

APPROACH/AVOIDANCE-RELATED MOTOR ACTIONS AND THE PROCESSING OF AFFECTIVE STIMULI: INCONGRUENCY EFFECTS IN AUTOMATIC ATTENTION ALLOCATION

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Two experiments investigated the influence of approach/avoidance-related motor actions on attention allocation to affective stimuli. Employing a modified visual search paradigm, Experiment 1 demonstrated that orientation-incongruent stimuli have a stronger attention grabbing power than orientation-congruent stimuli. Using a dual-task paradigm, Experiment 2 extended these findings by showing that incongruency effects in attention allocation mirror differences in the attentional resources required to encode affective information, such that orientation-incongruent stimuli require more attentional capacity than orientation-congruent stimuli. Interestingly, effects were generally stronger for positive as compared to negative stimuli, and for approach- as compared to avoidance-related motor actions. Functional and theoretical implications are discussed.

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Attention is naturally selective. If every stimulus that enters our perceptual field was subject to higher-order cognitive processing, we would probably face an informational overload, such that adequate reactions to the environment would be strongly undermined. The functional value of selective attention is to reduce this overload, such that adaptive behavior is facilitated and efficient goal pursuit is possible (for a review, see Johnston & Dark, 1986).

First and foremost, efficient goal pursuit calls for selective attention to stimuli that are relevant to achieve the goal (e.g., Aarts, Dijksterhuis, & De Vries, 2001; Moskowitz, 2002). Such processes of selective attention keep the focus on requirements to achieve the goal, and protect goal pursuit from distracting influences. However, even when a stimulus is goal-relevant, it can still be congruent or incongruent with that goal. For example, both positive and negative features of an object are relevant for the tendency to approach this object. However, whereas positive characteristics are clearly congruent with a behavioral tendency of approach, negative characteristics are obviously incongruent with this tendency.

The main objective of the present research was to investigate the influence of approach/avoidance-related motor actions on selective attention to positive versus negative stimuli (see Gray, 1990; Lang, 1995). From a functional perspective, this question seems important because selective attention to stimuli that are congruent or incongruent with a given behavioral orientation may either facilitate or inhibit the current action, and thus effective goal pursuit. For instance, selective attention to orientation-congruent stimuli may further enhance a given behavioral tendency to approach or avoid an object. From this point of view, selective attention to orientation-congruent stimuli may be regarded as functional because it promotes the current action focus. At the same time, however, selective attention to orientation-congruent stimuli can lead to self-perpetuating feedback loops, such that alternative information that could lead to a change of the current orientation might not be recognized. From this perspective, selective attention to orientation-congruent stimuli may be regarded as dysfunctional because of the disregulation of a triggered behavioral tendency. Drawing on these considerations, the main goal of the

present studies was to investigate whether approach/avoidance-related motor actions lead to selective attention to positive versus negative stimuli, and whether such effects imply selectivity with regard to orientation-congruent or orientation-incongruent stimuli.

MOTOR ACTIONS AND THE PROCESSING OF AFFECTIVE STIMULI

The present assumption that approach/avoidance-related motor actions might influence attention to affective stimuli is based on previous evidence for motor congruency effects in the encoding of affective information (for reviews, see Neumann, Förster, & Strack, 2003; Strack & Deutsch, 2004). Specifically, it has been demonstrated that motor actions of approach (e.g., pulling an object toward the body) facilitate the encoding of positive information, whereas motor actions of avoidance (e.g., pushing an object away from the body) facilitate the encoding of negative information. Neumann and Strack (2000), for example, demonstrated that participants engaging in approach-related motor actions were faster in categorizing positive than negative words in a lexical decision task. Participants engaging in avoidance-related motor actions, in contrast, were faster in categorizing negative than positive words. In a similar vein, Förster and Strack (1996) found that participants engaging in approach-related motor actions exhibited a better recognition performance for positive as compared to negative adjectives. Participants engaging in avoidance-related motor actions, in contrast, showed a better recognition performance for negative as compared to positive adjectives (see also Förster & Strack, 1997, 1998). These findings are usually explained by the natural co-occurrence between the encoding of affective information and the resulting motor actions of approach or avoidance (Neumann et al., 2003; Strack & Deutsch, 2004). Specifically, a number of studies have demonstrated that the encoding of emotional stimuli facilitates affectively congruent motor actions, such that positive stimuli lead to spontaneous motor actions of approach whereas negative stimuli lead to spontaneous motor actions of avoidance (e.g., Chen & Bargh, 1999; Duckworth, Bargh, Garcia, & Chaiken, 2002; Lang, Bradley, & Cuthbert, 1990; Solarz, 1960). Hence, the behavioral ten-

