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Key words: Approach/Avoidance, Emotion, Motion Congruency, Action Effects

Word Count: 4159

Approach and Avoidance as Action Effects

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Abstract

Numerous studies use arm movements (arm flexion and extension) to investigate the interaction between emotional stimuli and approach/avoidance behavior. In many experiments, however, these arm movements are ambiguous. Arm flexion can be interpreted either as pulling (approach) or as withdrawing (avoidance). On the contrary, arm extension can be interpreted as reaching (approach) or as pushing (avoidance). This ambiguity can be resolved by regarding approach and avoidance as flexible action plans that are represented in terms of their effects. Approach actions *reduce* the distance between a stimulus and the self, whereas avoidance actions *increase* that distance.

In this view, action effects are an integral part of the representation of an action. As a result, a neutral action can become an approach or avoidance reaction if it repeatedly results in decreasing or increasing the distance to a valenced stimulus. This hypothesis was tested in the current study. Participants responded to positive and negative words using key-presses. These ‘neutral’ responses (not involving arm flexion or extension) were consistently followed by a stimulus movement toward or away from the participant. Responses to emotional words were faster when the response’s effect was congruent with stimulus valence, suggesting that approach/avoidance actions are indeed defined in terms of their outcomes.

Approach and Avoidance as Action Effects

Imagine that while reading this paper, suddenly, from the corner of your eye, you noticed a large hairy spider crawl onto it. How would you respond? You might react by withdrawing your hands from the paper, or by pushing it away. Withdrawing your hands from the paper involves arm flexion. Pushing it away involves arm extension. Although these responses involve opposite arm movements, both can be classified as avoidance behavior. The same two arm movements, however, also are often executed in response to positive stimuli. People extend their arm when they reach for a desirable object, and they flex their arm when they pull a desirable object toward themselves.

Thus, two opposite movements, arm flexion and arm extension, both can be defined either as approach or as avoidance. This ambiguity also emerges from the extensive literature on the topic of approach/avoidance behavior. Numerous researchers have studied how affective stimuli trigger approach and avoidance reactions. They have approached the topic from various angles, including a cognitive perspective (e.g. Lavender & Hommel, 2007), a social perspective (Strack & Deutsch, 2004; Wentura, Rothermund, & Bak, 2000), a personality perspective (Puca, Rinkenauer, & Breidenstein, 2006), and a clinical perspective (Rinck & Becker, 2007). Researchers have used different types of affective stimuli, such as valenced words (Chen & Bargh, 1999), facial expressions (Marsh, Kleck, & Ambady, 2005; Rotteveel & Phaf, 2004), abstract images (Duckworth, Bargh, Garcia, & Chaiken, 2002), pictures of objects and scenes (Lavender & Hommel, 2007) and pictures of spiders (Rinck & Becker, 2007). Despite the differences in focus, methodology and materials, these studies all converge on the point that they use arm movements as the behavioral measure of interest. All studies show affective stimulus-response congruency effects: positive words elicit faster approach reactions than avoidance reactions, and negative words elicit faster avoidance reactions than approach reactions. However, the mapping of approach and avoidance on arm movements is inconsistent. Whereas some researchers interpret arm extension as an avoidance reaction and arm flexion as an approach reaction, others use the opposite mapping. For example, in the seminal study of Chen and Bargh (1999), participants responded to positive and negative words by pushing or pulling a lever. Pushing the lever was defined as an avoidance response, and pulling was defined as an approach response. Responses to positive words were faster when the reaction involved a pulling motion, whereas responses to negative words were faster when a pushing motion was performed.

Chen and Bargh (1999) interpreted these results as evidence that valenced stimuli automatically activate particular muscular patterns (arm flexion and extension) associated with approach or avoidance. However, as argued above, arm flexion can also be associated with avoidance (withdrawal from an aversive stimulus) and arm extension can be associated with approach (reaching for a desirable stimulus). For example, in a study by Wentura et al. (2000) participants were instructed to either press or release a button whenever a stimulus (a positive or negative word) was presented on the computer screen. The button was placed on the screen, near the location where the words appeared. Therefore, button presses, involving arm extension, were defined as approaching the word. Button releases, involving arm flexion, were defined as withdrawing from the word. Participants responded faster to positive words when they pressed the button than when they released the button. Conversely, they responded faster to negative words when they released the button than when they pressed it.

