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Current Opinion in Behavioral Sciences

How perception of control shapes decision making

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Perceived control—the belief in our ability to successfully influence the environment—significantly shapes how we make decisions and interact with our environment. Because of its intrinsically rewarding nature, the opportunity to exert control tends to bias individuals towards behaviors that endow an enhanced perception of control. Here, we leverage recent behavioral and neuroimaging work to highlight three particular attributes of control (i.e. affective, motivational and protective), which contribute to how perceived control shapes decision making via the corticostriatal circuits and impacts wellbeing. We then consider how impairments in perceived control could represent a transdiagnostic feature across psychopathologies.

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Current Opinion in Behavioral Sciences 2021, **41**:85–91

This review comes from a themed issue on **Cognition and perception – *value-based decision-making***

Edited by **Bernard Balleine** and **Laura Bradfield**

https://doi.org/10.1016/j.cobeha.2021.04.003

Introduction

The belief in our ability to exert change in the environment has significant consequences to our physical and mental wellbeing [1]. Such enhanced perception of control often drives everyday decisions, from mundane, such as picking out numbers when playing the lottery rather than letting the computer pick, to more complex as in the case of pain and stress management [e.g. coping with stress during the Covid-19 pandemic; 2,3]. Indeed, our perception of control shapes our decision making in ways that dictate how we interact with our environment, including propelling us to seek out situations—even at a cost—to fulfill our sense of control.

Although perceived control has been an enduring construct in psychology for more than half a century [4], more recent attention from fields such as behavioral economics and neuroscience has helped highlight the value of perceiving control in the environment. In the context of decision making specifically, the influence of perceived control can be distilled to three attributes: affective, motivational and protective. First, the affective attribute is related to the inherently rewarding nature of perceived control such that it can generate neural signals associated with positive affect in the brain and engender approach behavior [5]. Second, the motivational attribute finds its root in perceived control carrying effectance motivation—individuals have a natural tendency to try to experience competence by causally engaging with the environment [6]. Finally, perceived control has protective attributes in largely aversive contexts that help buffer against maladaptive responses to environmental stressors [7].

In this review, we explore the influence of perceived control on decision making via these three attributes. We first provide a brief historical account of the construct of perceived control and provide an operational definition in the context of decision making. We then focus on interdisciplinary efforts, from behavioral economics to neuroscience that investigate perceived control in relation to the three previously described attributes of perceived control. Finally, we discuss how perceived control can be a transdiagnostic feature whose perturbation has implications across many psychopathologies.

The construct of perceived control

Although Robert White first introduced his theory on effectance motivation stipulating a human drive for control in 1959, the term *perceived control* first appeared in Rotter's seminal work on the theory of internal versus external locus of control [8]. Subsequent interpretations of this construct included Bandura's self-efficacy theory, which described the belief that an individual has the ability to succeed in a given task or environment [9] and Seligman's groundbreaking work on *learned helplessness*, which proposed that perceived control can blunt the negative effects induced by external stressors [10]. Along with these interpretations, it did not take long for the field to recognize the importance of perceived control in the health domain when Wallston *et al.* translated this construct into clinical research with their introduction of the health locus of control [11]. Since then, prominent research including that of Langer on the illusion of control [12], Iyengar and Leppar on the choice paradox [13], Deci and Ryan on intrinsic need for control [14] and Ajzen's formulation of the theory of planned behavior [15] have all contributed significantly to updating our understanding of perceived control and affirming its profound influence on human behavior. This behavioral influence was reaffirmed in Skinner's formative dissection of perceived control [16] where she emphasized the implication of *perception* in explaining and studying perceived control. As long as the individual subjectively believes in having control—irrespective of any objective control—behavior is influenced by such perception.

