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The neuroscience of motivated cognition

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Goals and needs shape individuals' thinking, a phenomenon known as motivated cognition. We highlight research from social psychology and cognitive neuroscience that provides insight into the structure of motivated cognition. In addition to demonstrating its ubiquity, we suggest that motivated cognition is often effortless and pervades information processing.

The pervasive influence of motivation on cognition

People often believe that their thinking aims squarely at gaining an accurate impression of reality. Upon closer inspection, this assumption collapses. Instead, like the inhabitants of Garrison Keillor's Lake Woebegon, individuals often see themselves and close others as possessing unrealistically high levels of positive attributes such as likeability, morality, and attractiveness. This bias persists among individuals who should know better: over 90% college professors believe their work is better than that of their peers, CIA analysts overestimate the accuracy of their predictions for future events, and doctors overconfidently estimate their medical knowledge [1].

These cases exemplify the phenomenon of motivated cognition, by which the goals and needs of individuals steer their thinking towards desired conclusions [1–3]. A variety of motivations pervasively shapes cognition (Box 1). For example, people wish to live in a coherent and consistent world. This leads people to recognize patterns where there are none, perceive control over random events, and shift their attitudes to be consistent with their past behaviors [2,3]. People also need to feel good about themselves and about others with whom they identify. As such, people often self-enhance, evaluating themselves as having more desirable personalities and rosier future prospects than their peers, and taking personal credit for successes, but not failures [1–3]. People likewise elevate their relationship partners and in-group members (e.g., people who share their political affiliation) in demonstrably unrealistic ways [3,4]. Motivations can also have the opposite effect, leading people to derogate out-group members, even when the lines that divide 'us' from 'them' are defined *de novo* by researchers [3,4].

Motivated cognition across the information processing stream

Motivation not only shapes what people think, but also how they think. Decades of psychological research identify mechanisms through which motivation affects cognition (Box 1), but it has only recently become a focus of neuroscientific research. These recent efforts converge with behavioral approaches to provide insights into the structure of motivated cognition (Box 2). Together, these efforts suggest that motivated cognition pervades information processing at various stages, including perception, attention, and decision-making. Although these processes are intricately related and frequently interact, we use them here as an organizing principle to briefly summarize how motivations affect what people see, how they think, and what they decide.

Perception

A research tradition dating back to the 'New Look' movement demonstrates that motives influence what people see. For example, people tend to see desirable objects as being physically closer to them, and tend to imbue ambiguous stimuli (e.g., similar shades of a color) with interpretations associated with reward [5]. Recent neuroscientific investigations echo these findings. In one recent study, participants viewed arrays of moving dots whose direction of motion was difficult to discern, and decided which direction they were predominantly moving [6]. Before seeing these arrays, participants learned that they would receive a reward if the dots predominantly moved in a particular direction. People tended to see the dots moving in the direction associated with reward, and did so by biasing their visual search in favor of the desired perception. Moreover, occipital regions involved in perceptual encoding, and prefrontal regions involved in top-down control, were modulated by these motivational effects on vision (Figure 1 and [6]).

Motivation also shapes people's visual perception of themselves and others. For example, people see their own faces and those of close others as being more physically attractive than they really are [7], and in-group faces as being more distinct and likable than out-group faces [4]. In one recent study, participants viewed images of their own face morphed with positive (i.e., trustworthy) or negative (i.e., untrustworthy) faces, and evaluated the extent to which each morph looked like them [7]. Participants identified more-trustworthy morphs as being more similar to themselves than were less-trustworthy morphs. As the similarity between the untrustworthy morphs and the self decreased, activation in occipitotemporal structures associated with facial encoding and prefrontal regions involved in top-down control increased. Taken together, these data suggest that motivation influences lower-level perception towards desired conclusions and away from undesired conclusions. In addition, they suggest that top-down processes (reflected by prefrontal cortical activation) influence lower-level perception by biasing visual search in the direction of desired conclusions [8].

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Box 1. Three principles of motivated cognition

Classic social psychological research makes several key points about motivated cognition:

It is pervasive: motives affect a wide array of judgments and perception, including self- and other-enhancement, illusions of control, confirmation bias, and in-group bias [2–4].

