Hadjichristidis, Evans, Handley, & Sloman, 2007). On this account, the probability of a conditional “if A, then B,” is the conditional probability, that is, the probability of B given A:  $Probability(B/A)$ . The representation of a causal conditional is akin to a causal Bayes net (e.g., Pearl, 2000; Sloman, 2005; Sloman & Lagnado, 2005). A valid inference is one in which the uncertainty of its conclusion does not exceed the sum of the uncertainties of its premises, and uncertainty is defined as 1 minus the probability of a statement. Inferences participants make about the probabilities of causes and effects are based on their prior beliefs or knowledge about base rates as well as the calculation of the probabilities of the antecedent and consequent and their relation (e.g., Ali, Chater, & Oaksford, 2011; Over et al., 2007; Sloman et al., 2009). Similarly, participants may calculate the probability of a reason and an action and their relation based on their prior beliefs or knowledge about base rates.

The suppression of the AC inference by alternatives in a pair of causal conditionals such as “If you turn the key, the car starts; if you hot-wire it, the car starts,” is explained by the proposal that the conditionals are interpreted as conditional probabilities,  $Probability(if P then Q) = Probability(Q|P)$ , and they specify  $Probability(Car starts|Key turned)$  and  $Probability(Car starts|Hot wired)$  (Ali et al., 2011). It is assumed that people have access to base rates, that is,  $Probability(Car starts)$  and  $Probability(Key turned)$ , so that the probability associated with the AC inference, that is,  $Probability(Key turned|Car starts)$ , can be computed by Bayes’ theorem (e.g., Oaksford & Chater, 2007). The suppression occurs because the second conditional raises the probability of the car starting without the key being turned. As the base rates are fixed,  $Probability(Car starts|Key turned)$  has to decrease (i.e., the probability associated with the conditional), which also means that  $Probability(Key turned|Car starts)$  must also decrease (i.e., the probability associated with the inference), and as a result, the inference is endorsed at a lower rate (e.g., Ali et al., 2011). Suppression is explained as increasing uncertainty in the conclusion (e.g., Stevenson & Over, 1995).

From this analysis of probabilities, it has been suggested that inferences are suppressed by exceptions rather than counterexamples (Geiger & Oberauer, 2007). The distinction rests on the idea that for any conditional, for example, “If it thardons, the ground becomes soft,” there are counterexamples such as the disabler “If it thardons, but if there is Gas K in the air, the ground does not become soft,” and there are exceptions, “of the last 1,000 times that it has thardoned, 900 times it has thardoned and the ground became soft; 100 times it has thardoned and the ground did not become soft.” When participants make a likelihood judgment, exceptions and not counterexamples suppress the MP inference (Geiger & Oberauer, 2007; see also Ali et al., 2011). But when they make a judgment about whether the conclusion can be logically drawn, counterexamples and not exceptions suppress the inference (Markovits et al., 2010). For an unfamiliar causal conditional such as “If it thardons, then the ground becomes soft,” the conditional probability is  $Probability(ground softens|it thardons)$ . One issue that suppression with unfamiliar content raises for the probability account is that the base rates are unknown for unfamiliar events,  $Probability(ground softens)$ ,  $Probability(it thardons)$ . One suggestion is that when a disabler is present, for example, “If Gas K is in the air, the ground does not become soft,” the conditional probability of this second conditional,  $Probability(ground does not soften|Gas K is present)$ , leads to an adjustment even in the absence of prior beliefs about the base rates, so that  $Probability(ground softens|it thardons)$  is set at 0. When there are exceptions (a number of times in which it thardons and the ground does not soften),  $Probability(ground softens|it thardons)$  is set to somewhere between 0 and 1 depending on how many exceptions there are. Hence, it is suggested that the level of  $Probability(ground softens|it thardons)$  can explain the suppression of inferences even in the absence of prior beliefs about base rates. It may be fruitful to examine in future research the likelihood judgments participants make about intention conditionals and their responses about their degrees of confidence in the conclusion.

