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Don't Let Anything Bad Happen: The Effect of Consequence Valence on Conditional Reasoning

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Introduction

Rationality and emotions are often considered as polar opposites: Emotional factors cloud the transparency of logic and intelligence, while rational factors are unable to grasp emotional significance. When reasoning, people like to be considered as rational beings that are able to deduce normatively valid and pragmatically adequate arguments without interference from emotions. Nonetheless, research showed that emotional factors often perturb the thinking process: Patients suffering from phobia or hypochondria display a strong 'emotion-biased' reasoning that leads to the persistence of their fears (De Jong, Haenen, Schmidt, & Mayer, 1998; de Jong, Mayer, & Van den hout, 1997). There are some findings showing that 'mood' or affective state influences the reasoning style (e.g. Oaksford, Morris, Grainger, & Williams, 1996). Relatively little research examined whether the affective valence of the content influences the reasoning behaviour. In a recent paper Blanchette and Richards (2004) showed that people are less likely to draw logically valid inferences when reasoning about emotional content. However, they did not find an effect of positive versus negative emotional content. This led them to conclude that '*there might be something about processing emotional content [...]. The precise mechanism through which processing emotional content affects logical reasoning should be made clear by future research*' (p. 750). In this article we will test a central functional mechanism that contributes to effects of emotional content. We will demonstrate that the simple emotional drift '*don't let anything bad happen*' gives rise to an avoidance tendency when the causal conditionals

have an emotionally aversive consequent. The avoidance tendency is not present with positive or neutral content. This kind of wishful thinking is a previously uninvestigated factor that provides an important insight in how emotion interacts with the available background knowledge in influencing the conditional inference process. To investigate the effects of emotional factors while controlling for effects of necessity and sufficiency, we will use a specific kind of conditionals, namely causal conditionals of the form 'if cause, then effect'.

We first discuss the principles of conditional reasoning; next we turn to the effect of negative consequence valence.

Conditional reasoning

Drawing inferences from known 'If cause, then effect' relations is a paradigmatic case of human inference making. The four traditional inferences from causal conditionals are:

MP: Modus Ponens If cause, then effect. Cause, therefore effect.

MT: Modus Tollens If cause, then effect. No effect, therefore no cause.

AC: Affirmation of the Consequent If cause, then effect. Effect, therefore cause.

DA: Denial of the Antecedent If cause, then effect. No cause, therefore no effect.

Although normative theories consider the first two inferences as valid and the latter two as fallacious, it is found that the inference acceptance rates do not follow this normative criterion: The inference acceptance ratios vary according to the information that reasoners have available in their background knowledge (Cummins, 1995; Politzer & Bourmaud, 2002). This contextualization process is characteristic of common-sense reasoning and is responsible for people's ability to adaptively cope with everyday situations.

There are two known factors that influence the inference acceptance rates. A first factor is the number of available alternative causes and disabling conditions (Cummins, Alsknis, Lubart & Rist, 1991). A disabling condition is a situation that prevents the effect from occurring even when the cause is present. The effect of the number of available disablers on MP (likewise for MT) can be illustrated with the following two sentences:

- If you water a plant well, then it will stay green.
- If butter is heated, then it will melt.

For sentence a people have many disablers available: deprivation of sunlight, disease, lack of fertiliser, polluted water etc. When reasoners think of at least one of these disablers while solving an MP inference, they will not accept the default conclusion. Since there are many disablers available, the probability of retrieving at least one is high, resulting in an overall low MP acceptance ratio. For sentence b, people have only few disabling conditions available. The probability of retrieving at least one disabler while reasoning will be lower resulting in an overall high MP acceptance rate. Alternative causes have a similar effect on AC (and DA) acceptance. Two sentences to illustrate:

- If someone goes on a diet, then he will loose weight.
- If the light switch is flipped, then the light will go on.

For sentence c people can come up with many alternative causes: sickness, exercise, stress, hard work etc. This results in a high probability that at least one alternative can

be retrieved during reasoning, yielding a low AC acceptance rate. For sentence d there are only few alternative causes available. The probability of coming up with an alternative cause during reasoning will be considerably lower, resulting in a high AC acceptance ratio. Disabling conditions and alternative causes are jointly referred to as counterexamples. The effect of the number of available counterexamples is firmly established (Cummins 1995; Cummins et al., 1991; Thompson 1994; 1995; 2000) and is taken into account by many –if not all– researchers investigating conditional reasoning with everyday sentences.

