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Why do we do what we do? The Attention–Readiness–Motivation framework

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Abstract

According to many theories of motivation, the principal driver of human behavior is the affectively driven valuation of actions. Actions are valued by maximizing the difference between stimulus value (the benefits and costs inherent in the stimulus outcome that is the expected result of a given action) and action costs (the effort required to perform that action). However, such accounts have difficulty explaining why individuals act inconsistently in what appear to be comparable situations and often act in ways that seem inconsistent with relevant action values. In particular, we highlight several seemingly anomalous default effects which cannot be explained via traditional valuation-based factors. In this article, we present the Attention–Readiness–Motivation framework, according to which such behavioral anomalies occur because stimulus value and action costs are respectively influenced by endogenous attention and action readiness—cognitive variables that are typically not considered as a part of the valuation calculus.

1 | INTRODUCTION

Why do we do what we do? According to many researchers (Barron & Hulleman, 2015; Fehr & Rangel, 2011), our actions are governed by a relatively simple calculus. This calculus hinges on determining the value of any given action by computing its expected benefits and costs in a particular context. At any given moment, we are thought to initiate the action that has the highest value. This intuitively plausible account has explained a wide range of behavior in humans (Simon, 1959) and other animals (Leathers & Olson, 2012). From purchasing stocks to going out for a jog, people often appear to select actions that have the highest value.

2 | THE VALUATION CALCULUS

Researchers working in different domains and at different levels of analysis embrace the valuation calculus. They agree that, at its core, the valuation calculus involves maximizing the difference between the benefits and costs likely to occur from the performance of a given action with respect to a given stimulus.

For neuroeconomists (Glimcher & Fehr, 2013; Sanfey, Loewenstein, McClure, & Cohen, 2006)—who seek to identify neural mechanisms in the domain of economic choices—"stimulus value" is defined as the difference between the expected benefits of the stimulus (that is the expected result of the action) and the inherent costs of the stimulus. For example, the stimulus value of a magazine is the difference between the anticipated benefit derived from the magazine and the price paid to obtain it. "Action costs" are defined as the costs inherent to performing the action that is being valued. They may involve physical or mental effort (Kool, McGuire, Rosen, & Botvinick, 2010). For example, the action cost of purchasing a magazine may include the effort of walking to a nearby store. The stimulus benefits and action costs are affective representations in different brain networks, and they are integrated into stimulus values, which govern action selection.

According to psychologists interested in motivation (Weiner, 2012)—who seek to identify psychological mechanisms in the domain of goal-directed behaviors—the value of an action is determined by (a) the expectancy of being successful in the action (i.e. "Can I do the action?"), (b) the value of engaging in the action (i.e. "Do I want to do the action?"), and (c) and the cost of performing the action (i.e. "How much physical or mental effort is involved in completing the action?"). For example, in computing the value of studying for a mathematics test, a student might assess the probability of doing well on the test, the benefit derived from doing well, and the mental effort required to prepare for the test. Such valuation calculations determine the level of motivation with respect to an action—and therefore determine whether a given action will be completed.

These two views of valuation in preference based decision making—one from neuroeconomists and the other from psychologists interested in motivation—show a great deal of convergence. Both suggest that actions are selected by computing benefits and costs. Both hold that benefits may be "primary" (e.g. food) and possess an innate value as essential for homeostasis and reproduction, or benefits may be "secondary" (e.g. money) in that they are not directly related to survival and gain value through association with primary benefits (Sescousse, Caldú, Segura, & Dreher, 2013). Similarly, there is agreement that costs may be inherent to a stimulus or context (e.g. the price one must pay to obtain food) or related to the action one must perform to obtain a stimulus (e.g. driving a long distance to a favorite restaurant). Such action-related costs may involve physical or mental effort (Rangel & Hare, 2010). Finally, it is generally accepted that affect is the common currency underlying all valuation (Peters, Västfjäll, Gärling, & Slovic, 2006).

The valuation calculus represents one of the best "unified theories" of motivated behavior (Schoemaker, 1982). Indeed, the explanatory power of the valuation calculus has been so great that researchers have often attempted to explain apparent behavioral anomalies—in which people select options that do not appear to have the highest valuation—not by adjusting or rejecting valuation-based accounts but by seeking hidden valuation drivers that may not initially be apparent. One particularly intriguing behavioral anomaly is the default effect.