dencies resulting from the encoding of affective stimuli may become sufficient to inversely induce a corresponding processing preparedness (see Bruner, 1957). This processing preparedness, in turn, may reduce the cognitive capacity required for the encoding of affectively congruent stimuli, but increase the capacity required for the encoding of affectively incongruent stimuli (Neumann, Förster, & Strack, 2003; Strack & Deutsch, 2004).

Based on Logan's (2002) instance theory of attention, we argue that attention to and encoding of affective stimuli are strongly intertwined. Specifically, Logan proposed that "attention selects objects by categorizing them [and] objects are categorized by attending to them" (p. 376). This idea can be traced back to William James, who argued that "the effort to attend [...] consists in nothing more nor less than the effort to form as clear an idea as is possible of what is there portrayed" (James, 1890, p. 438). Thus, once a goal-relevant stimulus has entered the perceptual focus of a perceiver, it can be assumed to capture attention until it is sufficiently encoded (see Egeth & Yantis, 1997; Kinchla, 1992; Pashler, Johnston, & Ruthruff, 2001). If a stimulus can be encoded quite easily, it should be easier for perceivers to disengage from allocating attention to this stimulus. If, however, a given stimulus is difficult to encode, attentional disengagement may be more difficult, at least until the stimulus is categorized. In other words, difficulty of encoding and attention allocation are assumed to be positively related, such that increased difficulty in encoding is associated with enhanced attention allocation. The crucial variable connecting attention and encoding is attentional capacity, such that stimuli that are difficult to encode require more attentional capacity, which in turn leads to stronger attention grabbing power. Applied to the present question, these assumptions imply that the well established *congruency effects* of approach/avoidance-related motor actions in the encoding of affective information (e.g., Förster & Strack, 1996, 1997, 1998; Neumann & Strack, 2000) should be associated with *incongruency effects* in attention allocation, such that orientation-incongruent stimuli have a stronger grabbing power than orientation-congruent stimuli (see also Johnston & Hawley, 1994; Johnston, Hawley, & Farnham, 1993; Johnston, Hawley, Plewe, Elliott, & DeWitt, 1990). That is, motor actions of approach should lead to stronger attention to

negative as compared to positive stimuli. Motor actions of avoidance, in contrast, should lead to stronger attention to positive as compared to negative stimuli.

PREVIOUS EVIDENCE

Preliminary evidence for incongruency effects in attention allocation comes from several studies demonstrating that explicit gain-and-loss expectations lead to enhanced attention to expectancy-incongruent information (e.g., Derryberry, 1993; Rothermund, 2003; Rothermund et al., 2001). Derryberry (1993), for example, found evidence for stronger attention to gain information after negative feedback, whereas attention to loss information was increased after positive feedback. In a similar vein, Rothermund, Wentura, and Bak (2001) found that attention to chance and danger stimuli was stronger when an outcome focus of the opposite valence had been induced. Finally, Rothermund (2003) demonstrated that perceivers automatically allocate attention to stimuli that are affectively incongruent with their current outcome-related motivational state as compared to stimuli that are affectively congruent. However, even though these results are generally consistent with the proposed incongruency effect in attention allocation, they are limited to effects of explicit gain-and-loss expectations. Hence, they offer no evidence for the present assumption that approach/avoidance-related motor actions lead to incongruency effects in attention allocation.

In order to test the influence of approach/avoidance-related motor actions on attention allocation, we conducted two experiments. Experiment 1 tested the assumption that orientation-incongruent stimuli have a stronger attention grabbing power than orientation-congruent stimuli. Experiment 2 tested the assumption that incongruency effects in attention allocation are directly related to the amount of attentional capacity required to encode orientation-congruent and orientation-incongruent stimuli.