However, not all disablers and alternative causes are alike. A second factor showing the robust effect of background knowledge on inference making is the strength of association of the counterexamples. Quinn and Markovits (1998) showed that the inference acceptance rates depend on the association strength of the counterexamples. For sentences with an equal number of disablers it was found that when there is a strongly associated available disabler MP acceptance rates are much lower than when disablers are all weakly associated (Quinn & Markovits, 1998). An MP inference on the sentence: 'If a dog has skin disease, then it will scratch' was overall less accepted than an MP inference on the sentence: 'If a dog has fleas, then it will scratch'. The association strength of alternatives has a similar effect on AC and DA acceptance rates (De Neys, Schaeken, & d'Ydewalle, 2003).

Both lines of research emphasise the massive impact of the reasoners' available background knowledge on their reasoning performance. We argue that this counterexample availability can be mediated by emotional factors. This will be explained in the following paragraph.

Consequence valence

Cognitive-affective biases have been investigated in social cognition (e.g., Marcus & Zajonc, 1986) but have long been neglected by researchers investigating the fundamentals of our *everyday* reasoning process. The current predictions are based on the positive-negative asymmetry theory (Peeters & Czapinski, 1990; Rozin & Royzman, 2001; Taylor, 1991), of which Lewicka (1988, 1998) has demonstrated that it can account for human deviations from normative models of reasoning. According to the theory, human information processing bears the marks of a general tendency to have greater subjective necessity associated with avoiding negative outcomes than with obtaining positive outcomes. In this way, Peeters (2002) found that associations elicited by negative word stimuli (gangster) expressed more necessity (*must* be arrested) than associations elicited by positive word stimuli did (e.g., friend: *can* be helpful).

Because of the greater necessity associated with avoiding negative outcomes, participants should attend more to conditions that may prevent expected negative events than to conditions that may thwart expected positive events. Hence we predict that participants in a conditional reasoning task will search more for disabling conditions when they are reasoning from a sentence with a negative consequent than when they are reasoning from a sentence with a positive consequent. Alternatively formulated: When there are two sentences with equally sufficient causes and one with a neutral or positive consequent (e.g. *If someone gives you a present, then you are happy.*), the other with a negative consequent (e.g. *If you sit in the draft, then you catch a cold.*), we expect that reasoners will be less inclined to accept the MP argument for sentences with a negative consequent compared to when the consequent is neutral or positive. This prediction will be tested in the following experiment.

Experiment

The current experiment investigates whether disabler retrieval in causal reasoning is triggered by the presence of negative effects. We will use a thinking-aloud setup in order to closely monitor the use of disablers on MP inferences. We will also monitor the use of alternatives in AC inferences, but there are no specific predictions for this second criterion.

The sentences will be divided in two groups depending on the rating of consequence valence: One group will have a marked positive valence; the other group will have a marked negative valence. Additionally, we will run a generation task in order to verify whether the availability of counterexamples is comparable for both the positive consequent and negative consequent- group.

Method

Participants

A total of 86 students of the University of Leuven (Psychology and Social Sciences) participated in this study. They were all native speakers who participated in partial fulfilment of course requirements. A first group of 21 students rated the consequent valence. A second group of 44 students rated first the co-occurrence of cause and effect, and next they filled in the generation task: A total of 20 students rated the sufficiency of the cause first, then they generated alternatives; 24 other students rated first the necessity of the cause for the effect, then they generated disablers. A third group of 21 students participated in the reasoning task.

Material

Based on previous research (Verschuere, Schaeken, & d'Ydewalle, 2005a) we selected 16 sentences with either a positive (neutral) or negative consequent valence. To control for effects of available background knowledge, we selected 4 sentences of each causal type: (a) there were 4 sentences with a low-sufficient and low-necessary cause, (b) 4 sentences with a low-sufficient and high-necessary cause, (c) 4 sentences with a high-sufficient and low-necessary cause and (d) 4 sentences with a high-sufficient and high-necessary cause. The level of sufficiency and necessity was tested by asking participants to rate how often the effect followed the cause (sufficiency), and how often the cause preceded the effect (necessity) (Thompson, 2000; Verschuere, Schaeken, & d'Ydewalle, 2005b). Participants answered by circling one out of five answer options: never, seldom, sometimes, often or always (coded 1 to 5), they rated either the sufficiency of all sentences or the necessity of all sentences. Table 1 provides an overview of the 16 sentences and their mean rating of $P(q|p)$ - indicator of sufficiency- and $P(p|q)$ - indicator of necessity of the cause.

Table 1. List of sentences used in Experiment 1 including their mean sufficiency and necessity rating.