3 | ANALYZING DEFAULT EFFECTS USING THE VALUATION CALCULUS

A default option is defined as an option that is realized if a person does nothing, or continues doing what she is currently doing. By definition, any context has an in-built default option—i.e. the state that will be realized if a new action is not taken. Thus, understanding the conditions under which individuals persist with defaults (or leave them) is central to understanding the nature of all motivated action.

Individuals are known to frequently persist with default options that appear to have inferior valuations to other possible actions in that particular context (Samuelson & Zeckhauser, 1988). Default preferences have been observed in diverse decision contexts such as organ donation (Johnson & Goldstein, 2003), savings behavior (Choi, Laibson, Madrian, & Metrick, 2004), voting patterns (Gow & Eubank, 1984), and choices in utility and insurance providers (Samuelson & Zeckhauser, 1988). Why do such default effects occur? To date, explanations have sought to argue that there are subtle benefits that increase the valuation of the default option and/or subtle costs that decrease the valuation of the non-default options.

Past research (Dinner, Johnson, Goldstein, & Liu, 2011; Kahneman, Knetsch, & Thaler, 1991) has identified three such valuation-based factors: mental costs of evaluating the available options, an implied recommendation, and loss aversion associated with leaving a default state. We describe each of these in turn.

Selecting among several options often incurs costs in terms of the required physical or mental effort (Hofmann & Kotabe, 2012; Westbrook, Kester, & Braver, 2013). Filling out a form, composing an email, or collecting necessary documentation are types of activities that may be prerequisites to exercising a particular option; however, each of them involves the expenditure of effort. Moreover, performing any single action carries an opportunity cost related to the next best action (Kurzban, Duckworth, Kable, & Myers, 2013). The costs associated with such effort are sometimes not as salient compared to the benefits on offer—and therefore may not be seen as an important part of the valuation calculus. Nevertheless, their effect on decision making can be profound (Suri, Sheppes, Schwartz, & Gross, 2013). Mental costs (related to the analysis of available options) can decrease the valuation of non-default options (since resources must be gathered to select a particular option) while increasing the relative valuation of the default option (since no effort is required to continue with the default option). This increases the likelihood of default effects.

An implied recommendation is present when the default state is seen to be the suggested option of the policy maker, experimenter, or other person with expertise or privileged information (McKenzie, Liersch, & Finkelstein, 2006). For example, in downloading new software, many people elect to use the recommended defaults of the software manufacturer instead of attempting to customize parameters. In such cases, staying with the default provides the dual benefit of conforming to the experts' recommendations and avoiding effortful steps related to identifying the best option. For these reasons, implied recommendations may also lead to default effects.

Loss aversion (Kahneman et al., 1991) refers to preferring to avoid losses over achieving equivalent benefits. For example, the positive value of finding $100 on the street is often less than the negative value of losing $100 from one's pocket. In the context of default effects, loss aversion may create a disproportionately high valuation of potential losses related to leaving the default state and a disproportionately low valuation of potential gains related to non-default states. For this reason, even though staying with the default state may appear to be inconsistent with the actual values of potential actions, it may be consistent with the subjective values of potential actions in light of the premium people seem to place on avoiding losses.

To see how these efforts to explain apparently anomalous behaviors within the valuation calculus might work, consider the following classic demonstration of default effects. In this study, Samuelson and Zeckhauser (1988) asked one group of participants to allocate funds among four investment portfolios that offered economically identical returns. Predictably, each of the portfolios was picked at equal rates. Another group was also asked to allocate funds between the same four portfolios; however, they were told that their funds—that they had inherited from a great uncle—were already invested in one of the portfolios. They were free to keep the funds as they were (the default option) or invest them in one of the other three portfolios. Participants in this group showed a strong preference for the default—they elected to leave the funds in the existing portfolio.

At first glance, the preference for the current portfolio may seem to violate the rules of the valuation calculus. Why should a portfolio appear more attractive just because it happens to be the default? However, the factors described above provide viable explanations that could show participant preferences to be fully consistent with the valuation calculus. For example, it is possible that participants wished to avoid loss aversion associated with leaving the default portfolio. The gains on offer from the other portfolio options may not have the same valuation as the (financially equivalent) losses that could result from leaving the default.