EXPERIMENT 1

Experiment 1 tested the hypothesis that approach/avoidance-related motor actions lead to incongruency effects in attention allo-

cation to affective information, such that orientation–incongruent stimuli have a stronger attention grabbing power than orientation–congruent stimuli. In order to test this assumption, we employed a modified visual search task (see Wolfe, 1998). Participants were asked to memorize a number of meaningless symbols that were randomly presented in one of the four corners of a computer screen, and to distinguish between old and new symbols in a following recognition task. Symbols were presented in the presence of distracter stimuli of either positive or negative valence. In addition to this manipulation, participants were asked to engage in a motor action related to either approach or avoidance. Drawing on the assumption that orientation–incongruent stimuli have a stronger attention grabbing power than orientation–congruent stimuli, we expected participants to be more distracted by orientation–incongruent distracters than by orientation–congruent distracters. Hence, recognition memory for the neutral target symbols should be higher when these symbols were presented in the context of orientation–congruent distracters, than when they were presented in the context of orientation–incongruent distracters.

METHOD

Participants and Design. A total of 62 students (47 female) took part in a study on “visual attention and memory.” Subjects were drawn from a volunteer pool and were paid 6 € (approximately U.S. \$6 at the time) for their participation. The experiment consisted of a 2 (motor action: approach vs. avoidance) \times 2 (distracter valence: positive vs. negative) mixed–model design with the first variable as a between–subjects factor and the second as a within–subjects factor. Data from one participant who indicated memorization of the distracter photographs instead of the target symbols were excluded from analyses.

Stimulus Material. A total of 80 meaningless symbols were created via computer drawings (300 \times 200 pixels), with 40 of these symbols being used as targets and 40 being used as distracters. Symbols were created such that each of the 40 target symbols had one corresponding distracter symbol sharing at least one of its basic features (e.g., shape, pattern, color). Symbols were separated

into two sets of 20 target–distracter pairs, which were counterbalanced across the two valence conditions.

Stimulus Presentation. Participants were instructed to memorize 40 meaningless symbols that were presented randomly in one of the four corners of a computer screen. In the three remaining corners, three photographs of either positive or negative valence were presented (300 × 200 pixels). Photographs were taken from the International Affective Picture System (Lang, Bradley, & Cuthbert, 2001) presenting stimuli of either positive valence (e.g., puppy, baby, flowers) or negative valence (e.g., gun, spider, accident). Twenty symbols were accompanied by positive photographs, 20 symbols were accompanied by negative photographs. Participants were instructed to memorize the meaningless symbols and to ignore the photographs. Symbols and photographs were presented simultaneously for 4,000 ms on the screen with an inter-trial interval of 2,000 ms.

Approach/Avoidance. To manipulate approach/avoidance-related motor actions, we referred to the isometric muscle contraction procedure of arm flexion and arm extension developed by Cacioppo, Priester, and Berntson (1993). This procedure is based on previous findings in research on proprioceptive muscle feedback (see Stepper & Strack, 1993; Strack, Martin, & Stepper, 1988), indicating that arm flexion is associated with a behavioral orientation of approach, whereas arm extension is associated with a behavioral orientation of avoidance (e.g., Cacioppo et al., 1993; Förster, 2003; Förster, Higgins, & Idson, 1998; Förster & Strack, 1997, 1998; Friedman & Förster, 2002; Neumann & Strack, 2000; Priester, Cacioppo, & Petty, 1996; Riis & Schwarz, 2003). Specifically, participants were instructed to press the palms of both hands either facing upward from the bottom of the table (arm flexion = approach), or facing downward from the top of the table (arm extension = avoidance). Participants in both conditions were asked to press their hands such that they experienced a slight tension in their arms, and to keep this position until they were instructed to relax their arms. Relaxation instructions were given after the last item of the presentation phase.