## Conclusions

The experiments reported here corroborate our proposal that people distinguish between biconditional, conditional, and en-

abling intention conditionals by retrieving different sorts of counterexamples such as alternatives and disablers. Of course, there are other sorts of intention relations between a reason and an action. After all, an action can occur without a reason—by mistake or through absentmindedness—and the intention relation differs in this respect from a causal relation, in that an effect rarely occurs without a cause. Likewise, a reason can occur without an action—people often do not act even when they have a good reason to do so—and again the intention relation differs in this way from a causal relation, in that a cause rarely occurs without an effect (e.g., [Donnellan, 1967](#); [Smith & Jones, 1986](#); see [Walsh & Byrne, 2007](#)). The distinction between biconditional, conditional, and enabling intention conditionals provides a rich avenue for exploring how people think about their reasons for doing things.

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## Appendix

### The 104 Intention Conditionals Used in Experiments 1–4

The corpus of 48 intention conditionals used in the materials pretest and in Experiment 1 is presented with the English translation first and the original Portuguese second. The additional 32 accompanying conditionals used in Experiment 2 are presented in parentheses for conditional and enabling conditionals. The 12 asterisked conditionals were used in Experiments 1 and 4. The 24 unfamiliar content conditionals used in Experiment 3 are presented for the Set A assignment first, followed by the 24 in Set B.

#### Biconditional Intention Conditionals (Few Alternatives, Few Disablers)

##### Goals

- \*If João's goal is to get his driving license then he goes to a driving school.  
*Se o João tem o objectivo de tirar a carta, então vai para uma escola de condução.*
- If Diana's goal is to make underwater videos then she buys a waterproof case for the camera.  
*Se a Diana tem o objectivo de fazer vídeo subaquático, então compra uma caixa impermeável para a câmara.*
- If Tiago's goal is to get good grades then he studies hard.  
*Se o Tiago tem o objectivo de ter boas notas, então estuda muito.*

- If Cristina's goal is to be an architect then she majors in architecture.  
*Se a Cristina tem o objectivo de ser arquitecta, então tira o curso de arquitectura.*

##### Beliefs

- \*If Carlota believes in the tooth fairy then she places her tooth under the pillow.  
*Se a Carlota acredita na fada dos dentes, então põe o dente debaixo da almofada.*
- If António believes he is going to win the poker match then he places a high bet.  
*Se o António acredita que vai ganhar o jogo de poker, então faz uma aposta alta.*
- If Samuel believes in Islam then he prays facing Mecca.  
*Se o Samuel acredita no Islamismo, então reza virado para Meca.*
- If Daniel believes that there is a chance to win the case then he sues his employers.  
*Se o Daniel acredita que tem uma possibilidade de ganhar o caso, então processa os patrões.*

##### Obligations

- \*If Ricardo is required to do so by the police then he shows his ID at the police station.

(Appendix continues)

*Se o Ricardo for obrigado pela polícia, então vai à esquadra para ser identificado.*

10. If Raquel is required to do so by her mother then she goes to bed at 9 o'clock.

*Se a Raquel for obrigada pela Mãe, então vai para a cama às 21h00.*

11. If Celeste is required to do so by her teacher then she hands in her notes.

*Se a Celeste for obrigada pelo professor, então entrega as cábulas.*

12. If Eduardo is required to do so by the court then he pays alimony.

*Se o Eduardo for obrigado pelo tribunal, então paga pensão de alimentos.*

### Social Norms

13. \*If Graça is an advocate for children's rights then she is against child labor.

*Se a Graça for defensora dos direitos das crianças, então é contra o trabalho infantil.*

14. If Rui is polite then he gives his seat to an older person.

*Se o Rui for educado, então dá o lugar aos mais velhos.*

15. If Ricardo's father dies then he attends the funeral.

*Se o Pai do Ricardo morreu, então o Ricardo vai ao funeral.*

16. If Fátima is an honest person then she pays her taxes.

*Se a Fátima for uma pessoa honesta, então paga os impostos.*

### Conditional Intention Conditionals (Many Alternatives, Few Disablers)

The second conditional, in parentheses in each pair, contains an alternative antecedent and was used in Experiment 2 only.

### Goals

17. \*If Isabel's goal is to replace her car tires then she goes to a mechanic.

(If Isabel's goal is to get her car serviced then she goes to a mechanic.)