Sentence		
If you are insulted, then you get angry.	2,4*	4,875
If you call someone, then his phone rings.	3,06*	3
If you cut your finger, then your finger will bleed.	3,11*	3,75

If a girl is pretty, then boys fall in love with her.	3,3*	3,625
If you drink too little water, then you get a headache.	3,45*	2,375*
If you unplug the cable, then the computer shuts down.	3,6*	3*
If you drink coffee during the evening, then it takes longer to fall asleep.	3,75*	2,375*
If someone gives you a present, then you are happy.	3,75*	2,5*
If you have a high income, then you are rich.	3,85	4,125
If you sit in the draft, then you catch a cold.	3,95	2,625*
If the road is slippery, then there are car accidents.	4,05	3
If you call someone, then his phone rings.	4,3	4,5
If you sit in the sun, then you get tanned.	4,8	3,125*
If you eat lots of candy, then you get cavities.	4,8	3,375
If you water a plant regularly, then it will stay green.	4,8	4,125
If you jump in a pool filled with water, then you get wet.	4,9	2,75*

Note: Ratings below average are indicated by *.

Procedure and designValence rating task

The participants were presented with the 16 sentences and asked to judge the valence of the consequent on a 5-point scale: (1) very negative, (2) slightly negative, (3) indifferent, (4) slightly positive, (5) very positive. Every participant rated all sixteen sentences, the presentation order of the sentences was counterbalanced. The rating task was administered collectively. The instructions can be found in the Appendix.

Generation task

The generation task was the same as the one used by Cummins et al. (1991), Cummins (1995) and Verschueren et al.(2004).

For generating disablers, the task looks as follows:

- Rule: If a plant is well watered, then it will stay green.
- Fact: A plant is well watered but it does NOT stay green.

List as many explanations for this situation as possible.

For generating alternatives:

- Rule: If a plant is well watered, then it will stay green.
- Fact: A plant stays green but it is NOT well watered.

List as many explanations for this situation as possible.

Participants were asked to write down as many explanations for the given scenario as possible. It was explicitly mentioned that variants to previously given answers would

not be scored, nor will answers that refer to fantasy stories. The participants were given 15 to 20 minutes to generate either disablers or alternatives for all 16 sentences.

Reasoning task

The reasoners were tested individually. Each reasoning problem was presented on a different sheet. An example of an MP problem:

- If you cut your finger, then your finger will bleed.
- Some cuts his finger.
- Will his finger bleed or not?

Participants read the problem aloud and were asked to give whatever information they considered relevant to answer the question in an everyday setting. Their answers were recorded on audiotape. Reasoners were free to elaborate or revise their conclusions online and leafed through the pages in a self-paced manner. It took participants about 15 minutes to complete the task. All 16 sentences occurred in MP as well as in AC format. The resulting 32 reasoning problems were blocked by inference type: The inference order was counterbalanced, with a short break after the first block of 16 inferences. Participants were asked to clear their mind and to reason in the second block as though they just started the experiment.

ResultsRating task

Based on the results of the rating task we divided the sentences in a positive and a negative valence group. The average rating for the 8 sentences of the negative-valence group was 1.67 ($SD = .28$, Range [1.24, 1.95]), the average rating for the 8 sentences of the positive-valence group was 3.79 ($SD = .67$, Range [3.05, 4.95]). The valence rating for the two groups of sentences was clearly distinct, $t(14) = -8.27$, $p < .001$. One group has a marked positive mean consequence valence, the other group has a marked negative mean valence. There was no significant correlation between the disabler generation results and the alternative generation results, *Spearman R* = .04, $N = 16$.

Generation task

Based on the generation task results, we checked whether both groups of sentences differed in the number of available counterexamples. There was no significant difference in the number

Based on the generation task results, we checked whether both groups of sentences differed in the number of available counterexamples. There was no significant difference in the number of available disabling conditions ($M_{pos} = 1.99$, $M_{neg} = 2.09$), nor in the number of available alternative causes ($M_{pos} = 3.0$, $M_{neg} = 2.62$). We replicate the findings of Verschueren et al. (2004) that there are overall less disablers generated than alternative causes, $t(15) = -3.78$, $p < .01$ ($M_{dis} = 2.04$, $M_{alt} = 2.82$).