With this historical backdrop in mind, *perceived control* can be operationally defined as having the belief that performing a certain behavior will produce a desired effect. In experimental settings, perceived control has been primarily manipulated in two ways: either by presenting the individual with the ability to choose freely [e.g. Ref. 17] or by affording the individual with behavioral contingencies in the sense of temporal contiguity between his or her action and an outcome [e.g. Ref. 18]. These experimental manipulations permit us to examine individuals' perception of control that reveals both its trait-like and state-like characteristics. For instance, perceived control can be considered trait-like, which is in line with Rotter's [8] definition of internal versus external locus of control where *internals* operate on the belief that they control their lives whereas *externals* believe and behave according to the assumption that outside forces control their lives. At the same time, perceived control is also state-like where individuals have the adaptive ability to fluctuate between being an *internal* and an *external* depending on their emotional state and the context [19]. Notably, perceived control carries three attributes (i.e. affective, motivational and protective; Figure 1) that lead to its behavioral influences, which we consider in subsequent sections.

The affective attribute of perceived control

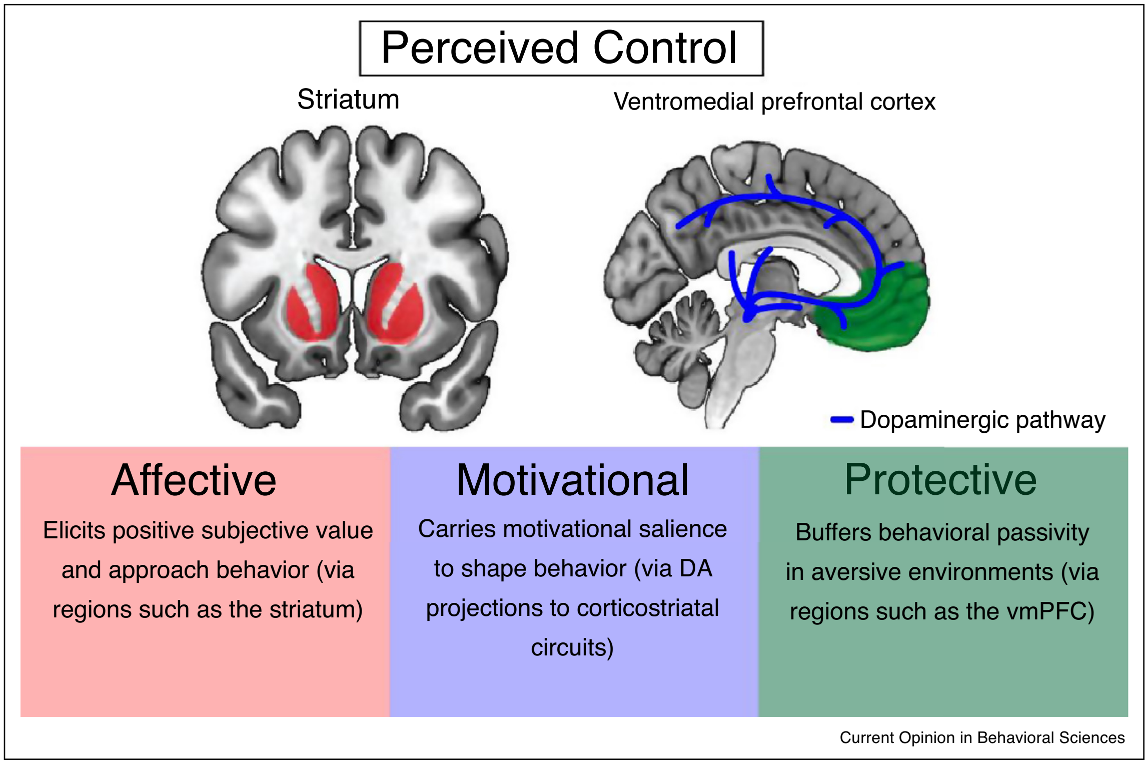
At the core of perceived control is the notion that individuals need to be able to detect control in their environment. One classic way to introduce control is by conferring the opportunity to make a choice. For instance, giving individuals a choice between options A and B induces greater perception of control compared to no choice (e.g. option is chosen for individuals or they are presented with a *forced* choice between two identical options). Prior work that leveraged the opportunity to choose as a proxy for perceived control suggested that the act of choosing is itself valuable and rewarding [1]. More specifically, the opportunity to exert control (compared to a forced-choice trial) is preferred by individuals, elicits subjective positive feelings and neural responses in regions associated with reward-related processing such as the ventral striatum/nucleus accumbens and anterior cingulate cortex [20,21•,22,23••]. An implication of this research is that perceiving and exerting control can carry an intrinsically affective attribute that is tied to a *subjective* value processed by brain regions canonically involved in computing value and subserving value-based decision making such as the ventromedial prefrontal cortex [vmPFC; 24,25].