*Se a Isabel tiver o objectivo de substituir os pneus do carro, então vai a uma oficina.*

*Se a Isabel tiver o objectivo de fazer a revisão, então irá a uma oficina.*

18. If Carla's goal is to be a teacher then she goes to college.

(If Carla's goal is to be a scientist then she goes to college.)

*Se a Carla tiver o objectivo de ser professora, então tirará um curso superior.*

*Se a Carla tiver o objectivo de ser cientista, então tirará um curso superior.*

19. If Hugo's goal is to be a professional photographer then he buys a good camera.

(If Hugo's goal is to take very good pictures on his vacation then he buys a good camera.)

*Se o Hugo tem o objectivo de ser fotógrafo profissional, então compra uma boa máquina fotográfica.*

*Se o Hugo tiver o objectivo de tirar fotografias muito boas das férias, então comprará uma boa máquina fotográfica.*

20. If Bruno's goal is to read his e-mails then he turns on his computer.

(If Bruno's goal is to do research on the Internet then he turns on his computer.)

*Se o Bruno tiver o objectivo de ler os e-mails, então ligará o computador.*

*Se o Bruno tiver o objectivo de fazer uma pesquisa na internet, então ligará o computador.*

### Beliefs

21. \*If Paulo believes the police are watching then he stops at the red light.

(If Paulo believes he will run over a pedestrian then he stops at the red light.)

*Se o Paulo acreditar que polícia está a ver, então parará no sinal vermelho.*

*Se o Paulo acreditar que irá atropelar o peão, então parará no sinal vermelho.*

22. If Teresa believes that her partner has AIDS then they use condoms.

(If Teresa believes she could get pregnant then they use condoms.)

*Se a Teresa acreditar que o parceiro tem SIDA, então usarão preservativos.*

*Se a Teresa acreditar que pode engravidar, então usarão preservativos.*

23. If Manuela believes in original sin then she baptizes her son.

(If Manuela believes it will make her family happy, then she baptizes her son.)

*Se a Manuela acreditar no pecado original, então baptizará o filho.*

*Se a Manuela acreditar que fará a família feliz, então baptizará a filha.*

24. If Camilo believes that pesticides are bad for his health then he buys organic food.

(If Camilo believes organic food tastes better then he buys organic food.)

*Se o Camilo acreditar que os pesticidas são maus para a saúde, então comprará comida orgânica.*

*Se o Camilo acreditar que a comida orgânica sabe melhor, então comprará comida orgânica.*

### Obligations

25. \*If Daniel is required to do so by security then he leaves the nightclub.

(Appendix continues)

(If Daniel is required to get home early by his parents then he leaves the nightclub.)

*Se o Daniel for obrigado pela segurança, então retirar-se-á da discoteca.*

*Se o Daniel for obrigado pelos pais a chegar cedo a casa, então retirar-se-á da discoteca.*

26. If Paula is required to do so by the court then she goes to trial.

(If Paula is required to be a witness for the police then she goes to trial.)

*Se a Paula for obrigada pelo tribunal, então irá a julgamento.*

*Se a Paula for obrigada pela polícia a testemunhar, então irá a julgamento.*

27. If Henrique is required to do so by the teacher then he goes to the blackboard.

(If Henrique is required to do so by an examiner then he goes to the blackboard.)

*Se o Henrique for obrigado pelo professor, então irá ao quadro.*

*Se o Henrique for obrigado por um examinador, então irá ao quadro.*

28. If Elvira is required to do so by her mother then she shares the toy with her sister.

(If Elvira is required to do so by her baby-sitter then she shares the toy with her sister.)

*Se a Elvira for obrigada pela mãe, então partilhará o brinquedo com a irmã.*

*Se a Elvira for obrigada pela baby-sitter, então partilhará o brinquedo com a irmã.*

### Social Norms

29. \*If Humberto is in a church then he speaks quietly.

(If Humberto is in a library, then he speaks quietly.)

*Se o Humberto estiver numa Igreja, então falará baixo.*

*Se o Humberto estiver numa biblioteca, então falará baixo.*

30. If Patricia goes to a job interview then she dresses well.

(If Patricia goes to a wedding then she dresses well.)