Although the results of this study were interpreted in terms of approach and avoidance, they are diametrically opposite to the findings of the studies of Chen and Bargh (1999) and others (e.g. Rotteveel & Phaf, 2004). Consequently, arm flexion and extension cannot be unambiguously connected to either approach or avoidance behavior.

Recently, various researchers have proposed that this ambiguity can be solved by defining approach and avoidance in terms of their effects (e.g. Puca et al., 2006; Seibt, Neumann, Nussinson, & Strack, in press; Strack & Deutsch, 2004). Arm movements may in themselves be ambiguous, but their perceivable consequences are not. Rather than being associated with particular muscular patterns, approach and avoidance reactions should be defined as flexible action plans, represented in terms of their perceivable effects. Approach reactions *reduce* the distance between a stimulus and oneself, whereas avoidance actions *increase* that distance. For example, faced with a spider sitting on a paper in your hands, you could effectively increase the distance between that spider and yourself by pushing the paper away, or by withdrawing your hands from the paper.

During everyday interaction with objects in the environment, arm movements usually result in clearly perceivable effects. However, in an experimental setting, the effects of one’s actions are often not so evident. Typically, participants respond to stimuli (words or pictures) appearing on a computer screen by making an unrelated movement; they move a joystick forward or backward or press a button placed nearby or far away. In most experiments, this does not result in actually bringing the stimulus nearer or farther away, which makes the response ambiguous and open for various interpretations. For example, moving a joystick forward can be interpreted as reaching for the stimulus or pushing it away. Moving a joystick backward can be interpreted as pulling the stimulus closer or withdrawing from it.

The ambiguity can be resolved when the action is followed by a clear effect. For example, consider again the study by Wentura et al. (2000), in which participants responded to valenced words by pressing or releasing a button fixed on the computer screen. Following a button press (approach), the word size increased gradually, creating the illusion that the word was moving toward the participant. This response thus resulted in the perception of a decrease in distance between the stimulus and oneself. In contrast, following a button release (avoidance), word size decreased, which made the word appear to move away. This response thus resulted in the perception of an increasing distance.

If approach and avoidance actions are indeed represented in terms of their effects, then any action could potentially become an approach or avoidance reaction, as long as that action consistently resulted in decreasing or increasing the distance between a stimulus and oneself. As a consequence, new affective stimulus-response congruency effects could emerge. Actions followed by a decreasing distance would be performed faster in response to positive stimuli and actions followed by an increasing distance would be performed faster in response to negative stimuli. This hypothesis was addressed in the current experiment. The purpose of this study was to show that neutral responses (not involving arm flexion or extension) become approach or avoidance reactions when they are repeatedly followed by a stimulus movement toward or away from oneself. Participants responded to positive, negative and neutral words by pressing one of two keys on the keyboard. Critically, these responses did not involve arm flexion or arm extension. However, each response resulted in a clear effect. Following a key-press, the stimulus word either moved toward the participant or away from the participant. A particular response always resulted in a motion in the same direction, thereby causing a strong association between the response and its effect. As a result of the consistent pairing of a response with a specific effect, this effect would become incorporated in the representation of the response. Consequently, we expected to find an interaction between word valence and movement direction. Responses to positive words should be faster when they result in a stimulus movement toward the participant than in a movement away from the participant. Conversely, responses to negative words should be faster when resulting in an away movement than in a toward movement.

The aim of this study was to show that action effects not only constrain the interpretation of ambiguous movements, as demonstrated in previous studies, but that they are an integral part of the representation of actions. We suggest that perceiving the effects of a neutral response is sufficient to turn that response into an approach or avoidance action. As a result, when this action is performed in response to emotional stimuli, affective congruency effects may emerge.

Method

Participants

Fifty-six undergraduates from Florida State University took part in the experiment in return for course credits.