4 | "ANOMALOUS" DEFAULT EFFECTS

Although mental costs, implied recommendations, and loss aversion successfully explain some behaviors that may appear counter-intuitive or anomalous, there is a growing list of consequential and ubiquitous examples of default effects that are not readily explained by any of these factors. For example, patients frequently do not take medications that are important to their health (Harris, Kapor, Lank, Willan, & Houston, 2010), and employees do not start retirement accounts crucial to their financial future (Beshears, Choi, Laibson, & Madrian, 2006).

These behaviors are not easily attributable to subtle drivers of valuation. For example, consider the act of taking medicine that has been paid for, is easily accessible, and has no noticeable negative side effects. There is no loss aversion associated with taking such medicine since there are no losses to be avoided. The implied recommendation, if any, encourages patients to take the medicine and not avoid it. There appear to be significant benefits and minimal costs, and yet patients frequently persist with the (unhealthy) default of not taking their medication (Vermeire, Hearnshaw, ValRoyen, & Denekens, 2001). Similarly, many company retirement plans do not entail a time-consuming application process, out of pocket costs, a high degree of choice difficulty, or potential losses upon leaving the current state (of an uncertain financial future)—and yet a large fraction of employees do not enroll in them (Beshears et al., 2006).

In this article, we propose that these and other behavioral anomalies occur because both stimulus value and action costs (the variables that determine the value of an action) are influenced by cognitive variables that are typically not considered as part of the valuation calculus. We begin with a description of the Attention–Readiness–Motivation (ARM) framework and then present evidence supporting each component of the framework.

5 | THE ARM FRAMEWORK

The valuation calculus is central to motivated behavior. Motivation theorists attempt to explain people's selection of actions, their persistence in those actions, and their vigor in carrying them out (Wigfield & Eccles, 2000). Each of these three facets of motivation involves a choice: a choice of one action over another action, a choice of persisting with the selected action over stopping the selected action, and a choice regarding the extent of resources to dedicate to implementing the selected action—and each of these choices involves the valuation calculus (Atkinson, 1957; Eccles et al., 1983).

According to the ARM framework, the valuation calculus, unlike the calculus pertaining to physical bodies, does not refer to actions that occur a featureless space in which the same variables always result in the same outcomes. Instead, the valuation calculus occurs in the context of brain networks in which changes in key internal variables—*endogenous attention* and *action readiness*—may result in different behavioral outcomes, even without apparent changes to stimulus values and/or action costs (the determinants of the value of a given action).

The first claim made by the ARM framework is that stimulus value is only relevant in the valuation calculus to the extent that *endogenous attention* (Lawrence & Klein, 2013) is directed towards that stimulus. When levels of endogenous attention towards a stimulus are high, stimulus values powerfully shape behavior; when levels of attention are low, stimulus values are less determinative of behavior. On this account, for example, patient non-compliance occurs not because there are subtle drivers of stimulus value or action costs but because patients do not always direct their attention towards the stimulus associated with taking the medicine (and/or the stimulus associated with not taking the medicine).

When considering the role of attention in motivated behavior, it is important to emphasize that attention is not a unitary construct. In this context, we are concerned with *orienting* attention (not alerting or sustained; Petersen & Posner, 2012) of the *endogenous* (not exogenous) variety. Some affectively laden states of the world are evolutionarily "hard-wired" to exogenously elicit attentional and perceptual prioritization (Öhman, Flykt, & Esteves, 2001). However, other stimuli—even stimuli whose effects are equally consequential—do not automatically capture attention. On our account, the valuation of such stimuli requires the implementation of *endogenous* attentional processes. For example, the act of choosing a healthy snack over an unhealthy one often requires attention towards one's eating behavior.

Why might people fail to direct their attention towards stimuli that are important to them? Research on mind wandering (Smallwood & Schooler, 2015) provides one potential explanation for this phenomenon. Stimulus independent thought (mental events that arise without external precedent) has been shown to interfere with the processing of online information—presumably including the valuations of potential actions. Experience sampling studies suggest that up to 50% of waking thought is stimulus independent (McVay, Kane, & Kwapil, 2009). Thus, it is possible that "zoning out" (Smallwood, McSpadden, & Schooler, 2008) prevents endogenous attention from being directed to important stimuli.