Recognition Task. After the presentation phase, participants were asked to distinguish between symbols that were part of the initial presentation, and new symbols that were not part of the

presentation. Symbols were presented on the screen one at a time. Participants had to press a left-hand key when the symbol was part of the initial presentation (“old”), and a right-hand key when the symbol was not part of the presentation (“new”). The recognition task included the 40 target items of the initial presentation and 40 new symbols that were not part of the presentation.

Measures. Participants’ performance in the recognition of meaningless symbols was analyzed according to the logic of signal detection (Green & Swets, 1966), using Two-High-Threshold Theory (Snodgrass & Corwin, 1988).¹ In order to rule out the possibility that motor actions of arm flexion and arm extension influence attention to affective stimuli by the induction of positive and negative mood states, participants were asked to indicate their personal mood on a rating scale ranging from 1 (very good) to 5 (very bad).

RESULTS

Discrimination Performance. Drawing on Two-High-Threshold Theory (Snodgrass & Corwin, 1988), we calculated two *Pr* sensitivity indices reflecting participants’ recognition performance in the discrimination between old and new symbols as a function of distracter valence. These indices were submitted to a 2 (motor action) \times 2 (distracter valence) mixed-model analysis of variance (ANOVA), revealing a significant interaction between motor action and distracter valence, $F(1, 59) = 6.67, p = .01, \eta^2 = .102$ (see Figure 1). Consistent with the assumption that orientation-incongruent stimuli have a stronger attention grabbing power than orientation-congruent stimuli, participants under approach

1. To apply the logic of Signal Detection Theory (Green & Swets, 1966) to cases with small numbers of observations, Snodgrass and Corwin (1988) derived two measures from Two-High-Threshold Theory. The *Pr* index of discrimination sensitivity conceptually corresponds to Signal Detection Theory’s *d'* index. The *Br* index of response tendency to say “yes” regardless of stimulus status conceptually corresponds to Signal Detection Theory’s β index. Arithmetically, $Pr = H - FA$, and $Br = FA / [1 - (H - FA)]$, with *H* indicating the relative proportion of correct identifications (hits), and *FA* indicating the relative proportion of incorrect identifications (false alarms). In the present analyses, Two-High-Threshold Theory was preferred over Signal Detection Theory, because many of our participants did not commit a single false alarm, which requires a correction in Signal Detection Theory, but not in Two-High-Threshold Theory.

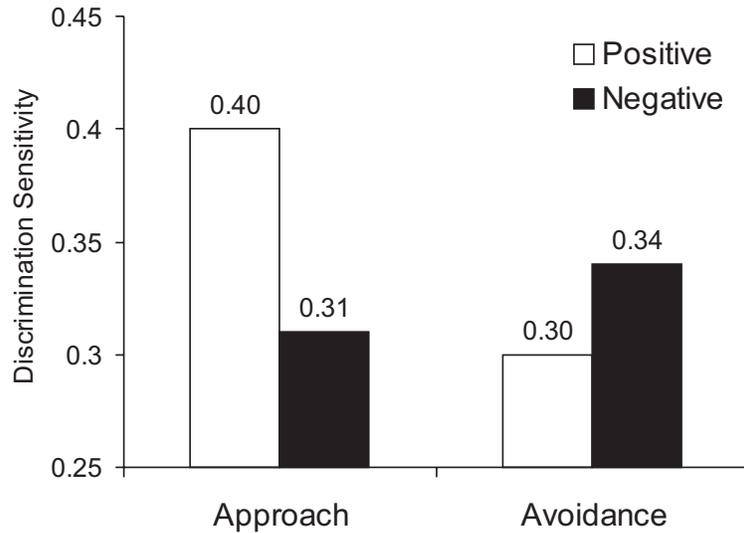


FIGURE 1. Mean P_r values of discrimination sensitivity in the recognition of meaningless symbols as a function of motor action (approach vs. avoidance) and valence of distracter stimuli (positive vs. negative) presented during memorization, Experiment 1.

showed lower discrimination performance when distracter photographs were negative than when they were positive, $F(1, 29) = 6.31, p = .02, \eta^2 = .179$. In contrast, participants under avoidance exhibited a nonsignificant tendency for lower discrimination performance when distracter photographs were positive than when they were negative, $F(1, 30) = 1.16, p = .29, \eta^2 = .037$. Moreover, discrimination performance for symbols memorized in the presence of positive distracter stimuli was significantly lower under avoidance than under approach, $F(1, 59) = 4.12, p = .05, \eta^2 = .065$. In contrast, discrimination performance for symbols memorized in the presence of negative distracter stimuli did not differ as a function of motor actions, $F(1, 59) = .41, p = .53, \eta^2 = .007$.