*Se a Patrícia for a uma entrevista de emprego, então irá bem vestida.*

*Se a Patrícia for a um casamento, então irá bem vestida.*

31. If Gustavo speaks to a judge then he speaks with respect.

(If Gustavo speaks to a police man then he speaks with respect.)

*Se o Gustavo se dirigir ao Juiz, então falará com respeito.*

*Se o Gustavo se dirigir a um polícia, então falará com respeito.*

32. If Elsa is engaged then she is introduced to her boyfriend's family.

(If Elsa goes to her boyfriend's hometown then she is introduced to her boyfriend's family.)

*Se a Elsa estiver noiva, então será apresentada à família do namorado.*

*Se a Elsa for à terra do namorado, então será apresentada à família do namorado.*

### Enabling Intention Conditionals (Few Alternatives, Many Disablers)

The second conditional, in parentheses in each pair, contains a disabling antecedent and was used in Experiment 2 only.

#### Goals

33. \*If Mario's goal is to look thinner then he has liposuction. (If Mario's goal is to be in good shape, then he does not have liposuction.)

*Se o Mário tiver o objectivo de parecer mais magro, então fará uma lipoaspiração.*

*Se o Mário tiver o objectivo de ficar em forma, então não fará uma lipoaspiração.*

34. If Xavier's goal is to talk to his friend then he phones his friend.

(If Xavier's goal is to surprise his friend, then he does not phone his friend.)

*Se o Xavier tiver o objectivo de falar com o amigo, então telefonará ao amigo.*

*Se o Xavier tiver o objectivo de surpreender o amigo, então não telefonará ao amigo.*

35. If Dulce's goal is to look younger then she has a face-lift. (If Dulce's goal is to look natural then she does not have a face-lift.)

*Se a Dulce tiver o objectivo de parecer mais nova, então fará um face-lift.*

*Se a Dulce tiver o objectivo de parecer natural, então não fará um face-lift.*

36. If Vanda's goal is to get pregnant then she has fertility treatment.

(If Vanda's goal is to get pregnant naturally then she does not have fertility treatment.)

*Se a Vanda tiver o objectivo de engravidar, então fará um tratamento de fertilidade.*

*Se a Vanda tiver o objectivo de tentar engravidar naturalmente, então não fará um tratamento de fertilidade.*

#### Beliefs

37. \*If Rita believes it is going to rain then she takes an umbrella.

(If Rita believes she will be in a car then she does not take an umbrella.)

*Se a Rita acreditar que vai chover, então levará um chapéu-de-chuva.*

*Se a Rita acreditar que ficará no carro, então não levará um chapéu-de-chuva.*

38. If Duarte believes in good luck symbols then he hangs a horseshoe on the door.

(Appendix continues)

(If Duarte believes it will look ridiculous, then he does not hang a horseshoe on the door.)

*Se o Duarte acreditar em amuletos, então pendurará uma ferradura na porta.*

*Se o Duarte acreditar que parecerá ridículo, então não pendurará uma ferradura na porta.*

39. If Madalena believes she is an alcoholic then she goes to rehab.

(If Madalena believes recovery is painful, then she does not go to rehab.)

*Se a Madalena acreditar que é alcoólica, então fará um tratamento de desintoxicação.*

*Se a Madalena acreditar que a recuperação é dolorosa, então não fará um tratamento de desintoxicação.*

40. If César believes in the political party then he becomes militant in his support.

(If César believes he has no responsibility then he does not become militant in his support.)

*Se o César acreditar no partido político, então tornar-se-á militante.*

*Se o César acreditar que não tem disponibilidade, então não se tornará militante.*

### Obligations

41. \*If Gonçalo is required to do so by the thief then he puts his wallet on the floor.

(If Gonçalo is required to put his hands in the air by the thief, then he does not put his wallet on the floor.)

*Se o Gonçalo for obrigado pelo ladrão, então porá a carteira no chão.*

*Se o Gonçalo for obrigado pelo ladrão a pôr as mãos no ar, então ele não porá a carteira no chão.*

42. If Emília is required to do so by her employer then she accepts a lower salary.

(If Emília is required to do so by the union, then she does not accept a lower salary.)