Procedure and materials

A total of 128 English words were selected from a normed list. There were thirty-two positive words, thirty-two negative words, and sixty-four neutral words. Most of the words were nouns, concrete (e.g. 'funeral', 'clock') as well as abstract (e.g. 'peace', 'phase'), but there also were some verbs (e.g. 'kiss', 'mutilate') and adjectives (e.g. 'romantic', 'yellow'). Average word length and word frequency, taken from the CELEX database (Baayen, Piepenbrock, & van Rijn, 1993), did not differ between the word types.

Participants were seated approximately 50 cm from a 15-inch computer screen, which displayed a corridor, producing an illusion of depth (based on the setup of Markman & Brendl, 2005). Target words were presented in the center of the corridor (see Figure 1). Participants were instructed to judge whether the words were emotional or neutral, by pressing one of two keys on the keyboard (Z-key and M-key). Critically, key presses always resulted in a consistent motion of the target word, either toward the participant or away from the participant. The instruction emphasized that words had to be moved according to their emotional value. In the *emotional toward/neutral away* condition, participants were instructed to move emotional words toward themselves, and to move neutral words away from themselves. In the *emotional away/neutral toward* condition, participants received the opposite instruction. They were told to move emotional words away, and to move neutral words toward themselves.

(Figure 1 about here)

The experiment consisted of two instructional blocks, with the order of instructions counterbalanced between participants. Half of the participants first received the emotional toward/neutral away instruction, followed by the emotional away/neutral toward instruction. The other half of the participants received the instructions in the opposite order.

Mapping of the Z- and M-key to responses was counterbalanced between participants. Each key was consistently associated with a particular motion. For half of the participants, the M-key was followed by a toward motion and the Z-key was followed by an away motion. The opposite mapping was used for the other half of the participants. In addition, two different counterbalanced stimulus lists were created for presentation during the first and second instructional block. This resulted in a total of eight different counterbalanced versions.

Each trial started with the presentation of the target word in the center of the screen, remaining visible until the participant made a response or until 3000 ms had passed. Each response was followed by a stimulus movement with a duration of 250 ms. A toward movement was simulated by gradually increasing the size of the word and moving it slightly downward. An away movement was simulated by decreasing the size of the word and moving it slightly upward. To check whether these manipulations indeed resulted in the impression of forward and backward movement, five independent judges were asked to interpret the perceptions. Answering the very general question to “describe what you see”, each judge spontaneously mentioned the intended directions of motion.

Following an incorrect response, the text “ERROR” was presented for 1500 ms in red uppercase letters. After a delay of 500 ms during which only the corridor was visible, the next trial was initiated.

The experiment consisted of four experimental blocks of trials, each consisting of 32 trials. The first two trials of each block were fillers, serving as warm-up trials. The experiment started with a general instruction, followed by a practice block. Following the practice block, two experimental blocks were presented. After each block, participants could take a short break. They received feedback on their performance in the most recent block. If they had made fewer than four errors, they were commended on their performance. If they had made four or more errors, they were urged to be more accurate in the next block. After two blocks, the instruction was reversed. Participants who had first received the emotional toward/neutral away instruction now received the emotional away/neutral toward instruction. The other participants received the opposite instruction. A second practice block was presented to familiarize participants with the new instruction, followed by the two final blocks. When the experiment was finished, participants were debriefed and thanked.

Results

Items with an error rate higher than 20% were removed from the analysis. This resulted in the exclusion of 6 of the valenced items (3 positive and 3 negative items). Incorrect responses were removed from the analysis. In addition, response times more than 2 standard deviations from the subject’s condition mean were considered outliers and removed. In total, 6 % of the data was excluded because of errors and 5 % was removed because of outlying reaction times. The data were analyzed by a 2 x 2 ANOVA, with Word Valence (positive vs. negative) and Motion Direction (toward vs. away) as within-participant factors. The results of this analysis are shown in Table 1.