Response Bias. In order to test possible effects of motor actions and picture valence on general response tendencies we calculated two Br indices, reflecting participants' tendency to say "yes" (old) regardless of the stimulus category (Snodgrass & Corwin, 1988).

Submitted to a 2 (motor action) \times 2 (distracter valence) mixed-model ANOVA these indices revealed a significant main effect of motor action, $F(1, 59) = 11.56, p = .001, \eta^2 = .164$. Specifically, participants exhibited a stronger response bias under avoidance than under approach ($M_{\text{approach}} = .30; M_{\text{avoidance}} = .42$). No other main or interaction effect reached statistical significance.

Mood Effects. Approach/avoidance-related motor actions had no significant influence on participants' general mood states, $F(1, 59) = .01, p = .92, \eta^2 < .001$. Hence, positive or negative mood states cannot account for the obtained effects on discrimination sensitivity. This conclusion was also confirmed by an analysis of covariance (ANCOVA) using distracter valence and motor action as fixed factors, mood ratings as a covariate, and discrimination sensitivity as a dependent variable. This analysis revealed no significant main or interaction effect of mood. The interaction between motor action and distracter valence remained statistically significant after controlling for possible effects of mood, $F(1, 58) = 6.62, p = .01, \eta^2 = .102$.

DISCUSSION

The results from Experiment 1 support our assumption that approach/avoidance-related motor actions lead to incongruency effects in attention allocation to affective information, such that orientation-incongruent stimuli have a stronger attention grabbing power than orientation-congruent stimuli. In the present study, participants showed impaired performance in a modified visual search task (see Wolfe, 1998), when the valence of distracter stimuli was orientation-incongruent than when it was orientation-congruent. These effects were independent of a general response tendency. Moreover, approach/avoidance-related motor actions did not affect participants' mood, thus ruling out possible interpretations in terms of motor-related mood states. Most importantly, because participants in the present study were explicitly instructed to ignore the distracter stimuli, the obtained influence of distracter stimuli can be assumed to reflect automatic, rather than intentional, effects of attention allocation (cf. Shiffrin & Schneider, 1977).

Somewhat to our surprise, however, the proposed incongruency effect in automatic attention allocation was much more pronounced for positive stimuli and motor actions of approach than for negative stimuli and motor actions of avoidance (see also Derryberry, 1991). This unexpected finding may indicate a particularly strong vigilance for negative stimuli (e.g., Pratto & John, 1991) that is independent of approach/avoidance-related behavioral orientations. In a similar vein, there seems to be a stronger robustness of avoidance-related motor actions against attentional shifts to positive stimuli. Even though we did not predict this asymmetry in automatic attention allocation, it may be regarded as functional considering that it is often more difficult to reverse the negative consequences of harmful events than to reverse the consequences of failed opportunities (Cacioppo & Gardner, 1999). We will turn back to this asymmetry in more detail in the General Discussion.

EXPERIMENT 2

The main goal of Experiment 2 was to test the assumption that the obtained influence of approach/avoidance-related motor actions on automatic attention allocation is directly related to the amount of attentional capacity required for the encoding of affective stimuli. Specifically we assume that the stronger attention grabbing power of orientation-incongruent stimuli results from the higher amount of attentional capacity required to encode these stimuli. Preliminary evidence for this assumption can be found in a study by Förster and Strack (1996, Experiment 3). Using a dual-task paradigm (see Pashler, 1994), these researchers found that participants nodding their heads (approach) exhibited better performance in a finger dexterity test when they simultaneously had to memorize positive words than when they had to memorize negative words. In contrast, participants shaking their heads (avoidance) exhibited better performance when they had to memorize negative words than when they had to memorize positive words. According to Förster and Strack (1996), these results indicate that participants' residual capacity for a good performance in the finger dexterity test was higher when the words that they had to memorize were affectively

congruent with their motor action than when they were affectively incongruent.