The second claim made by the ARM framework is that action costs are influenced by the level of *action readiness* —the ease with which an action may be initiated given the pre-action-launch state of the individual. When levels of readiness for an action are high, the action cost for that action is lower than it would have been if levels of readiness for that action were low.

Among potential actions with apparently undifferentiated action costs, some actions with high readiness may be launched even though their stimulus valuations are not the highest of all potential actions (because their action costs, while apparently undifferentiated from competing actions, are subjectively low); alternatively, some actions with low readiness may not be launched even though their stimulus valuations are the highest of all potential actions (because their action costs, while apparently undifferentiated from competing actions, are subjectively high). On this account, for example, momentum eating occurs not because an additional bite has a greater stimulus value than stopping but because action readiness reduces the action costs of taking another bite (whereas the action of not taking another bite has low action readiness and relatively higher action costs).

Why might levels of action readiness for a particular action vary? Research on repetition priming has revealed that when an object is frequently and/or recently encountered, we become faster and more accurate at identifying it (Henson, Shallice, & Dolan, 2000). In a similar vein, we propose that when an action is frequently and/or recently executed, its action readiness increases (and the costs of performing that action decrease). Readiness for an action may also increase due to the following factors: watching someone perform that action; mentally rehearsing that action; and/or attending to affordances present in a stimulus that are related to that action (Gibson, 1977). Affordances are defined as the properties of a stimulus that suggest the possibility of an action (e.g. the handle of a suitcase may suggest lifting it).

Considering its two main claims together, the ARM framework suggests that in the context of executing an action "A" with a positive stimulus valuation, a person may have high or low levels of endogenous attention and high or low levels of action readiness (see Figure 1). The action "A" is most likely to occur when both endogenous attention and action readiness are high and least likely to occur when both variables are low. If one variable is high and the other is low, then the particular levels of each variable should determine the probability of action execution. The above reasoning regarding an action with a positive stimulus value can be extended to an action with negative stimulus value (say B), since the act of *not* performing B has a positive stimulus value.

6 | THE ROLE OF ENDOGENOUS ATTENTION IN MOTIVATED BEHAVIOR: EMPIRICAL FINDINGS

Recent studies (Suri & Gross, 2015) have directly tested the relationship of endogenous attention towards a stimulus and valuation. In one such study, participants had the choice to approach positive stimuli or avoid negative stimuli (stimuli were images of emotionally evocative pleasant or unpleasant scenes; Lang, Bradley, & Cuthbert, 1999). When asked to choose between viewing one of two stimuli, participants reliably chose (~85% of all trials) to view the more positive (or less negative) stimulus. However, a small change in instructions created a large change in participant behavior: When participants were required to proactively press a button to move from an inferior to superior image