(Table 1 about here)

The predicted interaction between word valence and direction of motion was significant, $F(1,55) = 7.5$, $p < .01$, $\eta^2 = .12$. Responses to positive words were faster when they resulted in a stimulus movement toward the participant than in a movement away from the participant, whereas responses to negative words were faster when they resulted in a movement away from the participant than in a movement toward the participant. In addition, there was a main effect of valence. Overall, responses to positive words were 22 ms faster (M = 654, SE = 12.0) than responses to negative words (M = 676, SE = 10.9), $F(1,55) = 7.3$, $p < .01$, $\eta^2 = .12$. This main effect of valence is in line with the results of other studies, using lexical decision or valence judgment tasks (e.g. Meier & Robinson, 2004; Seibt, Neumann, Nussinson, & Strack, in press; Wentura, Rothermund, & Bak, 2000). If we correct for this effect by adding 22 ms to the RTs of the positive items, a cross-over interaction pattern appears. In the toward condition, the positive items are faster than the negative items. In the away condition, the negative items are faster than the positive items.

With respect to the error scores, none of the main effects nor the interaction effect was significant (all *F*'s < 1). This suggests that the effect found in the reaction times was not due to a speed-accuracy trade-off.

Discussion

Previous studies have shown that arm movements cannot be unambiguously connected to approach or avoidance behavior. Extending one's arm can either be part of an approach movement (as in reaching for a desirable stimulus) or of an avoidance movement (as in pushing an aversive stimulus away). On the other hand, flexing one's arm can also be part of either approach (as in pulling a desirable stimulus toward oneself) or avoidance (as in withdrawing from an aversive stimulus).

In the present study, we tried to resolve the ambiguity by interpreting the actions in terms of their effects, rather than in terms of their actual physical properties (see also Rinck & Becker, 2007). After all, both approach actions (reaching for a stimulus and pulling it towards oneself) *decrease* the distance between oneself and the stimulus. In contrast, both avoidance actions (pushing a stimulus away and withdrawing from it) *increase* the distance between oneself and the stimulus. When these arm movements are executed during an experiment, however, they typically do not lead to clearly perceivable effects. This makes them ambiguous and open to cognitive interpretation. In those situations, instructing the participants to interpret their responses either as approach or as avoidance can strongly affect the results, as demonstrated by Seibt et al. (in press). They instructed participants to respond to emotional words by pushing or pulling a joystick. Importantly, instruction was given either with reference to the self, or with reference to the word. In the self reference condition, participants imagined pulling the word toward themselves or pushing it away from themselves. In the word reference condition, they imagined pulling their hand away from the word or reaching for the word. The same joystick movement could thus be interpreted as approach or avoidance. This resulted in a significant three-way interaction between word valence, motion, and instruction. Responses interpreted as toward movements (toward the body *or* toward the word) were executed faster in response to positive words, whereas responses interpreted as away movements were executed faster in response to negative words. This indicates that the responses to a large degree derive their meaning from the conscious interpretation given to them.

However, the cognitive interpretation of an action can be overridden by perceiving the effect of that action. The strength of the perceptual effect has been demonstrated by Rinck &

Becker (2007), who studied approach and avoidance behavior in people with spider phobia. In their experiment, spider phobics responded to pictures of spiders and neutral pictures by moving a joystick. Pulling the joystick increased the size of the picture, whereas pushing decreased picture size. Spider phobics responded faster to the spider pictures by pushing than by pulling the joystick. In a second experiment, the instructions were given with reference to the picture, rather than to the body. Thus, pulling the joystick was described as pulling it away from the picture, and pushing the joystick was described as pushing it toward the picture. The perceptual consequences of the actions, however, were not altered. Pulling the joystick still resulted in a growing picture, whereas pushing resulted in a shrinking picture. Reframing the instruction did not affect the results. Spider fearfuls were still faster to push the joystick in response to spider pictures. This suggests that the cognitive interpretation of the arm movements is overridden by the perceptual consequences of those movements.