The present study expanded on these findings by investigating the relative amount of residual capacity in the encoding of positive and negative pictures, such as those used in Experiment 1. For this purpose, participants were asked to attend to positive and negative photographs under conditions of either arm flexion (approach) or arm extension (avoidance). At the same time, participants had to attend to acoustically presented numbers and to press a key each time an odd number was presented (see Pashler, 1994). Drawing on the assumption that the encoding of orientation-congruent stimuli requires less attentional capacity than the encoding of orientation-incongruent stimuli, we expected that there should be more residual capacity for the discrimination between odd and even numbers when the valence of the pictures is congruent than when it is incongruent with participants' motor action. Hence, participants should exhibit better performance in the discrimination of odd and even numbers when the valence of the pictures that they have to memorize is orientation-congruent than when it is orientation-incongruent.

METHOD

Participants and Design. A total of 42 students (28 female) drawn from a volunteer pool were recruited for a study on "parallel task performance." Participants were paid 6 € (approximately U.S. \$6 at the time). The experiment consisted of a 2 (motor action: approach vs. avoidance) \times 2 (picture valence: positive vs. negative) mixed-model design with the first variable as the between-subjects factor and the second as the within-subjects factor. Data from eight participants were excluded from analyses. One participant did not respond to any of the numbers. Seven participants indicated that they paid attention exclusively to the numbers, but not to the pictures.

Dual-Task Procedure. Participants were instructed to memorize a total of 48 pictures presented on a computer screen (640 \times 480 pixels). Pictures were taken from the International Affective Picture System (Lang et al., 2001). Half of the pictures were of positive valence, half were of negative valence. Pictures were

presented on the screen for 4,000 ms with the next picture being presented immediately afterward. Parallel to this primary task, participants were acoustically presented odd and even numbers from 1 to 12 via headphones. Numbers were presented with an onset of 1,000 ms, thus resulting in a presentation of four numbers for each picture. Participants were instructed to press a mouse key as fast as possible when an odd number was presented. Memorizing the pictures was indicated as the primary task; reacting to the numbers was indicated as the secondary task.

Approach/Avoidance. Manipulations of approach/avoidance-related motor actions were identical to Experiment 1, the only exception being that half of the participants were instructed to take the mouse into their dominant hand, and to press it upward from the bottom of the table (arm flexion = approach). The remaining half were instructed to press the mouse downward from the top of the table (arm extension = avoidance). Relaxation instructions were given after participants had finished the picture memorization task.

Measures. Participants' responses to odd and even numbers served as the main dependent measure, using Two-High-Threshold Theory's (Snodgrass & Corwin, 1988) indices of discrimination sensitivity (*Pr*) and response bias (*Br*). In order to test the impact of approach/avoidance-related motor actions on participants' memory for positive and negative stimuli (e.g., Förster & Strack, 1996, 1997, 1998), participants were asked to discriminate between the 48 old pictures that were presented in the memorization task and 48 new pictures that were not part of the prior presentation in a following recognition task. Moreover, to rule out the possibility that motor actions of arm flexion and arm extension affect the processing of affective stimuli by the induction of positive and negative mood states, participants were asked to indicate their personal mood during the task on a rating scale ranging from 1 (very good) to 5 (very bad).

RESULTS

Discrimination Sensitivity. Drawing on Two-High-Threshold Theory (Snodgrass & Corwin, 1988), we calculated two *Pr* sensitivity indices, reflecting participants' ability to discriminate be-