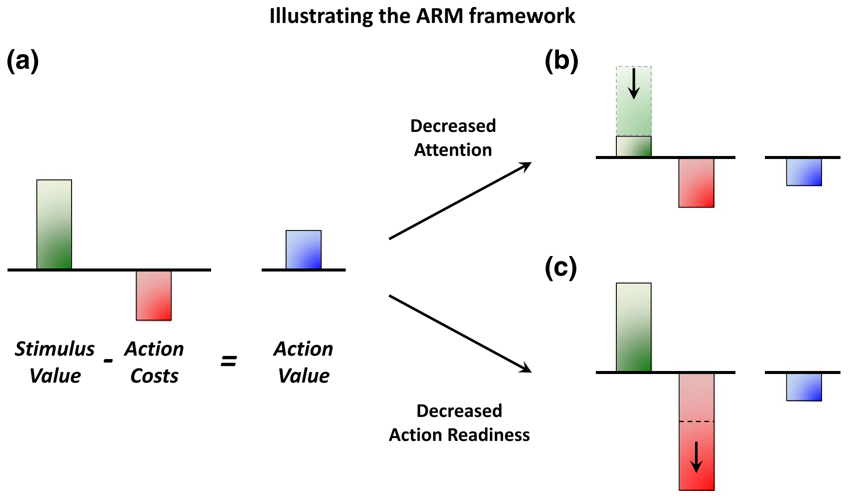

FIGURE 1 The three panels illustratively depict the valuation calculus for the hypothetical action A. The baseline depicts zero values associated with the next best available alternative action to A. In panel (a), the absolute value of Stimulus Value (depicted above the baseline) exceeds the absolute value of Action Costs (below the baseline), and the resulting Action Value is positive (above baseline)—implying that the action is likely to occur. In panel (b), the attention directed towards the medication is reduced which in turn lowers the absolute value of Stimulus Value below the absolute value of Action Costs, resulting in negative Action Value—implying that the action is unlikely to occur. In panel (c), reduced action readiness increases the absolute value of Action Costs resulting in a negative Action Value

(as opposed to being asked to pick one image from a pair), they often persisted with viewing the inferior image and switched to the "better" image infrequently (~30% of all trials), despite the presence of a caption underneath the default image reminding them that they had an option to switch.

One interpretation of this behavior is that endogenous attention was required to proactively press a button to switch images, and in the absence of such attention, participants persisted with viewing inferior images. Support for this hypothesis was provided by placing a red border around the caption reminding participants that they had an option to switch (5 s after trial commencement). This red border facilitated the initiation of endogenous attention, which in turn unlocked the valuation process favoring the viewing of more pleasant images. Image switching rates increased from 29% (without the red border) to 50% (with the red border).

To check whether participants interpreted the red border as an implied recommendation from experimenters, a subsequent study (Suri & Gross, 2015) introduced trials in which a button press resulted in a switch from a "better" image to an inferior image. In these cases, the red border did not increase the switching rate, which lends support to the hypothesis that participant choices could be ascribed to attention-unlocked valuation, but not to implied recommendations.

Additional evidence is provided by a field study (Suri & Gross, 2015) in which a sign that read "APPLES" increased apple sales in company cafeterias. This sign was not designed to affect the valuation of apples (a sign that read "SWEET APPLES" may have increased valuation); rather, it was designed to increase attention towards the apples. In a similar experiment (Suri, Sheppes, Leslie, & Gross, 2014) signs that read "Stairs" and "Stairs or Escalator?" were shown to increase the number of pedestrians choosing to take the stairs at the stair/escalator choice point. These signs were not designed to affect the valuation of taking the stairs (a sign that read "Take the Stairs for your Health" may have increased valuation); rather, it was designed to increase attention towards the stairs.

Several field studies provide additional support for the link between endogenous attention and motivated behavior. For example, preferentially displaying healthy items over unhealthy ones in school cafeteria lines (Hanks, Just, Smith, & Wansink, 2012) increased sales of healthier food items increased by 18% and decreased sales of less healthy food items by 28%. Presumably, the students knew that they had access to the previously preferred non-healthy food items. However, these items did not, on our account, receive enough endogenous attention to be valued and acted upon.

A similar example involved displaying tax-inclusive prices for products subject to sales tax for a 3-week period. This tax-inclusive tax display reduced demand by roughly 8% compared to control products (Chetty, Looney, & Kroft, 2007). Presumably, customers knew that they would have to pay sales tax on their purchases but a lack of orienting attention on that fact led them to purchase items that they otherwise would not have. When taxes were included in the display, the higher price was attended to at the time of the purchasing decision and relatively fewer sales occurred. These field studies often occurred in the context of first-time decisions, suggesting that action readiness was not involved.

7 | THE ROLE OF ACTION READINESS IN MOTIVATED BEHAVIOR: EMPIRICAL FINDINGS

There is substantial evidence that the activation of representations of previously completed actions (i.e. increasing their action readiness) increases the likelihood of their performance. For example, in cases of utilization behavior syndrome (Chapados & Petrides, 2014), observing an object in their environment can cause patients with frontal damage to perform relatively complex actions (e.g. the manipulation of tools) that are sometimes at odds with their stated intentions. Such affordance-related effects are also present in individuals without frontal damage. For example, encountering incidental stimuli that can be gripped potentiates one's tendency to form a grip. This may occur because looking at or recalling a visual object propels afforded actions related to that object (Ellis, 2009). Similarly, in choice response tasks, the mere presence of musical notation affects the responses of musicians, but not non-musicians (Levine, Morsella, & Bargh, 2007). On our account, such phenomena occur because environmental cues increase the action readiness of associated actions.

