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Anticipatory Control of Approach and Avoidance: An Ideomotor Approach

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Abstract

This article reviews evidence suggesting that the cause of approach and avoidance behavior lies not so much in the presence (i.e., the stimulus) but, rather, in the behavior's anticipated future consequences (i.e., the goal): Approach is motivated by the goal to produce a desired consequence or end-state, while avoidance is motivated by the goal to prevent an undesired consequence or end-state. However, even though approach and avoidance are controlled by goals rather than stimuli, affective stimuli can influence action control by priming associated goals. An integrative ideomotor model of approach and avoidance is presented and discussed.

Keywords
approach–avoidance motivation, goal-directed action, ideomotor theory

One of the best studied animal behaviors is prey-catching and predator-avoidance in frogs and toads (Biersner & Melzack, 1966). Frogs are mainly terrestrial, usually sitting in the open on dry land. When approached by a large object (i.e., a potential predator), they jump quickly into the water; however, when the object is below a critical size (i.e., a potential prey), they snap at it as soon as it is within reach. Thus, simple visual discriminations, performed by specialized detector systems, evoke preprogrammed approach and avoidance responses that enable the frog to survive in its habitat.

It is fair to say that emotion psychology has at times portrayed a picture of human behavior that appears somehow froglike. In analogy to detectors for predators and prey, it is assumed that the human brain is furnished with an affective system that scans the environment for threats and rewards. Once detected, these stimuli have the capability to excite a matching response more or less automatically: approach if the stimulus is "appetitive" and avoidance or escape if it is "aversive." Behavior is thus seen as a mere reaction to appetitive and aversive stimulation—an emotional response that is evoked by motivational processes that translate a stimulus input into a motor output.

Stimulus Control of Approach and Avoidance

This conception of an "emotional response" is deeply rooted in emotion psychology and has had a lasting influence on research on approach and avoidance behavior. Starting with the behaviorist work on Pavlovian reflex conditioning, myriad studies have demonstrated that animals show appetitive reactions to stimuli that are associated with pleasure, but defensive reactions to stimuli associated with pain. In fact, this hedonic principle of behavior organization was so plausible, and the supporting evidence was so convincing, that exceptions to the general rule (e.g., learned helplessness; Maier & Seligman, 1976) were considered more noteworthy than additional confirmation.

Modern research on humans has continued this line with studies on emotional reflex modulation. Investigating the blink reflex that protects the eye, Lang and colleagues have collected an impressive body of evidence showing that the startle blink is potentiated during the processing of (intense) negative compared to pleasant stimuli (Lang, Bradley, & Cuthbert, 1990). Similar observations, but with a reversed emotional potentiation, were found with the postauricular reflex that acts to pull

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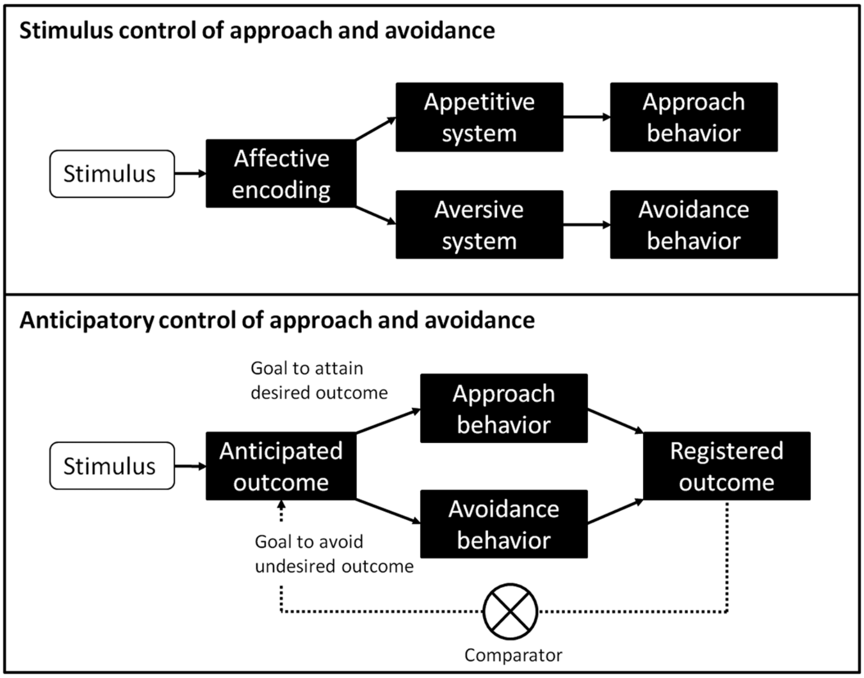