The ability for perceived control to engender approach behavior is corroborated by behavioral studies employing economic paradigms to evaluate choice behaviors, thereby permitting the measurement of an individual's valuation of exerting control during decision making. These studies reported a 'control premium' where individuals were willing to incur a cost in order to retain control even when relinquishing control was the objectively better decision [26,27•]. By having a price tag that individuals are willing to pay for, perceived control bears a positive decisional value that biases behavior accordingly. The affective attribute of perceived control is further substantiated and reflected in its *subjective* value, which can be quantified and studied across individuals based on their differential control-seeking behavior. For instance, during decisions where the alternative option to relinquish choice varied in reward value, participants maintained a preference for having control, and such subjective value of control, which was observed to correlate with activity in the vmPFC, artificially inflated the associated outcome value by an average of 30% [21•]. The vmPFC, a key neural node representing a common currency for choice-inferred subjective values [25], has also been found to increase its functional coupling with the ventral striatum under conditions conferring perceived control [23••]. Taken together, these findings allude to perceived control carrying an affective attribute that is both intrinsic and subjective and recruits the corticostriatal circuit. The affective attribute of perceived control is also heavily dependent on the contextual valence of the decision. For example, when a choice is presented in a context associated with potentially positive outcomes—such as the opportunity to gain money or experience positive stimuli—compared to potentially negative outcomes, there is greater behavioral bias towards seeking and exerting control [28,29,30••], primarily if we can reasonably predict the outcome valence [31••]. Yet, this is a topic that requires continued investigation as the context in which control is perceived (e.g. approach/avoid potential outcome) can interact with individual differences to drive the neural processing of perceived control [32].

The motivational attribute of perceived control

The rewarding nature of perceived control—where feeling in control elicits positive emotions—motivates us to willingly put in effort to effectively influence our environment. This motivational salience conferred by the value of perceived control—aptly termed 'effectance motivation' [6]—can shape our behavior in two ways. First, it affects how much we 'want' to exert effort (response frequency) and second, it affects how efficient we are at exerting effort (response speed). By manipulating the temporal contiguity between our action and the outcome to perturb our perception of control, it has been

Figure 1



Perceived control and its three attributes.
Perceived control carries three attributes (affective, motivational and protective) that recruit the corticostriatal circuit and dopaminergic system and influence decision making.

shown that increased perception of control is associated with greater response frequency and faster response speed [33,34]. When we perceive control over our effort exertion, there is an associated stronger signal in the striatum in the absence of extrinsic rewards [35], potentially linking striatal function with the motivational salience of perceived control on behavior.

This change in response frequency and response speed—two components that together characterize behavioral vigor [36,37] driven by perceived control is closely tied to dopaminergic transmission that originates from the ventral tegmental area [VTA; 5]. Dopaminergic projections from the VTA to the ventral striatum/nucleus accumbens and cortical regions subserves a cue-induced incentive salience or 'wanting' that engenders approach behavior [38]. One idea is that variability in tonic dopaminergic transmission should positively track how much perceived control engenders approach behavior and the associated response vigor. Recent studies seem to lend support to this notion by observing that individuals who have greater perceived control—via a more internal locus of control [8]—have greater striatal dopaminergic transmission, as measured by raclopride Positron Emission Tomography [39], and greater control-seeking behavior [40]. These findings hint at the possibility that dopamine levels play an important role in the differential control-seeking and control-exerting behaviors across individuals.