*Se a Emília for obrigada pelo patrão, então aceitará baixar o salário.*

*Se a Emília for obrigada pelo sindicato, então não aceitará um salário mais baixo.*

43. If Filipa is required to do so by the security guard then she allows her luggage to be searched.

(If Filipa is required to carry drugs, then she does not allow her luggage to be searched.)

*Se a Filipa for obrigada pelo segurança, então deixará que revistem a bagagem.*

*Se a Filipa for obrigada a transportar droga, então ela não deixará que lhe revistem a bagagem.*

44. If Fábio is required to do so by the mob then he pays protection money.

(If Fábio is required to do so by his dad then he does not pay protection money.)

*Se o Fábio for obrigado pela máfia, então pagará para ter protecção.*

*Se o Fábio for obrigado pelo pai, então ele não pagará para ter protecção.*

### Social Norms

45. \*If Ivo is married then he wears a wedding ring.

(If Ivo loses his wedding ring then he does not wear a wedding ring.)

*Se o Ivo for casado, então usará uma aliança de casamento.*

*Se o Ivo tiver perdido a aliança, então não usará aliança de casamento.*

46. If Simone worries about the environment then she separates her trash.

(If Simone does not have a recycling bin nearby then she does not separate her trash.)

*Se a Simone se preocupar com o ambiente, então separará o lixo.*

*Se a Simone não tiver um caixote de reciclagem perto, então não separará o lixo.*

47. If Luísa is an advocate for animal rights then she protests against bullfights.

(If Luísa comes from a traditional bullfighting family then she does not protest against bullfights.)

*Se a Luísa for defensora dos direitos dos animais, então protestará contra as touradas.*

*Se a Luísa vier de uma família tradicional de toureiros, então não protestará contra as touradas.*

48. If Leandro is a good colleague then he lends his notes to his colleagues.

(If Leandro does not know his colleagues then he does not lend his notes to his colleagues.)

*Se o Leandro for um bom colega, então emprestará os apontamentos aos colegas.*

*Se o Leandro não conhecer os colegas, então não empresta os apontamentos aos colegas.*

### Causes

#### Biconditional Causal Relations

1. If the trigger is pulled then the gun fires.

*Se o gatilho for premido, então a arma dispara.*

2. If Fernando cuts his finger deeply then his finger bleeds.

*Se o Fernando fizer um corte profundo no dedo, então o dedo sangra.*

(Appendix continues)



3. If an individual has a Y chromosome then the individual is a man.

*Se uma pessoa tem um cromossoma Y, então é um homem.*

4. If somebody hits the gong then it makes a sound.

*Se alguém bate no gongo, então o gongo faz barulho.*

### Conditional Causal Relations

5. If Carla chokes then she coughs.

*Se a Carla se engasga, então tem que tossir.*

6. If the fruit is ripe then it falls from the tree.

*Se a fruta estiver madura, então cai da árvore.*

7. If Manuel drinks coffee at night then he has trouble falling asleep.

*Se o Manuel bebe café à noite, então tem dificuldade em adormecer.*

8. If the roads are slippery then there are a lot of accidents.

*Se a estrada estiver escorregadia, então há muitos acidentes.*

### Enabling Causal Conditionals

9. If the product is advertised then the sales increase.

*Se o produto é publicitado, então as vendas aumentam.*

10. If a girl has sexual intercourse then she gets pregnant.

*Se uma rapariga tiver relações sexuais, então fica grávida.*

11. If a dog scratches then it has fleas.

*Se o cão se coça, então tem pulgas.*

12. If Ricardo studies statistics then he passes the exam.

*Se o Ricardo estudar estatística, então passa no exame.*

### Unfamiliar Intention Conditionals Used in Experiment 3

The conditional for the biconditional intention condition is presented first, the second conditional with an alternative was presented only in the alternative condition, and the third conditional with a disabler was presented only in the enabling condition.

#### Set A

#### Beliefs

1. If a Floop believes he has Xly in his blood, then he initiates Midosis.

*Alternative*

If a Floop believes he has Zhaa in his blood, then he initiates Midosis.