Figure 1. Models of approach and avoidance motivation that emphasize a stimulus control (upper part) and an anticipatory control (lower part) of approach and avoidance behavior.

the ear upward and backward (e.g., Benning, Patrick, & Lang, 2004).

Notably, the idea of a conditioned emotional response was also extended to more complex movements involving the flexor and extensor muscles of the forearm. As forearm flexion is more likely to go along with the acquisition of desired objects than forearm extension, it was hypothesized that, with countless repetitions over a lifetime, arm flexion becomes conditioned to an approach orientation and arm extension to an avoidance orientation (Cacioppo, Priester, & Berntson, 1993). Consistent with this hypothesis, many studies have shown that movements that require forearm flexion (e.g., a lever pull) are initiated faster in response to positive than to negative stimuli, whereas movements involving arm extension (e.g., a lever push) are emitted faster in response to negative than to positive stimuli (e.g., Chen & Bargh, 1999).

How do affective stimuli cause these responses? The most widely embraced model proposes two motivational systems—an appetitive and an aversive system—that translate emotional stimuli into matching responses (Konorski, 1967). As shown in the upper part of Figure 1, this translation process is assumed to proceed in linear stages: After the affective encoding of a stimulus, a matching motivational system is aroused that triggers a behavioral response. Note that this model is not specific for reflexes or particular classes of behaviors; rather, it is assumed that the efferent system as a whole (ranging from simple reflexes to instrumental actions) is tuned to the current status of the central-motivational organization (Lang et al., 1990).

To summarize, much evidence is in line with the idea that emotional stimuli arouse appetitive and aversive motivations and, through these states, specific behavior tendencies. Yet this approach is not without problems—not so much because of the simplicity of the studied behavior, but because of the inadequate characterization of emotional behavior, as stimulus-driven. Indeed, in the remainder of this article we will argue that the cause of most approach and avoidance behavior lies not so much in the presence (i.e., the stimulus) but, rather, in this behavior's anticipated future consequences (i.e., the goal). Our argument comes in two parts. In the first part, we will describe evidence that many movements that are arguably related to approach and avoidance are controlled by action goals. In the second part, we will present a theoretical model that explains how action goals are linked to approach and avoidance behavior, and how stimuli interact with action goals to generate automatic approach and avoidance tendencies.

Goal Control of Approach and Avoidance

The goal dependence of approach–avoidance behavior has been demonstrated by studies that managed to dissociate action goals from the movements carried out to reach them. In an early experiment, Wickens (1938) examined whether specific movements become conditioned to a motivational state when the movement is part of a learnt avoidance response. With one hand resting palm down, participants first learned to avoid making contact with a shock electrode by lifting the middle finger upwards when a shock was signaled. After sufficient training (i.e., conditioning), the hand was turned around with the palm up, so that a flexion now removed the finger from the electrode. Results showed that the participants immediately adjusted their behavior to avoid the shock without additional training. Since antagonistic movements are reciprocally inhibited, it is clear that the flexor movement could not have been part of the originally learned avoidance response. Thus, the movement was controlled by the goal to remove the finger from the electrode rather than a conditioned association with an aversive system.