Reasoning task

The reasoning data were scored by two independent raters. For each trial it was determined whether the answer referred to a counterexample, if this was the case it was noted how many counterexamples the reasoner mentioned. For trials where reasoners did not mention a counterexample, raters indicated whether the reasoner accepted the inference or referred to a likelihood or probability estimate. The sentence codes were removed during coding. In the first rating phase there were 9.03% discordances (excluding the number of counterexamples). We created a subset with the discording sentences, removed all codings from the first phase and asked the two (still independent) raters to attentively rescore the selected items. After this second rating

phase there were 2.78% discordances (on a total of 288 trials). Next, the raters reached an agreement on the discording trials. The interrater linear correlation on the number of counterexamples was .84 (288 trials). For the analysis we used the average of the number of counterexamples. For each sentence we summed the number of acceptance answers as well as the number of times reasoners mentioned counterexamples.

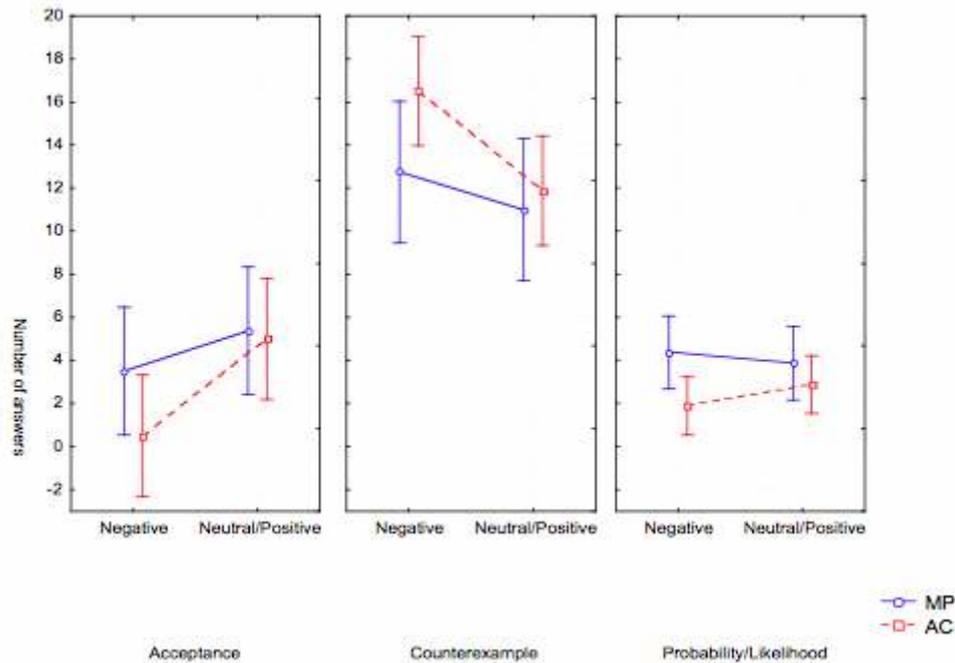


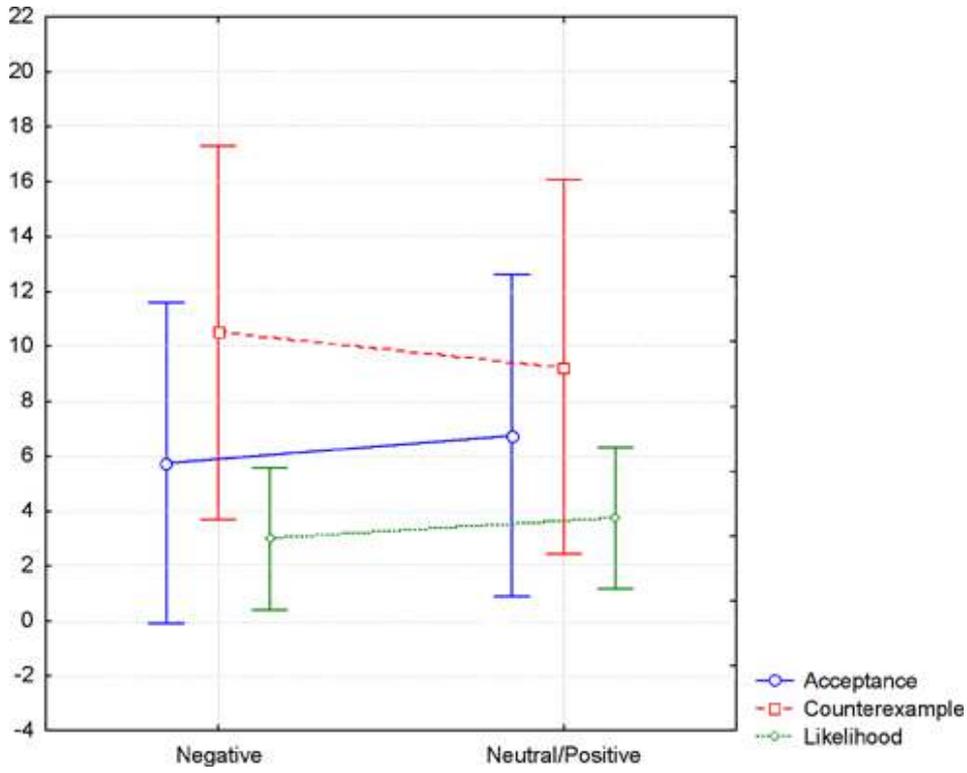
Figure 1. Total number of MP acceptance and counterexample responses for sentences with a negative or a positive consequent.

