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The Influence of Negative Language on Decision-Making

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Abstract. Negative Language may affect people's choices in daily life through two distinct routes: linguistic negation, which is the linguistic polarity of lexicalisation, and negative framing, which focuses on losses or undesirable outcomes. This paper studies how linguistic negation affects pre-decision states and changes the final choice of the negative frame according to cognitive and biological evidence. Based on the prior studies discussed in Section A, linguistic negation increases the cognitive load and reduces decision efficiency. Results of stop-signal tasks indicate that the cognitive resources required for negation processing overlap with those needed for inhibitory control, and event-related potential data have linked negation to delayed semantic reanalysis and integration. Surveys, bilingual and risk-choice studies in Section B have shown that negative framing can change people's judgments of objectively equivalent options in many languages, tasks and people. Neuroimaging studies have identified brain areas involved in gain- and loss-domain framing, and stimulation of the ventromedial prefrontal cortex shows that it regulates these decisions to be more rational. In short, the paper does not hold that negative language has a single or always harmful effect on decision-making. The scope of the negativity and the level of decision-making will affect how much of it is revealed.

Keywords: Linguistic negation, framing effect, decision-making

1. Introduction

Decisions are made all the time in various places, such as health communication, financial risk assessment, relationships, selecting a suitable way to travel according to cost and comfort, etc. However, the same information or choice options can be presented in positive or negative ways, thus changing people's choices in their pursuit of maximising personal utility. For example, a traveller is choosing between a cheaper train and a more comfortable plane, and they are told either that the train "arrives on time 90% of the time" or that "it is delayed 10% of the time". Although both statements refer to the same probability, the delay-focused expression may make the train seem less reliable and thus lead to a selection of the more expensive flight. Understanding the effect of negative language is thus necessary to develop theories of language and cognition and to reduce unintended bias in the information provided to decision-makers.

Negative Language includes both linguistic negation and negative framing. As shown in The Cambridge Handbook of Generative Syntax, linguistic negation refers to polarity and inverts the meaning or truth value of propositional content [1]. For example, it can change the affirmative

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sentence "The option is safe" into the negated sentence "The option is not safe"; negatively framed expressions do not need to include a negative lexical marker. It is a type of general framing that refers to altered judgments and choices that result from the manner in which a problem or decision is presented [2]. Negative framing is expressed in terms of losses, undesirable qualities or bad results. For example, the statement about the probability of delay in the previous paragraph is a typical case of negative framing. Loss-framed content is analyzed based on questionnaire-based research of risky decision-making in this paper. Negative Framing is not the same as linguistic negation. A loss-framed sentence may be grammatically positive, and a grammatically negative sentence can also indicate a good result. Therefore, the two will be used as independent analytical parameters.

2. Cognitive and neural mechanisms influencing pre-decisional processing through linguistic negation

Not all linguistic negations are harmful to decision-making or will lead to errors; therefore, such expressions should not be automatically excluded. Explore whether linguistic negation changes the pre-decision process at the level of cognition and neural networks, such as inhibition, and determine if such alterations lead to different subsequent judgments or choices under certain conditions.

Formal negation should first be understood as a modification of pre-decision processing rather than a change in the decision result. Research shows that linguistic negation generally increases the processing cost of judgment, although this cost varies depending on how it is presented [3]. Since good decisions need to be made promptly based on the analysis and evaluation of information, the extra work of negating may slow down decision-making under time constraints or high-information environments. Linguistic negation increases the cognitive demand of interpretation because the input needs to be mentally reversed [4]. Negative operators, such as "not", are available in all languages, but they may reduce the speed of information processing and increase the risk of error for decision-makers.

Negation can change how comprehenders evaluate the information provided by the candidate, and thus will be slower to verify and respond. Albu et al. proposed the ideas of plausibility and informativeness to explain the criteria people use to choose continuations for negative sentences [5]. Plausibility is the likelihood or reasonability of an event according to previous knowledge, and informativeness refers to whether a statement is worth expressing because it alters existing expectations. For instance, the proposition "The child will eat the yoghurt" is reasonable because it agrees with common knowledge. On the other hand, "The child will not eat the yoghurt" may be more informative because it denies an expected event. Albu and others carried out six behaviour experiments to study this problem in a four-choice cloze test. Participants chose among the continuations that varied in event plausibility and semantic compatibility to complete affirmative and negative sentence fragments. Participants chose the most reasonable continuation in both polarity cases. However, similar overt choices do not necessarily stem from the same interpretation. Affirmative continuations generally increase the plausibility of events, and negative continuations may be more strongly affected by the informativeness of denying an expected event. Adjusting the weight given to plausibility and informativeness can alter which information is noticed in the pre-decision stage. However, these linguistic criteria are only part of the larger set of reasons for consequential choices. Polarity-dependent evaluation may therefore affect the selection of pre-decisional information; however, as this study used a constrained sentence-completion task without personal consequences or risk, the same effect has not been observed in consequential decisions involving real trade-offs.