It is goal-directed: as with other motivated processes, biased cognition tracks the current need of an individual to fulfill a relevant goal. For example, people maximally self-enhance after being ostracized or negatively evaluated – consistent with an increased need to self-protect – and reduce enhancement following self-affirmation (e.g., focusing on core values) – consistent with a reduced need to self-protect [1–3]. Likewise, threats to group-related motives (e.g., intergroup competition) increase in-group biases, and reducing group-related motives by highlighting commonalities between groups reduces these biases [4]. Finally, individual differences associated with chronically elevated motives (e.g., narcissism) predict bias [3,4].

It is impactful: motivated cognition has far-reaching consequences, and its adaptiveness has been debated. On one hand, self-enhancement predicts positive adjustment in the face of adversity [1]. On the other hand, motivated biases are often harmful [1]. People who are overoptimistic about their health fail to take preventative health measures. Overconfident students show poor skill retention and academic disengagement. Overconfident CEOs take unwarranted risks. Finally, people who self-enhance are perceived as arrogant and maladjusted.

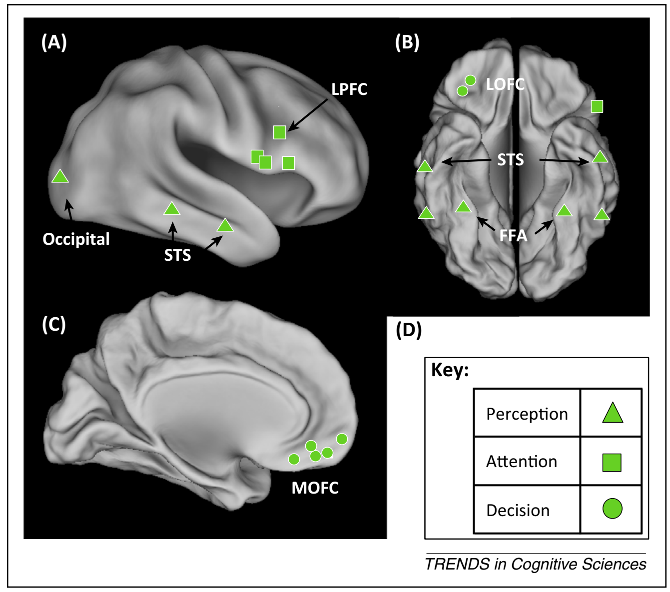

Figure 1. Neural systems modulated by motivated cognition. Each point corresponds to an activation peak that tracks bias, shape-coded in relation to processing stage. Activations are projected to the surface of the brain for illustrative purposes. Abbreviations: FFA, fusiform face area; LOFC, lateral orbitofrontal cortex; LPFC, lateral prefrontal cortex; MOFC, medial orbitofrontal cortex; STS, superior temporal sulcus. The key indicates which shapes correspond to motivation's influence along the information processing stream.

Attention

People often direct attention towards information that supports desired conclusions [2]. For instance, individuals quickly accept information that casts them in a favorable light (e.g., as being predisposed towards success), but carefully scrutinize threatening information (e.g., which suggests they are likely to fail) [2]. Motives likewise influence neural systems involved in attentional control (Figure 1), diverting attention towards desirable inferences and away from undesired ones. For example, in a recent study, participants rated the likelihood that they would experience various unpleasant future events (e.g., robbery, Alzheimer's disease), then learned the base-rate probability of experiencing those events, and finally re-evaluated their personal chances of having each event befall them [9]. Participants adjusted their personal estimates when base-rate information was better, but not worse, than their initial estimate. Crucially, reduced activity in lateral prefrontal cortex (LPFC) – a region involved in attentional control [10] – during the presentation of more pessimistic base-rates predicted an optimistic bias in their likelihood estimates [9]. Taken together, these findings suggest that people may heed motives by ignoring information that threatens their desired conclusions. This suggests that, in particular situations, tuning attention towards undesirable or threatening information may help people to reduce their motivated biases (Box 2).

Box 2. The influence of motivation on cognition: effortful or effortless?