We ran an ANOVA with consequence valence as categorical predictor (between sentence) and the type of response (acceptance, counterexample use or reference to probability or likelihood information) as dependent variable. There was a significant interaction between the consequence valence and the type of answer, $F(2, 28) = 4.6832$, $p < .05$. Figure 1 displays the observed means. There were more inferences accepted for sentences with a positive consequent than for sentences with a negative consequent, $F(1, 14) = 4.89$, $MSE = 16.64$, $p < .05$ ($M_{pos} = 5.18$, $M_{neg} = 2$). There were less counterexamples used when the consequent is neutral to positive, $F(1, 14) = 5.39$, $MSE = 15.08$, $p < .05$ ($M_{pos} = 11.44$, $M_{neg} = 14.6$). There was no significant difference in the use of likelihood information.

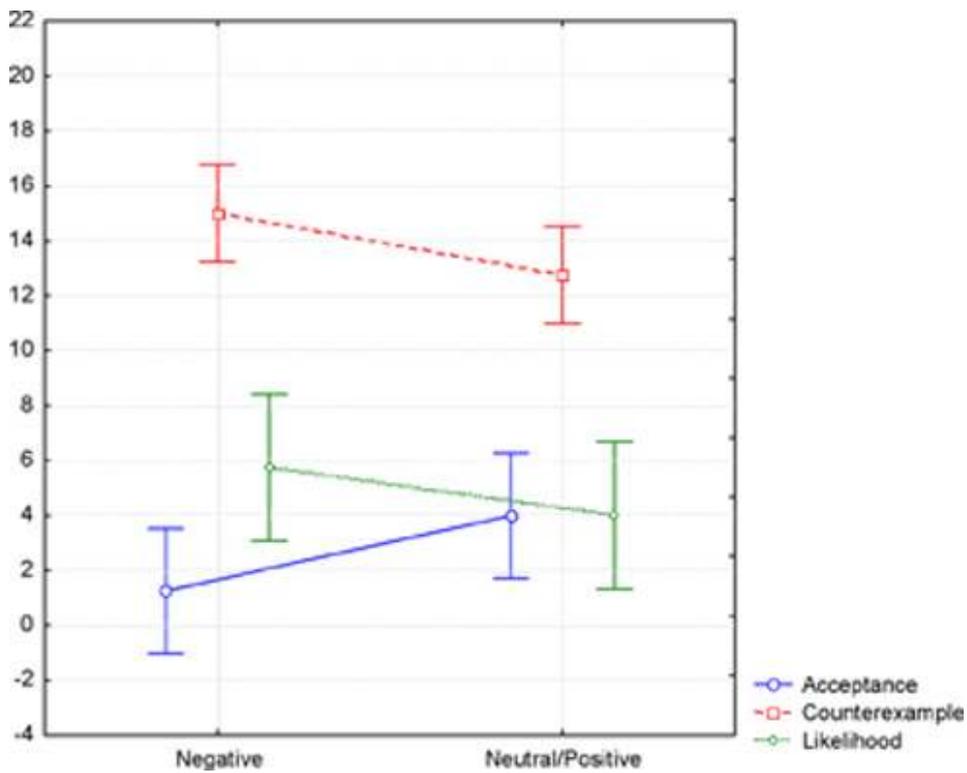
In order to get a firm grasp at the current data, we ran four additional ANOVA's. Two for MP and two for AC, each considering sentences with either many available counterexamples (disablers and alternatives respectively) or few available counterexamples. In the previous analysis the number of available counterexamples was not taken into account, although it can yield a mass variation that is orthogonal to the effect of our key variable.

For the few-disabler set, the results were in the right direction, but non-significant (note the large within group variation). For the many-disablers set, there was a marginally significant interaction between consequence valence and answer type, $F(2, 12) = 3.28$, $p = .07$: When there is a negative consequent there are less inferences accepted, $F(1,6) = 4.37$, $MSE = 3.45$, $p = .08$, and more counterexamples used, $F(1,6) = 4.76$,

$MSE = 2.13, p = .07$. There was no difference in the use of likelihood information. Figure 2 displays the means for both groups of sentences.