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A parallel line of research has investigated whether inhibitory control contributes to these effects of negation. Beltrán and others have provided support for a link between inhibition and negation [6]. Participants read affirmative and negative sentences, such as "You will cut the bread" and "You will not cut the bread", and completed a stop-signal task that required them to either respond or not respond based on the signal. Participants had a longer stop-signal reaction time after reading negative sentences than after reading affirmative sentences (191ms vs. 172ms, $p < .018$), and thus required more time for response inhibition in the negation condition. Montalti and others have conducted a related study of 960 stop-signal trials. They presented the "Go" trials twice as often as the "Stop" trials and found that negative sentences mainly inhibited action [7]. The above results indicate that negation processing and response inhibition partially utilise the same cognitive resources. Although these tasks measured motor inhibition rather than final choices, they may be related to decision-making; processing negatively formulated information may require people to suppress or change an initial interpretation. Therefore, it can be speculated that negation may also affect the timing of decision-making in the brain, not only by inhibition.

Farshchi and others have studied the difference between affirmative and negated meanings in sentence comprehension [8]. They recorded event-related potentials (ERPs) using electroencephalography (EEG) to measure the neural responses to semantic incongruity in affirmative and negated auditory sentences. The three time windows selected by the researchers were: N400 (450-650ms), P600 (650-800ms) and a late positive potential (LPP; 800-1000ms). Incongruities in affirmative sentences elicited an earlier N400 response, and incongruities under negation were mainly shown as later P600 and LPP responses. Therefore, creating an all-encompassing comprehension of a negated sentence will require more time for the following verification or re-examination. As comprehension and semantic integration occur before the selection is made, delayed neural responses to negation may provide an accessible route for linguistic polarity to affect the efficiency of the following decision-making. Directly impact the accuracy of choice and the result of tasks that require actual selection.

In short, most of the linguistic negations occur before the decision stage. Negation needs to add cognitive effort for reversal of meaning and evaluation of plausibility, etc. Evidence from stop-signal tasks shows that negation involves some inhibitory control, and ERP studies have shown that inconsistencies in negative sentences are corrected later than those in affirmative sentences. The above processes may reduce comprehension and alter the information that can be used for decision-making under time or cognitive pressure. However, they are not necessarily reflected in changes to the final selection results.

3. Context-dependent behavioral effects of negative language on judgement and choice

The evidence in Section A shows that linguistic negation raises processing demands and changes both inhibition and semantic integration. However, these pre-decision mechanisms do not provide substantial evidence in themselves that the final decision outcome has changed. Therefore, Section B will use negative framing to highlight the loss or an undesirable outcome without employing a negative operator. Determine if there are any obvious signs of negative framing in the decision-making and judgment scenarios listed below, such as survey responses, risk selection and moral judgments about finance. Then this section will study how negative framing alters the assessment of the same outcome and affects all other choices.

Negativity bias is a reason why people choose differently after negative framing. It is the tendency to pay more attention to negative events, objects and attributes than to positive ones [9]. Holleman and others have investigated in the context of negative framing why respondents project

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their interpretations of the attitudes conveyed by semantically negative expressions onto the decision outcome [10]. The researchers have presented this process through a forbid/allow asymmetry, and negative expressions may have a stronger emotional impact than positive ones. Participants were asked whether the United States should permit public speeches critical of democracy, and then the word "allow" was replaced with "forbid". Refusing to agree that such speeches should be permitted may express the same underlying view as agreeing that they should be prohibited, but the latter answer may seem more extreme. Therefore, the respondent may not agree with the negatively worded statement. Holleman and others have also applied this emotional explanation of negativity bias in their studies of bilingual decision-making [10]. They believe that if the negative expressions lead to stronger activation of emotional self-interpretations than the positive expressions, then the framing effect will be weaker for participants in a second language. The two samples of 475 and 503 Spanish- and English-speaking users were recruited, and the effects of risk-taking and attribute framing were studied. Based on the above results, positive and negative frames can result in different appraisals; however, it has not been confirmed that the effect of negativity-oriented framing is consistently weaker in a second language. Framing will, therefore, affect the decision outcome by changing people's subjective assessments of the choices presented in semantically negative or undesirable ways, based on the negativity bias.