Flexible behavioral control is also observed in studies that aimed to disentangle effects of arm movements from effects of distance regulation. In one study, pushing and pulling a lever moved an affective word either towards or away from the participant's name that appeared at the center of the computer screen (Markman & Brendl, 2005). Participants moved positive words faster toward than away from their name, while the opposite was true with negative words. Importantly, the same effect was obtained when positive words were moved towards with a lever push (requiring an arm extension) and negative words were moved away with a lever pull (requiring an arm flexion). Thus, action tendencies were controlled by the goal to move stimuli towards and away from their name.

These observations suggest that affective stimuli facilitate any behavior that is in the service of a distance regulation goal. Straightforward evidence for this conclusion comes from studies that assigned approach and avoidance effects to neutral responses like pressing keys on a keyboard. In one study (van Dantzig, Pecher, & Zwaan, 2008), a key press created the visual illusion that the stimulus moved closer to the participant, whereas a press of another key produced the illusion that the stimulus moved away. Other studies presented a manikin as a symbolic representation of the self on the computer screen, and key presses made the virtual manikin run towards and away from a centered affective stimulus (e.g., De Houwer, Crombez, Baeyens, & Hermans, 2001). Regardless of how distance regulation was visualized, a common observation was that positive stimuli facilitated responses that decreased the distance, whereas negative stimuli facilitated responses increasing it. Hence, what mattered was the intended distal effect to approach or avoid, rather than a particular proximal change in spatial distance, suggesting that it is the goal but not the means that is important (Krieglmeyer, De Houwer, & Deutsch, 2011; see also Förster & Friedman, 2013).

Based on these findings, it was argued that distance regulation is at the core of approach and avoidance, with positive emotions evoking an automatic tendency to decrease, and negative emotions to increase the distance. However, several observations suggest that this conception cannot fully capture the nature of affective action tendencies that are observed in these tasks. First, when affective stimuli are moved towards and away from a referent object in laboratory tasks, it makes little difference whether the referent object is a representation of the self, an empty box, or even another negative stimulus; rather, positive stimuli facilitate a movement toward and negative stimuli a movement away, irrespective of which type of object was actually approached and avoided (Proctor & Zhang, 2010; van Dantzig, Zeelenberg, & Pecher, 2009). Thus, it is the cognitive coding of the responses as towards and away from a salient reference—but not distance regulation with respect to a representation of the self—that is responsible for the affective response tendency.

Second, analogous behavioral tendencies were observed with action goals that bear no relation to distance regulation. For instance, arm extensions are facilitated by positive stimuli when referred to as movements in an "upward" direction but delayed when referred to as a movement "away" from the body, while arm flexions are facilitated by negative stimuli when instructed as "downward" movement but delayed when instructed as a movement "towards" the body (Eder & Rothermund, 2008). Thus, action tendencies are controlled by the affective connotation of the instructed movement goal, which was positive in the case of "upwards" and "towards" but negative in the case of "downwards" and "away".[1] If so, any goal-directed behavior that is described and coded in positive or negative terms can be primed by corresponding affective stimuli, irrespective of whether these behaviors do or do not refer to distance regulation.

Further experiments sought for the origin of an action goal's valence (Eder, Rothermund, & De Houwer, 2013). In one experiment, positive words were evaluated faster with a key press that turned the word *on*, whereas negative words were evaluated faster with a key press that turned the word *off*. This suggests that responses became temporally associated with the positive or negative valence implied by turning something on or off, respectively. Interestingly, this pattern was reversed when an aversive noise was turned on and off: Now, positive words were evaluated faster with the key that turned the noise off, while negative words were evaluated faster with the key that turned the noise on. Obviously, the valence of the goal to turn something on or off depended on the affective implication of the produced effect.