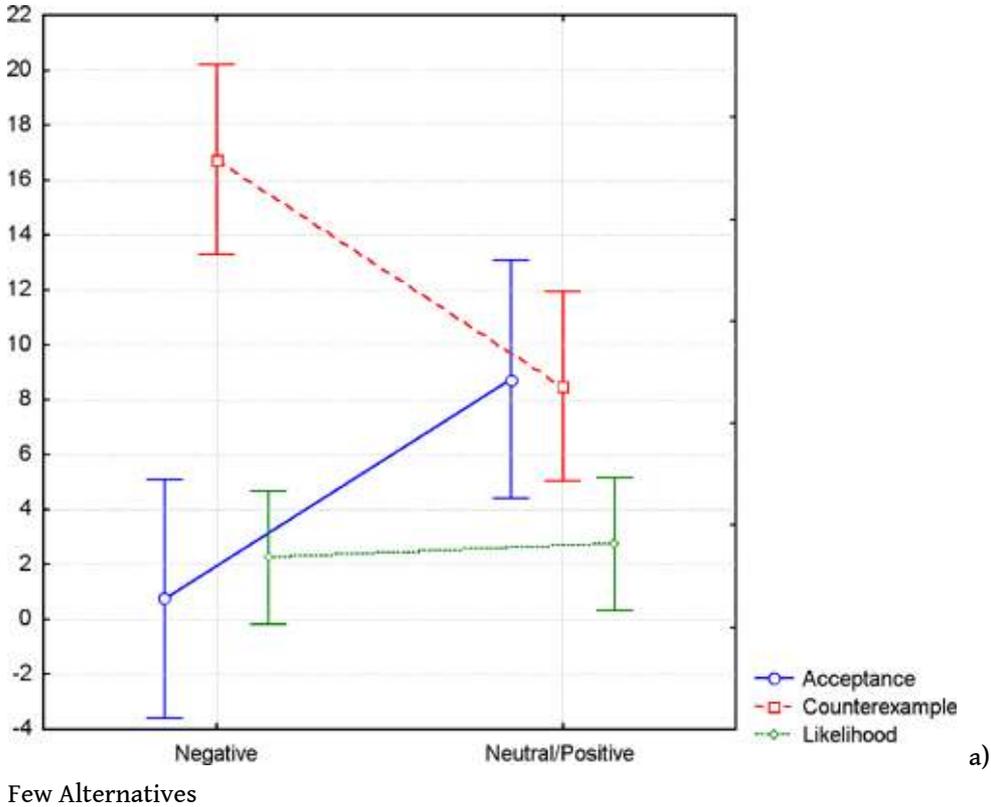
a) few disablers

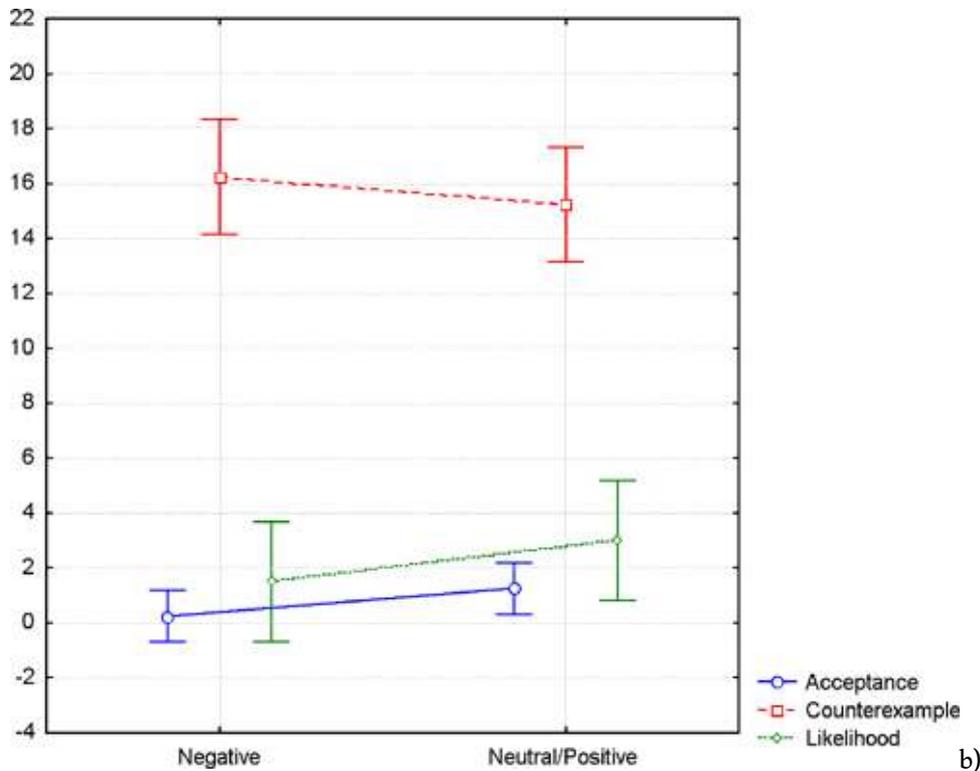


b) many disablers

Figure 2. Total number of MP acceptance and counterexample responses by consequent valence (negative/positive) and number of available counterexamples (few/many).

For the few-alternatives group, there was a significant interaction between consequence valence and answer type, $F(1, 2) = 11.92, p < .001$: There are markedly less inferences accepted for sentences with a negative effect $F(1,6) = 10.17, MSE = 12.5, p < .05$, and more counterexamples mentioned $F(1, 6) = 17.10, MSE = 7.96, p < .001$. There were no differences in use of likelihood information. For the many-alternatives group, the interaction consequence valence answer type returned non-significant. Both interaction effects on AC are illustrated in Figure 3.





Many Alternatives

Figure 3. Total number of MP acceptance and counterexample responses by consequent valence (negative/positive) and number of available counterexamples (few/many).

General discussion Current findings

The results were in line with the expectations. In case reasoners have many disablers available, they eagerly mention these counterexamples when the conditional has a negative consequent. This effect can be read as a cognitive simulation of prevention. Reasoners can be considered as emotionally driven to prevent negative effects, yielding a much more prevalent activation of the situations that might lead to prevention. When there are only few counterexamples available, the results were in the expected direction, but failed to reach significance. The smaller effect of consequence valence on sentences with few disablers might reflect an insufficient availability of disabling effects. Although people can still come up with disablers for these sentences when they are given a disabler generation task, the additional cognitive demands associated with a reasoning task, may increase the retrieval threshold for these disablers (see Verschueren, De Neys, Schaeken, & d'Ydewalle, 2004).

We also found significant effects of consequence valence on AC. Similar as on MP, we found that reasoners are more inclined to accept inferences that have a positive consequent, whereas for sentences with a negative consequent, reasoners retrieve more alternative causes. The retrieval of extra causes for negative effects could be seen as somewhat in contrast with the idea of mere mentally avoiding negative effects, indeed, but it is in line with the idea of controlling negative effects by getting