Negativity bias and Holleman and others' bilingual study of the framing effect have shown that negative framing can alter people's choices [10]. However, it is not clear whether this relationship also holds for risk-related moral judgment scenarios or among people with different cognitive styles in gain-loss framing. According to Tversky and Kahneman, even when the two risky decision situations have the same final outcome, people are more risk-averse when the outcomes are gain-framed and more risk-seeking when they are loss-framed [2]. Wang et al. investigated gain-loss framing more directly in four risky decision scenarios using a 2 (Chinese or English) x 2 (positive or negative frame) between-participants design with 524 adults [11]. They found that the framing effect was less pronounced in the foreign-language condition, and generally, the participants were more risk-seeking when making decisions in English. Holleman et al. found that the framing effect was the same in both native-language and foreign-language research, so it is possible that the impact of negative framing varies by language pair and decision context. However, both studies show that negativity bias can still explain why loss-related information is given more weight psychologically and alter risk preferences. Therefore, the framing effect will change the choice of visible outcomes, and this alteration varies among different language pairs, decision contexts and individuals.

Choice data from Holleman et al. and Wang et al. show that framing influences choice; however, the particular way in which framed information is transformed into subjective value and why the behaviour-framing effect changes under different decision-making circumstances have not been explained [10, 11]. Neural Evidence is a form of explanation. Sun and others combined a monetary decision task with functional Magnetic Resonance Imaging (fMRI) [12]. Participants selected between certain and risky options under positive and negative frames in both the gain and loss domains. The researchers found that the participants chose the risky option more often in the negative frame than in the positive frame, and the size of the framing effect was the same in both cases. The neural results did not show this division. In the gain domain, frame-consistent decisions were linked to activity in the right amygdala, and individual susceptibility to framing positively correlated with connectivity between the amygdala and the ventromedial prefrontal cortex (vmPFC); this network is involved in subjective value judgement. At the same time, in the loss domain, there was bilateral putamen activation and connectivity between the putamen and the dorsomedial prefrontal cortex (dmPFC), a network associated with evaluative control. These results offer

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biological support for the idea that the same behavioural framing effect can be generated via different neural pathways when people consider gains and losses differently.

Although Sun and others have found domain-specific neural systems in the susceptibility to framing, fMRI results have not demonstrated whether the activity of these systems causally affects decision-making [12]. Kroker and others have modified vmPFC excitability experimentally to address this defect [13]. Researchers applied excitatory and inhibitory transcranial direct current stimulation (tDCS) before a financial decision task and recorded magnetoelectric signals (MEG). In each trial, the two choices were framed either positively or negatively, and their objective expected monetary values (EMVs) were the same. Under the typical framing effect, participants chose the risky option more often in the loss frame. Excitatory stimulation reduced this effect to some extent by lowering risky choices in the loss-framed condition compared with inhibitory stimulation. It made the participants more aware of the risk of loss and thus increased their willingness to choose options with a high EMV, behaving more rationally and value-orientedly. Based on the above results, vmPFC-related regulation helps individuals process objective outcome information and does not rely solely on the emotional effects of loss-focused words. Therefore, negative framing can change the subjective assessment of the alternative that people are associating with their choice, and strong prefrontal cortex regulation may reduce this effect on risk-taking.

Overall, negative framing often makes people perceive things differently and choose according to their own values for objective equivalents. Negativity bias is likely the cause; therefore, losses are generally given more weight than equivalent gains. However, Holleman and others and Wang and others have conducted different research that shows framing effects vary according to language, task and individual cognitive traits [10, 11]. Sun and others have also found that the same behavioural changes are due to different neural systems; gain-domain choices involve the amygdala-vmPFC network, and loss-domain choices involve the putamen-dmPFC network [12]. Kroker and others found that altering the excitability of vmPFC reduced framing-based risk-taking and increased attention to probability and expected value [13]. Therefore, negative framing alters people's decisions by transforming objectively equivalent outcomes into subjectively different values through the interaction of emotional salience, expected-value evaluation, and prefrontal control.

4. Conclusion

This paper has examined how negative language influences decision-making by distinguishing linguistic negation from negative framing and analysing their effects from pre-decisional processing to observable decision outcomes. Based on the above evidence, linguistic negation may require more processing resources, alter the trade-off between plausibility and informativeness, partially engage inhibitory control, and need subsequent semantic reanalysis. Although the above mechanisms may reduce the speed of information processing, no studies have shown that they necessarily alter the final choice. Negative Framing may be more directly behavioural in changing people's subjective evaluations of objective results; however, the extent to which it achieves this effect varies with the language and decision context and individual cognition. Neural evidence further shows that the same framing effect in the gain and loss domains involves different brain networks, and regulation involving the vmPFC may reduce susceptibility to negative framing. Therefore, the impact of negative language on decision-making should be studied at both the pre-decision and post-decision stages, and specific real-world contexts, such as moral judgment and financial risk choice, should be included.

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