Affective response tendencies thus depend on how a response is cognitively represented, which in turn is influenced by its affective consequences. This finding has two important implications: First, if affective consequences become associated with an action's cognitive representation, this knowledge can be used to anticipate this action's affective outcomes. As a result, actions can be selected with respect to their potency to produce a desired outcome (i.e., approach) or to avoid an undesired outcome (i.e., avoidance). Second, this motivational process is not the only process that can cause congruency effects between affective stimuli and response. In fact, experiments have demonstrated that a response to negative stimuli is facilitated even when it generates a clearly aversive effect, like noise (Eder, Rothermund, & De Houwer, 2013), negative pictures (Eder, Rothermund, De Houwer, & Hommel, 2013), or even an electric shock (Beckers, De Houwer, & Eelen, 2002). We will come back to this issue in what follows.

Anticipatory Control of Approach and Avoidance

The evidence discussed so far implies that approach and avoidance need to be defined with respect to the consequences or end-states that are approached or avoided by means of a given behavior. This notion implies that the consequence of an action is anticipated *before* the action is selected, which in turn requires prior learning of action effects. In line with this reasoning, Elsner and Hommel (2001) proposed an ideomotor two-stage model that explains a gradual emergence of action control through associative learning of which sensory effects are produced by what behavior. First, repeated performance of an action creates increasingly strong associations between the representation of the movement and those of its sensory effects. The sensory effects can then act as retrieval cues for the associated movement pattern. As a result, a movement can be selected and initiated by retrieving its effects from memory, thus controlling action in an ideomotor fashion (Hommel, 2009).

Notably, this model was successfully extended to affective sensations that are contingent upon the execution of a response (Beckers et al., 2002; Eder, Rothermund, De Houwer & Hommel, 2013). In a first learning phase, participants could freely choose between two responses, each response producing a different affective outcome (e.g., the presentation of pleasant and unpleasant pictures). In a subsequent test phase, the same actions were emitted in response to a neutral feature of affective stimuli. Results showed that responses with affectively congruent effects were emitted faster than responses with affectively incongruent effects, irrespective of whether the produced effect was pleasant or unpleasant. Given the relative facilitation of a response that produced an aversive consequence (i.e., punishment), it is clear that the process responsible for the affective congruency effect was not hedonically motivated; rather, this effect provides strong evidence for an ideomotor approach, which assumes that the priming of a response effect in memory directly excites the corresponding response (even in the case of an unpleasant effect).

However, the hedonic implication of the produced effect did influence response selection in an experiment in which the forced-choice test was replaced by a free-choice test (Eder, et al., 2013). In this test situation, responses associated with pleasant effects were preferred over responses producing unpleasant effects, in line with the rich animal and human research literature on classic reinforcement learning. Notably, this hedonic effect was observed in addition to, and independently of, an affective congruency effect between stimuli and response effects. Thus, a hedonic evaluation of anticipated action outcomes constrains behavioral impulses induced by ideomotor processes, enhancing responses that produce a desired effect while suppressing responses that generate an undesired effect. In this way, the hedonic process may support an acquisition of alternative responses that do not lead to punishment in a given context (i.e., avoidance).

According to the present model, approach and avoidance behavior is thus controlled by anticipations of desired and undesired end-states (or outcomes) that are approached or avoided by means of specific behavior (see lower part of Figure 1). When the anticipated end-state is a desired outcome, a movement is triggered that is associated with producing this end-state. When the anticipated outcome is undesired, however, responses producing this outcome are suppressed by the hedonic process, and alternative responses are triggered to the degree that they are associated with the avoidance of the undesired outcome. After response execution, the outcome is compared with the anticipated outcome in an action-monitoring process. The result is a cybernetic control system which aims at reducing (in the case of approach) or increasing (in the case of avoidance) the discrepancy between the anticipated and achieved end-state (cf. Carver & Scheier, 1998).

Obviously, this model would be insufficient should it fail to take motivational properties of stimuli into account. In fact, one reason why researchers feel so compelled to approach and avoidance motivations is that voluntary behavior is often so difficult to control in the presence of emotional stimuli—just take the examples of being tempted to eat fatty food or being reluctant to grab a harmless spider. Without doubt, stimuli have a powerful influence on action control in these situations, which must be accounted for.

