

Frames and brains: elicitation and control of response tendencies

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Using magnetic resonance imaging, De Martino and colleagues investigated the neural signature that is associated with decisions between small sure amounts of money and large riskier amounts when the framing of the outcomes is varied. We interpret their results within a dual-system framework, in which different frames evoke distinct emotional responses that different individuals can suppress to various degrees. The study advances the integration of brain imaging results into cognitive theory.

Introduction

In a recent study, De Martino and colleagues [1] investigated the neural basis of a feature of rationality that has been termed ‘invariance’, the ability to resist irrelevant cues when making choices. They found that people differ considerably in this aspect of rationality and that the selection of the option that is described most attractively within a given frame exhibits different patterns of brain activation than decisions that resist these irrelevant cues. The authors relate their findings to prospect theory [2], a model of choice that predicts different preferences for equivalent outcomes that are framed either as gains or as losses. We note the relevance of two other lines of research: a demonstration that emotionally loaded words automatically evoke approach or avoidance tendencies [3] and a test of the ability to avoid intuitively compelling but incorrect solutions to puzzles [4].

The study

In the study by De Martino *et al.* [1], fMRI data were collected from 20 participants while they considered choices between sure outcomes and gambles of equal expected value. For example, after being told to imagine that they had received \$50, participants chose to either accept 40% of that amount or take a gamble that offered a 40% chance of keeping all the money and a 60% chance of losing it all. The gamble was represented graphically using a pie chart that showed the probabilities of the uncertain outcomes. The sure prospect was framed in one of two ways – ‘keep \$20’ or ‘lose \$30’. Although the two formulations are transparently equivalent, the sure option was chosen more often when it was framed positively (with the word ‘keep’) than when it was framed negatively (with the word ‘lose’). All 20 participants showed this effect, although their

susceptibility varied widely. Respondents who were less susceptible to the framing effect were described as scoring higher on a ‘rationality index’.

The main brain imaging results were (i) greater activation of the amygdala when a respondent’s choice was congruent with the imposed frame (i.e. when they chose to ‘keep’ the sure amount of money or when they chose to gamble so they did not ‘lose’ the rest of the money); (ii) greater activation of the anterior cingulate cortex (ACC) when choices were incongruent with the imposed frame; and (iii) a correlation between activation of the orbital and medial prefrontal cortex (OMPFC) and scores on the rationality index. In psychological terms, this might be translated as (i) choices are often dominated by an initial emotional evaluation; (ii) the suppression of this initial response induces conflict (indicated by ACC activation); and (iii) resistance to the framing effect might be mediated by the OMPFC, perhaps by inhibiting impulsive responses or by integrating emotional reactions with other information.

Translating the imaging findings into psychological propositions is helpful to the theoretical analysis of decision making. Specifically, the evidence of emotional involvement is compatible with an interpretation of risky choice that has been presented under the self-explanatory title ‘risk as feelings’ [5]. The results also demonstrate prospect theory’s ‘reflection effect’ – the tendency to avoid risk to secure a certain gain and to seek risk to avoid incurring a certain loss. A plausible account of the reflection effect is that sure gains are particularly attractive and sure losses are particularly aversive when pitted against gains and losses that are only probable. De Martino *et al.* [1] showed that the verbal label that is attached to the sure outcome engenders both an emotional response and a corresponding tendency to accept or avoid that prospect.

Related behavioral research

Several experiments have demonstrated the automatic elicitation of approach and avoidance tendencies by emotionally loaded words. In one study [3], participants were instructed to either push a lever away from them as quickly as possible when a word appeared on a screen or pull it towards them. Although the content of the word was irrelevant to the task, participants were quicker to pull the lever towards them for good words (e.g. ‘peace’) than for bad ones (e.g. ‘vomit’) and quicker to push it away for bad words than for good ones. The words ‘keep’ and ‘lose’ in the focal study [1] similarly evoked both an emotional response and a tendency to accept or reject a prospect.

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Available online 22 December 2006.

Frederick [4] described a test of the ability to resist intuitively compelling responses, and related this ability to the reflection effect of prospect theory. The cognitive reflection test (CRT) consists of questions such as ‘A bat and a ball cost \$1.10 in total. The bat costs a dollar more than the ball. How much does the ball cost?’. Each question in the CRT elicits a strong associative response (10 cents in this example) that can be recognized as wrong with a little additional thought. Like the ability to respond consistently across frames, the ability to avoid the intuitive error varies among people: 17% of undergraduates at the University of Toledo correctly answered ‘five cents’, compared with 66% of undergraduates at the Massachusetts Institute of Technology. Scores on the CRT predict the size of the reflection effect in risky choices. Low-scoring ‘impulsive’ people show the largest effect: they are much more likely to accept sure gains and to avoid sure losses. High scorers on the CRT do not show the reflection effect. Low scorers on the CRT also show greater preference for small immediate rewards over large delayed rewards – a tendency that seems to have a characteristic neural signature [6]. We hypothesize that performance on the CRT would correlate both with the rationality index that was used by De Martino and colleagues and with the pattern of brain activity that they observed.

Two types of rationality?

The results of De Martino and colleagues [1] highlight how initial emotional reactions are overridden and how resistance to framing ought to be conceptualized and described. Many popular ‘two-system’ models of judgment [7–10] suggest a distinction between two families of mental operations that are differentiated by their demands for mental effort and their susceptibility to interference from competing activities [11]. The two systems are associated with distinct forms of rationality. ‘System 1 rationality’ includes the effortless generation of accurate perceptual and conceptual representations that are part of our native endowment for some judgments (e.g. recognizing a face from various angles) and that are acquired through experience for other forms of judgment (e.g. recognizing the vulnerability of a particular configuration of chess pieces). In decision making, System 1 rationality includes the ability to encode choice problems in ways that capture the essential aspects of the situation and that disregard superficial features or ‘frames’. In contrast to the automatic and effortless performance of

System 1, the operations of System 2 are deliberate and susceptible to disruption by concurrent tasks. As illustrated by the bat-and-ball problem, the achievement of ‘System 2 rationality’ requires both the inclination to monitor initial impressions and the ability to reason accurately. (However, a few individuals who have highly developed mathematical skills might have correct intuitions and not require second thoughts, which would be a manifestation of System 1 rationality.)

Further behavioral and brain imaging data are required to understand how best to conceptualize the susceptibility to framing effects and the ability to resist them. However, the study by De Martino and colleagues confirms that serious theorizing in the domains of judgment and decision making can be informed by imaging results and that the integration of concepts from both lines of research is necessary and feasible.

Acknowledgements

We thank Benedetto De Martino for his patience in answering many questions. Jonathan Cohen, Drazen Prelec and Han Nguyen offered helpful comments.

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doi:10.1016/j.tics.2006.11.007

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