In addition to increasing behavioral vigor, our perception of control can also shape our motivation by driving feedback-based reinforcement learning, another system under dopaminergic modulation [41]. Indeed, the opportunity to choose can amplify positive reward prediction error, which has been linked to gene polymorphism in striatal dopaminergic plasticity [42], increase learning rates via a 'choice-confirmation bias' [43••], and engage cue-induced striatal activation to enhance subsequent memory-encoding activation in the hippocampus [44]. More studies are needed to elucidate the relationship between perceived control, dopaminergic transmission (e.g. tonic versus phasic) and their combined effect on choice bias and reinforcement learning. Nevertheless, these findings suggest that perceived control—by way of triggering dopaminergic transmission—governs our motivation by increasing response vigor and playing a role in how we learn about our environment.

The protective attribute of perceived control

When faced with an aversive environment, perceived control can have a protective effect over how we respond to the environmental stressor [45]. This protective effect can be both reactive and proactive where having control protects against both current and future stressors. For example, the theory of *learned helplessness* highlights how the presence of controllability over an aversive stimulus buffers organisms against behavioral passivity, anxiety and learning deficits both during the initial exposure to stressors and even after the animals were relocated to novel aversive environments [for review see Ref. 7]. Subsequent work has expanded on this protective effect to show that perceived stressor controllability is associated with blunted conditioned fear expression and improved fear recovery [46], decreased negative affect and increased behavioral persistence after acute stress [47], as well as reduced intensity and increased tolerability of painful stimuli [48,49•]. Thus, the ability to perceive control over the environment may have the adaptive benefit of assisting in regulating emotions, particularly dampening stress reactivity and associated negative emotions towards both current and future stressors.

The early rodent literature on *learned helplessness* has delineated a neural mechanism for the protective attribute of perceived control that is rooted in the medial prefrontal cortex [50,51]. Specifically, vmPFC functions as the neural substrate to integrate sensory signals from the environment to detect control and subsequently regulate activity in downstream regions such as the dorsal raphe nucleus, striatum and amygdala to influence avoidance and escape behaviors [52,53]. Human neuroimaging research has subsequently corroborated such a role for vmPFC by showing that controllable stressors reliability activated the vmPFC and increased the functional coupling between vmPFC and amygdala [54,55••]. Recent work also linked stronger vmPFC activity to greater recovery of avoidance behavior in a controllable environment after repeated exposure to uncontrollable environments [56]. In sum, the protective effect of perceived control is rooted in its ability to engage coping mechanisms and sustain the motivational drive to exert effort to perform adaptive behavior such as escape and avoidance. Understanding the potential protective effects of perceived control has significant implications as a way to boost emotion regulation when typical strategies (e.g. reappraisal) are more difficult to implement due to levels of cognitive effort, stress and situational context [57,58].

The transdiagnostic implication of perceived control in psychopathologies

Considering how perceived control can influence our behavior via its affective, motivational and protective attributes, it allows us to quickly and effectively assess a novel environment and evaluate our action plan. When faced with a new environment, the motivational attribute of perceived control drives us to perform control-seeking behaviors and look for environmental indicators that fulfill our desire to be able to influence our surroundings. At the same time, the affective attribute of perceived control reinforces a positive subjective value of control that heightens our positive emotion when we perform control-seeking behaviors and when our perception of control is fulfilled. In the event that we encounter environmental stressors, the protective attribute of perceived control helps preserve our motivation and allows us to adapt our behavior accordingly, in turn helping to support our mental and physical wellbeing. As such, we have a healthy bias towards perceiving and exerting control that shapes everyday decisions and promotes wellbeing.

However, there are times when our perception of control is perturbed insofar as we develop maladaptive behaviors. This is evident in many psychopathologies where individuals typically report changes in their perception of control to specific environmental triggers that engender behaviors detrimental to their wellbeing. For example, individuals with depression afflicted with anhedonia may have a sense of helplessness which is tied to their low perception of control [59]. The concept of depressive realism—where depressed individuals are more realistic and rational in their decision making [60]—hints at the notion that perceived control can lead to risk/optimistic gain-seeking decisions that are otherwise absent in depressed individuals. Indeed, recent studies report that depressed individuals, compared to healthy participants, have blunted reward-related neural responses to both the anticipation of the opportunity for control [61•] and the receipt of rewards following the exertion of control [62], similar to diminished striatal responses to rewards observed in this population [e.g. Ref. 63]. These findings suggest that depressed individuals might ascribe a lower subjective value to control.