*Disabler*

If a Floop believes he has Zhaa in his blood, then he does not initiate Midosis.

2. If a Philo believes his temperature is lowered to 20°C, then he secretes Bins.

*Alternative*

If a Philo believes he is receiving radiation Vixxana, then he secretes Bins.

*Disabler*

If a Philo believes he is receiving radiation Vixxana, then he does not secrete Bins.

#### Goals

3. If a Squik's goal is to call Thardon, then he rubs himself against the Plok.

*Alternative*

If a Squik's goal is to inhale gas K, then he rubs himself against the Plok.

*Disabler*

If a Squik's goal is to inhale gas K, then he does not rub himself against the Plok.

4. If a Valdy's goal is to seal the crater, then he catches Glowark.

*Alternative*

If a Valdy's goal is to mate, then he catches Glowark.

*Disabler*

If a Valdy's goal is to mate, then he does not catch Glowark.

#### Social Norms

5. If a Lipp respects the social norm of smoking Ara, then he puts on a Sileg.

*Alternative*

If a Lipp respects the social norm of visiting the Mool, then he puts on a Sileg.

*Disabler*

If a Lipp respects the social norm of visiting the Mool, then he does not put on a Sileg.

6. If a Kapp respects the social norm of moving in silence, then he activates the Voloo.

*Alternative*

If a Kapp respects the social norm of punctuality, then he activates the Voloo.

*Disabler*

If a Kapp respects the social norm of punctuality, then he does not activate the Voloo.

#### Obligations

7. If a Hool is required to belong to the Voolii, then he changes his skin.

*Alternative*

If a Hool is required to come out of his lair, then he changes the skin.

*Disabler*

If a Hool is required to come out of his lair, then he does not change his skin.

(Appendix continues)

8. If a Ziko is required to get pregnant, then she secretes Zikolix.

*Alternative*

If a Ziko is required to change her colony, then she secretes Zikolix.

*Disabler*

If a Ziko is required to change her colony, then she does not secrete Zikolix.

## Set B

### Beliefs

1. If a Hool believes he belongs to the Noolii, then he changes his skin.

*Alternative*

If a Hool believes he will come out of his lair, then he changes his skin.

*Disabler*

If a Hool believes he will come out of his lair, then he does not change his skin.

2. If a Ziko believes in getting pregnant, then she secretes Zikolix.

*Alternative*

If a Ziko believes she will change her colony, then she secretes Zikolix.

*Disabler*

If a Ziko believes she will change her colony, then she does not secrete Zikolix.

### Goals

3. If a Lipp has the goal of smoking Ara, then he puts on a Sileg.

*Alternative*

If a Lipp has the goal of visiting the Mool, then he puts on a Sileg.

*Disabler*

If a Lipp has the goal of visiting the Mool, then he does not put on a Sileg.

4. If a Kapp has the goal of moving in silence, then he activates the Voloo.

*Alternative*

If a Kapp has the goal of being punctual, then he activates the Voloo.

*Disabler*

If a Kapp has the goal of being punctual, then he does not activate the Voloo.

### Social Norms

5. If a Squik respects the social norm of calling Thardon, he rubs himself against the Plok.

*Alternative*

If a Squik respects the social norm of inhaling gas K, he rubs himself against the Plok.

*Disabler*

If a Squik respects the social norm of inhaling gas K, he does not rub himself against the Plok.

6. If a Valdy respects the social norm of sealing the crater, then he catches Glowark.

*Alternative*

If a Valdy respects the social norm of mating, then he catches Glowark.

*Disabler*

If a Valdy respects the social norm of mating, then he does not catch Glowark.

### Obligations

7. If a Floop is required to have Xly in his blood, then he initiates Midosis.

*Alternative*

If a Floop is required to have Zhaa in his blood, then he initiates Midosis.

*Disabler*

If a Floop is required to have Zhaa in his blood, then he does not initiate Midosis.

8. If a Philo is required to lower his temperature to 20°C, then he secretes Bins.

*Alternative*

If a Philo is required to receive radiation Vixxana, then he secretes Bins.

*Disabler*

If a Philo is required to receive radiation Vixxana, then he does not secrete Bins.

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