One way in which neuroscience informs the study of motivated cognition is by helping to uncover whether motivated biases are effortful or effortless. One possibility is that motivated cognition reflects effortful attempts to distort information and reach desired conclusions. However, recent evidence suggests that motivation may instead effortlessly influence cognition. Motivated biases exhibit features of automaticity, for instance arising quickly [5], and even when cognitive resources are limited [11]. Second, the most consistent pattern of brain activity associated with motivated bias is reduced neural activation in structures associated with deeper information processing [10,12]. For instance, reduced LPFC [9] and OFC [11] activation is associated with more positively biased evaluations of the self, close others, and in-group members. Taken together, the prepotency of biased cognition and its negative relation to activity in these regions suggest that motivated cognition may be effortless. This is not to say that bias is always effortless. For instance, when threatened, people protect the self by applying different standards during self-evaluation, an effect accompanied by increased OFC activation [13–15]. The effortful or effortless nature of motivated cognition is likely not fixed, but rather depends on the current motivational state of an individual.

Decision-making

People often (implicitly or explicitly) exploit convenient heuristics to reach desired conclusions [2]. For example, people draw on accessible information in a biased manner (e.g., by recalling a time they acted intelligently rather than foolishly) to uphold positive self-evaluations [2]. A recent study examined reliance on such cognitive loopholes when self-enhancing [11]. Participants evaluated themselves in comparison to their average peer on broad (e.g., 'talent', 'intelligence') versus narrow (e.g., 'cleanliness', 'tidiness') traits. When making broad inferences, people can self-enhance through reliance on goal-relevant availability heuristics because some evidence for their talent or intelligence (e.g., math, social skills) will likely be available. Narrower inferences (e.g., concerning tidiness) afford less opportunity for using such heuristics, constraining positivity biases. Consistent with this idea, participants evaluated themselves as being better-than-average on broad but not narrow traits. Further, the degree to which people self-enhanced was accompanied by reduced activity in medial and lateral orbitofrontal cortex (OFC) – regions associated with integrating affective and contextual information in the service of decision-making (Figure 1 and [12,13]). These findings raise the possibility that people may arrive at flattering views of themselves and close others by failing to recruit the OFC, and this may allow goal-relevant heuristics to be easily deployed (e.g., when considering broad traits). This suggests that a deeper consideration of desirable and undesirable information may reduce positivity biases (Box 2 and [13]).

At other times, people shift their attitudes to reduce discomfort with inconsistency [2]. In classic demonstrations, people are asked to make statements or perform behaviors that contradict previously held beliefs (e.g., performing a boring task and subsequently telling another participant that the task was enjoyable). Contradictions between one's actions and experience threaten the self-image of an individual as being moral and intelligent. Motivated to dispel this threat, people shift their beliefs to make them more consistent with their behavior (e.g., by evaluating the boring task more positively [2]).

Recent neuroscientific evidence sheds light on the processes underlying these shifts in belief. In one study, participants were asked to make difficult choices between options they found to be equally attractive, and subsequently re-evaluated their attitudes towards those options [14]. People evaluated the chosen options as being significantly more desirable than they had before making any choices. Crucially, the degree to which people shifted their attitudes was accompanied by increased activation in OFC. These findings suggest that shifts in attitude as a way to reduce dissonance and threat may be more deliberative than other forms of self-enhancement (Box 2 and [13,15]).

Concluding remarks

Budding neuroscientific endeavors have begun identifying mechanisms through which motivation affects cognition in various domains including self-perception, person perception, and intergroup relations. Although often considered separately, these social contexts all activate goals that bias information processing. These motives also pervade information processing at several stages including visual perception, attention, memory, and decision-making. Motivated cognition highlights the idea that even presumably low-level perceptions and inferences – which at first blush appear to be devoted to objective information gathering – are subject to motivational forces.

Understanding the structure of motivated cognition is crucial to reducing the harmful sequelae of biased thinking (Box 1). Strategies that promote deeper information processing can constrain bias (Box 2). For example, holding people accountable to a third party (e.g., by requiring a justification for decisions) reduces effortless biases [13]. At other times – when the self is threatened – affirming core values or highlighting shared identity may reduce people's sense of threat, as well as reactive biases in response to that threat (Box 1). Advances in our understanding of motivated cognition could provide individuals and policymakers with strategies to influence motivation in ways that reduce harmful biases. These strategies may allow people to gain self-insight, maximize adaptive decision-making, as well as to reduce favoritism towards close others and in-group members, and improve intergroup relations.

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