According to the present model, these stimulus-triggered motivations are incorporated by the assumption that representations of end-states are not only aroused by internal processes (during action planning), but also by associations with external stimuli. In fact, the evidence that affective stimuli prime responses with affectively congruent outcomes already points in this direction. More direct evidence comes, however, from learning experiments in which control over an instrumental response is transferred to a stimulus when the stimulus signals an outcome that is associated with the response—a phenomenon that was termed outcome-specific Pavlovian-to-instrumental transfer of control (specific PIT; Urcuioli, 2005). In a typical demonstration of specific PIT, relations between stimuli and differential outcomes (Pavlovian learning: S1–O1, S2–O2) and relations between responses and outcomes (instrumental learning: R1–O1, R2–O2) are established in separate training sessions. In a transfer test, both responses are then made available in extinction, and the preference for a specific response is measured in the presence of each conditioned stimulus (i.e., S1: R1 vs. R2; S2: R1 vs. R2). The typical result is a preference for the response whose outcome is signaled by the Pavlovian cue. Paredes-Olay, Abad, Gámez, and Rosas (2002), for instance, designed a video game in which participants had to defend "Andalusia" from navy and air force attacks. First, participants learned the relationship between two instrumental responses and two avoidance outcomes (destruction of the ships or destruction of the planes). Then they learned to predict which of two different stimuli predicted which outcome (Pavlovian learning). Finally, they had the opportunity of making either of the two instrumental responses in the presence of either stimulus (transfer phase). Results showed a preference for the response that shared an outcome with the current stimulus, suggesting that the avoidance response was triggered by the accompanying stimulus. Analogous transfer effects were observed with contingencies that involved food, money, and even drugs, showing that specific PIT is a general phenomenon that can account for a broad range of impulsive reactions.[2]

What makes stimuli "appetitive" and "aversive" in this model is their relation to representations of emotional outcomes that are shared with actions operating on those outcomes. A piece of cake, say, may arouse an anticipatory image of eating it, which in turn activates the behavior that was associated with cake-eating in the past (e.g., grasping and moving the cake into the mouth). This entire process is potentiated by an enhanced evaluation of cake-eating in a hungry state. Analogously, a dog that is snarling at you with exposed fangs may arouse an anticipatory image of being bitten, which in turn activates a behavior that was successful in avoiding animal bites in the past (e.g., keeping a safe distance). By activating representations of shared outcomes, stimuli thus can trigger approach and avoidance actions that were instrumental in dealing with these states.

Concluding Remarks

Approach and avoidance can be conceptualized in many ways, ranging from low-level descriptions of particular muscle activities to high-level descriptions of behavioral functions like growth, promotion, and survival. We argue that approach and avoidance motivation is best understood by relating them to the anticipated effects of, and thus the intended goals underlying, approach–avoidance behavior. While approach and avoidance behavior is controlled by goals, stimuli can bias behavioral control by priming particular, stimulus-related goals. By understanding how goals make our body move, we may thus also reach a better understanding of how emotions make us behave the way they do.

Notes

1 There is evidence that the distance to affective stimuli is regulated even without a corresponding task instruction (Krieglmeyer, Deutsch, De Houwer, & De Raedt, 2010; but see also Lavender & Hommel, 2007), suggesting that distance-regulation goals are activated automatically when spatial motion is rendered salient by task features (see Krieglmeyer, De Houwer, & Deutsch, 2013).

2 There exists also a second form of transfer, termed “general PIT,” in which a Pavlovian cue increases the vigor of an ongoing operant response when both contingencies involve appetitive or aversive stimuli, whereas it decreases the response strength when one of the contingencies is aversive and the other is appetitive. We attribute this form of transfer to an interaction between affective feature codes that are accessed by representations of stimuli and responses in a common coding domain (Eder & Klauer, 2009).

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