Another example is addiction, where individuals suffer from the compulsion to engage in substance use despite adverse consequences [64], and poor treatment outcomes such as higher relapse rates have been linked to low perception of control [65]. The inability for individuals to perceive having a choice over their drug-seeking behavior [66] suggests that perhaps enhancing their perceived control might be a key factor for improved clinical outcomes. Indeed, a recent study with nicotine-dependent individuals linked increases in perceived control with heightened mPFC and ACC function and reduction in subjective craving [67]. This is likewise observed in another psychopathology—post-traumatic stress disorder (PTSD)—that is characterized by diminished perceived control over emotional responses to stressors [68]. Research into techniques such as the recall of positive autobiographical memories, which can recruit neural systems involved in reward processing [69], have been shown to successfully enhance individuals' perceived control [70–72]. Taken together, these findings support the notion that impairments in perceived control represent a transdiagnostic feature in psychopathologies and highlight the importance of studying and understanding this psychological construct.

Future directions

Our ability to perceive control in the environment carries affective, motivational and protective attributes that profoundly influence how we behave and make decisions. Research on perceived control—spanning multiple disciplines including psychology, behavioral economics and neuroscience—has consistently affirmed its importance in contributing and maintaining our mental and physical wellbeing. Our understanding of perceived control's impact on wellbeing hinges on continued efforts to characterize ways that our perception of control shapes our behavior and how this is subserved by the corticostriatal circuit and dopaminergic system.

Our perception of control is likely shaped by both extrinsic (state-driven) and intrinsic (trait-driven) factors and appreciating both facets will deepen our knowledge of its influence on decision making. In terms of extrinsic factors, in light of research showing that perceived control responds differently to contextual valence [e.g. gain or loss frames; 28,29,30••,31••], a less-studied domain is how factors such as socioeconomic status and culture influence our perception of control. It is plausible that these factors are both causes and consequences of our perception of control—something that future research can illuminate. Additionally, another important future direction is understanding how the social context around us, which affects valuation and decision making [73], can impact neural systems involved in perceived control. Indeed, a recent study has shown that the presence of others during decision making can invoke neural activity in regions involved in mentalizing processes, such as the temporo-parietal junction [74] which can potentially make it more difficult to decide if and when to act [75]. With regards to intrinsic factors, the locus of control concept [8] suggests that there are individual differences in our perception of control where people fall on a spectrum of how much they perceive and desire control in their lives. This leads to the open question of whether individual differences in perceived control is domain-general or domain-specific; that is, whether there are universal control beliefs that most individuals subscribe to and more domain-specific control beliefs that precipitate individual differences. One potential way to study this is to adopt a computational approach to represent control. Such approaches can disentangle controllability and predictability [76], and help deploy tools such as Bayesian modeling to explain how perceived control in a given environment drives both how we learn differently from positive and negative outcomes [77••] and the accompanying behavioral flexibility we exhibit [78].

Such endeavors will ultimately have the potential to be translatable into clinical domains to examine the transdiagnostic feature of perceived control. We argued in this review that perception of control is likely perturbed under psychopathic states such as depression and addiction, leading to maladaptive behaviors and decisions. As such, restoring individuals' perception of control has the potential to help in treatment, as has been suggested in the practice of mindfulness [79].

Conflict of interest statement

Nothing declared.

CRediT authorship contribution statement

K. Wang developed the paper concept, drafted the manuscript. **Y. Yang** developed the paper concept, provided critical feedback and approved the final version of the paper. **M. Delgado** developed the paper concept, provided critical feedback and approved the final version of the paper

Acknowledgements

This work was supported by funding from the McKnight Foundation. The authors would like to thank Dr Jamil Bhanji for helpful comments.

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- •• of outstanding interest

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