Additional evidence for the role of action readiness is provided by the task-switching literature (Monsell, 2003) in which studies frequently discriminate between two types of trials: An nth trial is a switch trial if it involves a different task from the n-1th trial, and it is a repeat trial if it involves the same task as the n-1th trial. A large body of evidence has demonstrated that across various types of tasks, performance on switch trials is worse than performance trials (Wasylyshyn, Verhaeghen, & Sliwinski, 2011). While there are several explanations for this phenomenon, a prominent model suggests that repeated trials are more efficient because of transient carry-over of task-set "activation" from trial to trial (Gilbert & Shallice, 2002). This activation-based proposal supports the action readiness account described here.

However, neither utilization behavior nor task switching studies directly test whether action readiness effects could persist in cases that included unambiguous stimulus valuations. To test whether action readiness effects could exist in the presence of putatively stronger stimulus valuations, experimenters (Suri et al., 2013) asked participants to press one button to experience (an unpleasant) electric shock and another button to greatly reduce the probability of experiencing the shock. Not surprisingly over 85% of them elected to press the shock-probability-reducing button. However, a small change in instruction made a large difference in participant behavior: when participants were asked to proactively act to reduce the probability of being shocked (if they did nothing they would be shocked), participants pressed the shock-probability-reducing button in only about half the trials. This was another instance of an apparently "anomalous" (i.e. not explained by valuation-based factors discussed above) default effect.

Two properties of the button presses in the proactive condition suggested that action readiness may have played a role in this behavior (that ran counter to the predictions of models not including action readiness): First, participants pressed the shock-probability-reducing button more in the back-half trials compared to the front-half trials (when act of pressing was less familiar and less action ready). Second, when experimenters *required* participants to press the shock-probability-reducing button in one of two pre-experiment trials, participants pressed the button more throughout the experiment. The experimenters reasoned that this behavior occurred because the early mandatory button press increased action readiness whose effects cascaded throughout the experiment.

Additional support for action readiness comes from the study of action slips—a performance of an action that was not what was intended (Norman, 1981). While action slips may have many causes, many of them are related to the increased action readiness of the erroneous action. For example, William James (1890), famously described the situation a person going to his room to change for dinner and finding himself in bed. In this case, the person completed a behavior that had high action-readiness but otherwise had a negative valuation.

8 | RELATING THE ARM FRAMEWORK TO OTHER BEHAVIORAL CONSTRUCTS

The ARM framework connects to several behavioral constructs. Here, we discuss its connections to habits, psychological inertia, and implementation intentions.

8.1 | ARM and habits

A habit is defined a pre-existing association, strengthened by long-standing repetition, between cue and action (Neal, Wood, & Quinn, 2006). Action readiness, on the other hand, is the ease with which an action may be initiated given the pre-action-launch state of the individual. This readiness may be increased by prior (and recent) repetition, mentally rehearsing an action, watching someone else do the action, or environmental affordances. Action readiness effects have been observed after participants pressed an unfamiliar key a handful of times—which could hardly be labeled as a habit (Suri et al., 2013). However, it is of course possible that sustained action readiness associated with a cue may lead to habit formation over time.

8.2 | ARM and psychological inertia

Prior work has defined psychological inertia as the tendency to maintain the status-quo (Gal, 2006). Individuals may have more or less psychological inertia relative to each other. We propose that psychological inertia is an emergent property of attention and action readiness. In some cases, psychological inertia may also be caused by low levels of attention towards available outcomes in the environment. In other cases, a tendency to have high levels of action readiness across many action contexts would result in high inertia. This readiness may apply to actions or to inactions; thus, individuals with high psychological inertia may persist with the same actions in a given context (e.g. ordering the same meal at a restaurant) or with the same inactions (e.g. not taking medicine beneficial to their health).