Clearly, action effects play an important role in creating affective stimulus-response congruency effects. But what exactly is the mechanism underlying these effects? In other words, how do emotional stimuli trigger approach or avoidance behavior? According to a recent influential theory by Strack and Deutsch (2004), behavior is controlled by two different, interacting systems; a reflective, rule-based system, and an impulsive, associative system. These systems operate in parallel and compete for the control of behavior. In the reflective system, behavior is the result of deliberate decisions, derived from rational knowledge processing. In the impulsive system, on the other hand, behavior is activated through spreading of activation between associated nodes of information. Automatic approach and avoidance reactions are thought to be the result from processing in the impulsive system. According to Strack and Deutsch (2004), the impulsive system can assume two different *motivational orientations;* it can either be oriented toward approach or toward avoidance. An approach orientation is defined as “a preparedness to decrease the distance between the person and an aspect of the environment". An avoidance motivation is defined as "a preparedness to increase the distance between the person and the environment" (Strack & Deutsch, 2004, p. 231). These motivational orientations are associated bilaterally with the processing of affective information and with the activation of approach and avoidance behavior. This means that a motivational orientation can be elicited by processing affective information or by executing approach or avoidance behavior. In turn, when a particular motivational orientation is activated, this facilitates the processing of congruent information and the execution of congruent behavior. As a result of these bidirectional connections, affective stimuli can trigger approach or avoidance behavior, mediated by the motivational orientation of the impulsive system. Processing a positive stimulus, for example, orients the impulsive system toward approach. As a result, the execution of approach behavior is facilitated. In sum, this theory supposes that affective stimulus-response congruency effects are the result of associative processing in the impulsive system. An affective stimulus orients the system toward approach or avoidance, thereby eliciting the preparedness to reduce or increase the distance to that stimulus.

An alternative explanation for affective congruency effects is provided by the Theory of Event Coding (TEC) (Hommel, Müsseler, Aschersleben, & Prinz, 2001). This theory assumes that actions are represented by distributed patterns of features; so called *feature codes*. Importantly, these feature codes represent actions in terms of their perceivable effects in the distal environment, rather than the physical properties of the actual movement. This idea is based on the *ideomotor principle*, first proposed by 19th century scientists such as Lotze and James, among others (see Stock & Stock, 2004, for a historical overview). According to the ideomotor principle, when one executes a particular action, the motor pattern is automatically associated to the perceptual input representing the action's effects. On later occasions, the motor pattern can be triggered by the representation of the effect. In this way, thinking about the intended effect of an action primes the motor pattern that will lead to that effect.

The idea of *distal coding* implies that representing an action is very similar to representing a sensory event; both essentially involve activating perceptual feature codes. This explains how these two types of processing can interact. For example, (partial) overlap between the feature codes of a stimulus and a response will speed up the response, as demonstrated by the Simon effect. In a typical Simon task, participants respond to a particular feature of a stimulus (e.g. its color) by performing a response with their left or right hand. The location of the stimulus, even though irrelevant for the task, affects the response, such that responses are faster when the location of the response and the location of the stimulus are congruent than when they are incongruent.

Drawing upon this notion of feature overlap, The Theory of Event Coding can provide an alternative explanation for affective motion-congruency effects by assuming the existence of *affective features* (see also Beckers, de Houwer, & Eelen, 2002; Lavender & Hommel, 2007). An emotional stimulus may evoke a feature code that not only involves perceptual features such as color, location and size, but also contains an affective feature representing its emotional valence. Similarly, an action that results in a pleasant or unpleasant effect may activate, among other features, an affective feature to represent the valence of that effect (resembling Damasio's (1994) notion of *somatic markers*).

Approach and avoidance actions are likely candidates for this type of affective coding. Approach actions, typically resulting in bringing a desired object closer, are associated with a positive effect, and are accordingly coded as positive. Conversely, avoidance actions are generally performed in response to an aversive stimulus, and may therefore be coded as negative. Following this reasoning, affective congruency effects can be explained by affective feature overlap between stimuli and responses. Perceiving a positive stimulus will activate the feature <positive>. When this feature is also part of the feature code of the required response, as in an approach reaction, the execution of that response may be facilitated. When, on the other hand, the feature <positive> is not part of the required response, as in avoidance, the execution of the response may be hindered.