grip on their possible causes. In agreement with this explanation, Peeters and Czapinski (1990) have reviewed evidence that negative stimuli elicit more "why" questions than positive stimuli do and that this "informational negativity effect" may reduce straightforward avoidance reactions. Alternatively, we can consider the retrieval of causes for negative effects as an epiphenomenon of the effect of increased disabler-retrieval. According to

the paper of Markovits and Barrouillet (2002) disabler retrieval is often secondary to the retrieval of alternatives. It is thus possible that the mere presentation of a conditional with a negative effect triggers the cognitive reaction of disabler retrieval, which is partly mediated or at least correlated with alternative retrieval (see also De Neys, Schaeken, & d'Ydewalle, 2002, for comments on the interplay between disabler and alternative retrieval processes). Further research may differentiate between these two hypotheses.

Implications and suggestions

Although reason and emotion are often seen as mutually exclusive concepts, emotional factors can penetrate the reasoning process in a very subtle yet influential way. The current experiment shows that even plain, non-intrusive conditional inference patterns change depending on whether people reason about a positive or negative consequent. Nonetheless, replication and variation studies are mandatory in order to firmly establish this positive-negative effect on conditional reasoning. We make the following suggestions for further research: (a) Limit the sentence selection to conditionals with average to many counterexamples. (b) Carefully check the pragmatic type of the sentences. Some of the sentences we used can be understood as warnings. Using temporals or strict physical themata may purify the results (avoid mentioning 'you' in the antecedent and consequent terms). (c) Check the effect with more controlled, abstract material.

This currently observed effect of consequence valence on conditional reasoning, contributes an important insight to the effects of pragmatic content on inference acceptance rates. Newstead, Ellis, Evans & Dennis (1997) found that people reason differently with conditional promises and tips, which both have a positive consequent, than with threats and warnings, which both have a negative consequent. Verbrugge, Dieussaert, Schaeken & Van Belle (2004) explained this difference in terms of illocutionary effects. We argue that the valence of the consequent by itself may also contribute to the observed differences.