8.3 | ARM and implementation intentions

Gollwitzer and his colleagues (1999).have defined implementation intentions as the furnishing of the goal intention with an if–then plan specifying when, where, and how the person will instigate responses that promote goal realization. An implementation intention adds action specificity to goals that may only be represented at a high level of abstraction. Explicitly formulating implementation intentions has been shown to increase goal-directed behavior in a variety of contexts (Gollwitzer, 1999). We propose that the effectiveness of implementation intentions stems from an increase in the action readiness of the various sub-steps required to reach a desired goal (via mentally rehearsing the actions they plan to take to achieve their goal). There is evidence consistent with this proposal (Martiny-Huenger, Martiny, Parks-Stamm, Pfeiffer, & Gollwitzer, 2017; Webb & Sheeran, 2007) which, if proven correct, may provide a potential mechanism underlying implantation intentions.

9 | CONCLUDING REMARKS

In this article, we began by asking why people sometimes act in ways that seem inconsistent with relevant action values. We proposed that several behavioral anomalies—including puzzling instances of default preferences—could not be easily attributed to subtle drivers of valuation and instead ascribed them to the influence of endogenous attention (on stimulus value) and action readiness (on action costs). According to our ARM framework, these two cognitive variables—that are seldom considered to be influencers of putatively affect-driven motivated behavior—are crucial determinants of our actions.

The ARM framework makes two sets of predictions. First, related to attention, it predicts that in many contexts, manipulating attention will lead to changes in value based preferences, even when all other value-related factors are kept constant. Several researchers have demonstrated that merely increasing the time a participant looks at a generally positively valued option (e.g. an object or a face) increases the rate at which that option is chosen (Hare, Malmaud, & Rangel, 2011; Shimojo, Simion, Shimojo, & Scheier, 2003). Relatedly, increasing the salience of particular features has been shown to increase the influence of those features on ultimate choice (Krajbich, Armel, & Rangel, 2010). The ARM framework predicts that such attention-related effects should be seen across most preference-based choice domains. The ARM framework also predicts that if a stimulus or stimulus feature is rated negatively, then increasing attention towards it should decrease the rate at which that option is chosen.

Second, related to action readiness, the ARM framework predicts that any action—whether positively or negatively valued—will be more likely to be completed if it has been recently and frequently completed. The framework makes this prediction even if the action has been completed only once—and cannot be classified as a habit. There is emerging evidence related to this prediction as value-based choices in current trials have been shown to depend on prior trials (Suri, Sheppes, & Gross, 2015).

The ARM framework is predicated on the assumption that the valuation process consists of the maximizing of an objective function (i.e. expected value). It is also possible to conceive of the decision making process occurring via a distributed consensus among parallel processes in a neural network (Hunt & Hayden, 2017). Importantly, the ARM framework also applies under this conception of decision making. In this case, varying levels of attention correspond to varying levels of activation in the input units of the neural network, and varying levels of action readiness correspond to varying weights between cue/action units in the neural network.

In addition to providing insights into variables impacting basic valuation processes and making new predictions, the ARM framework may be applied to change behavior. In their influential book *Nudge*, Thaler and Sunstein (2008) identified several decisions in which individuals could be nudged to select more optimal options as long as these options were made to be the default options. Since then, nudges have been applied to several important behavioral contexts. The examples described in *Nudge* and related papers (Bhargava & Loewenstein, 2015) almost certainly have multiple drivers. However, we believe that the ARM framework may provide a systematic way of creating simple, but effective, nudges. For example, to address patient non-compliance, pharmacists may equip pill bottles by a chip that emits a beep to elicit endogenous attention to the act of taking medicine. Establishing a routine of taking medicine at the same time may increase compliance due to increased action readiness. To increase healthy eating, interventions may promote the level of attention towards healthy foods (e.g. by placing healthy food items in most frequently accessed locations; Gittelsohn, 2012).

Future studies are required to examine the specific nature of endogenous attention's influence on stimulus value and action readiness' influence on action costs. Future studies are also required to investigate how the interaction between endogenous attention and action readiness may interact to influence the probability of occurrence of a motivated action. For example, novel actions may require high levels of endogenous attention whereas more familiar actions (with high action readiness) may occur with very little attention. Finally, future studies must also investigate whether and how the ARM framework may be used to design effective and scalable behavioral interventions.

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