Thus, overlap between the affective code of a response and that of a stimulus may lead to affective congruency effects, as demonstrated by Beckers, De Houwer & Eelen (2002). In their experiment, participants responded to positive and negative words by moving a response button up or down. In a task prior to the actual experiment, one of the responses had been consistently followed by a mild electroshock, whereas the other response was never followed by a shock. The response that was associated with the electroshock hence received a negative connotation. Consequently, the negatively connotated response was performed faster in reaction to negative words, whereas the positively connotated response was faster in reaction to positive words. This study illustrates how intrinsically neutral responses can acquire affective connotations when they consistently result in positive or negative effects.

Summarizing, the Theory of Event Coding explains affective congruency effects as a result of feature overlap between the affective codes representing stimuli and responses. Stimuli and responses are represented in a common representational space, and interact with each other directly. The motivational orientation hypothesis, on the other hand, assumes an indirect relation between stimuli and responses. According to this theory, the interaction between stimuli and responses is mediated by the motivational orientation of the impulsive system. Emotional stimuli orient the impulsive system toward approach or avoidance. This motivational orientation leads to the activation of behavior resulting in actual approach or avoidance.

Both theories, however, emphasize that actions are represented in terms of their *effects*. This implies that a neutral action could become an approach or avoidance reaction if it repeatedly resulted in decreasing or increasing the distance toward a stimulus. The data of the current study confirm this hypothesis. Neutral responses that resulted in a stimulus movement toward or away from the participant became associated with approach or avoidance, respectively. This finding suggests that the perceptual and affective consequences of an action are integral to the representation of that action. As a result, action effects constrain the interpretation of ambiguous movements. Moreover, they can turn neutral movements into valenced actions.

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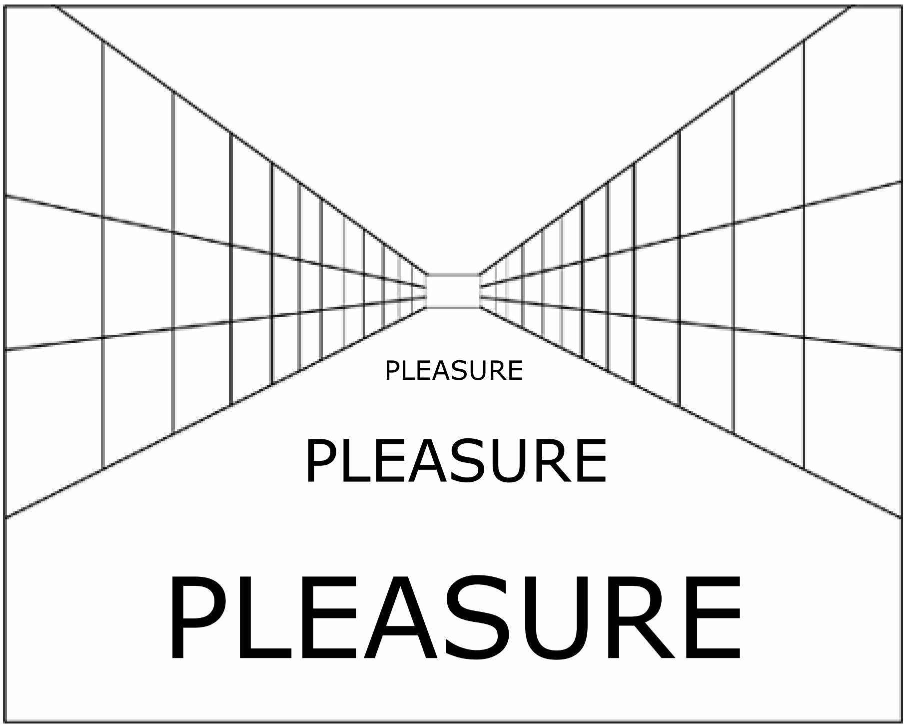
Table 1

Mean Reaction Times (in Milliseconds) and Error Rates (in Percentages) as a Function of Word Valence and Movement Direction (Standard Errors are in Parentheses).

	Reaction Times		Error Rates	
Word Valence	Toward	Away	Toward	Away
Positive	642 (11.5)	667 (16.3)	5.8 (.81)	5.4 (.89)
Negative	681 (11.4)	672 (13.3)	5.4 (.85)	4.0 (.81)

Figure 1. Example of an experimental item, the word is presented at the initial central location, and at the two most extreme locations (front and back).



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