Although social cognition and reasoning research both concern processes of higher cognition, their domains of research and insights often co-exist next to one another. The current study shows that insights from social cognition can further reasoning research. A more thorough crosspollination between social cognition and reasoning research might lead to fruitful progressions in both domains.

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Appendix Instruction of the Valence rating task Dutch:

Mensen gebruiken vaak 'als oorzaak- dan effect' zinnen in de dagdagelijkse omgang. De affectieve geladenheid van een effect bepaalt welke afleidingen er worden gemaakt. Om het onderzoek naar dit principe te kunnen starten willen we weten welke effecten door jou als negatief, neutraal of positief worden beleefd. Je zal worden gevraagd de geladenheid van een reeks effecten te beoordelen. In welke mate een effect 'negatief' is kan je beschouwen als de mate waarin mensen willen dat het effect niet optreedt. Voor elk effect duid je het bolletje aan van het antwoord dat aangeeft hoe jij het effect ervaart.

English

People often use 'if cause, then effect' sentences in everyday life. The emotional connotation of the effect influences how people reason. Researchers are currently investigating this effect. In order to perform the investigation we need to know whether you consider certain effects as negative, positive or neutral. You will be given a list of sentences and asked to judge the valence of the stated effect. How 'negative' an effect is can be inferred from the extent that people do not want the effect to occur. For each sentence you mark the answer alternative that corresponds to your judgment.

Sentences used Dutch

1. Als je 's avonds koffie drinkt, dan duurt het langer voordat je inslaapt.
2. Als je een kadootje krijgt, dan ben je blij.
3. Als je in de tocht zit, dan word je verkouden.
4. Als je in je vinger snijdt, dan begint de vinger te bloeden.
5. Als je in de zon zit, dan word je bruin.
6. Als een meisje mooi is, dan worden jongens op haar verliefd.
7. Als je te weinig drinkt, dan krijg je hoofdpijn.
8. Als je een plant regelmatig water geeft, blijft hij groen.
9. Als je veel snoept, dan krijg je gaatjes in je tanden.
10. Als er op een gong geslagen wordt, dan maakt de gong geluid.
11. Als je de stekker uittrekt, dan valt de computer uit.
12. Als je in een zwembad vol water springt, dan word je nat.
13. Als je wordt beledigd, dan word je kwaad.
14. Als iemand wordt opgebeld, dan rinkelt zijn telefoon.
15. Als het wegdek glad is, dan gebeuren er auto-ongelukken.
16. Als je veel geld verdient, dan ben je rijk.

English

1. If you drink coffee during the evening, then it takes longer to fall asleep. [N]
2. If someone gives you a present, then you are happy. -
3. If you sit in the draft, then you catch a cold. [N]
4. If you cut your finger, then your finger will bleed. [N]
5. If you sit in the sun, then you get tanned. -
6. If a girl is pretty, then boys fall in love with her. -
7. If you drink too little water, then you get a headache. [N]
8. If you water a plant regularly, then it will stay green. -
9. If you eat lots of candy, then you get cavities. [N]
10. If a gong is hit, then it sounds. -
11. If you unplug the cable, then the computer shuts down. [N]
12. If you jump in a pool filled with water, then you get wet. -
13. If you are insulted, then you get angry. [N]
14. If you call someone, then his phone rings. -
15. If the road is slippery, then there are car accidents. [N]
16. If you have a high income, then you are rich. -

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ABSTRACTS

Considerable evidence showed that there are two factors that influence the inference acceptance rates on conditional inferences: the number of available counterexamples and their strength of association. Inspired by the negativity effect, we propose that a third factor, the valence of the conditional terms, sorts an additional effect on the acceptance rates. The reported experiment shows that -when controlling for counterexample availability- the use of counterexample information is mediated by the perceived negativity of the conditional consequent.

De nombreux résultats ont montré qu'il y avait deux facteurs qui influencent les taux d'acceptation d'une inférence quand il s'agit d'inférences conditionnelles: le nombre de contre-exemples disponibles et la force de leur association. En prenant en compte l'effet de négativité, nous faisons l'hypothèse qu'un troisième facteur, la valence des termes conditionnels, joue sur les taux d'acceptation. Notre expérience montre que l'utilisation de l'information contenue dans ces contre-exemples, dont nous contrôlons la disponibilité, est médiatisée par la négativité perçue de la conditionnel consécutive.

INDEX

Keywords: conditional reasoning, Causal reasoning, Inference, Content, Outcome Valence

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