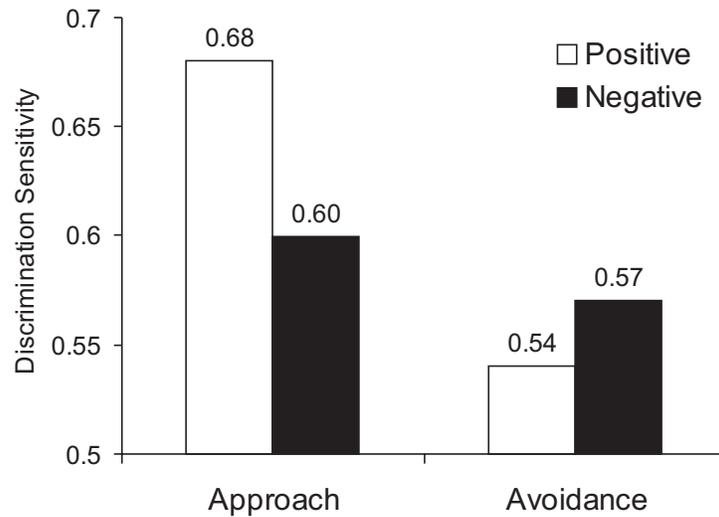


FIGURE 2. Mean P_r values of discrimination sensitivity in the identification of numbers as a function of motor action (approach vs. avoidance) and valence of simultaneously encoded pictures (positive vs. negative), Experiment 2.

tween odd and even numbers during the encoding of positive versus negative pictures. Submitted to a 2 (motor action) \times 2 (picture valence) mixed-model ANOVA, these indices revealed a significant two-way interaction between motor action and picture valence, $F(1, 32) = 6.96, p = .01, \eta^2 = .179$ (see Figure 2). Consistent with the hypothesis that the encoding of orientation-congruent stimuli requires less attentional capacity than the encoding of orientation-incongruent stimuli, participants under approach showed better performance in the discrimination between odd and even numbers when the pictures were positive than when they were negative, $F(1, 19) = 9.46, p = .006, \eta^2 = .333$. In contrast, participants under avoidance exhibited a nonsignificant tendency for better performance when the pictures were negative than when they were positive, $F(1, 13) = .75, p = .40, \eta^2 = .055$. Moreover, discrimination performance during the presentation of positive pictures was significantly better under approach than under avoidance, $F(1, 32) = 4.63, p = .04, \eta^2 = .126$. Discrimination performance during the presentation of negative pictures, in con-

TABLE 1. Means and Standard Deviations for *Pr* Values of Discrimination Sensitivity in the Recognition of Pictures as a Function of Motor Action (Approach vs. Avoidance) and Picture Valence (Positive vs. Negative), Experiment 2

Picture Valence		Motor Action	
		Approach	Avoidance
Positive	<i>M</i>	.85	.77
	<i>SD</i>	.13	.17
Negative	<i>M</i>	.75	.75
	<i>SD</i>	.20	.12

trast, did not differ as a function of approach/avoidance-related motor actions, $F(1, 32) = .40, p = .53, \eta^2 = .012$.

Response Bias. In order to test possible effects of motor actions and picture valence on general response tendencies, we calculated two *Br* indices, reflecting participants' tendency to say "yes" (old) regardless of the stimulus category (Snodgrass & Corwin, 1988). Submitted to a 2 (motor action) \times 2 (picture valence) mixed-model ANOVA, these indices revealed no significant main or interaction effect (all F s < 1).

Memory for Affective Stimuli. Drawing on the assumption that the encoding of orientation-congruent stimuli requires less capacity than the encoding of orientation-incongruent stimuli, one could argue that recognition memory for positive and negative pictures should be better when they are affectively congruent with participants' behavioral tendency than when they are affectively incongruent (e.g., Förster & Strack, 1996, 1997, 1998). In order to test this assumption, we calculated two *Pr* sensitivity indices of discrimination performance in the recognition of positive and negative pictures (Snodgrass & Corwin, 1988). Submitted to a 2 (motor action) \times 2 (picture valence) mixed-model ANOVA, these indices revealed a significant main effect of picture valence, $F(1, 32) = 4.76, p = .04, \eta^2 = .130$, indicating that recognition memory for positive pictures was better than recognition memory for negative pictures. Inspection of means further indicated that this effect was due to a particularly high recognition memory for positive pictures under approach (see Table 1). Specifically, participants under approach exhibited better recogni-

tion performance for positive as compared to negative pictures, $F(1, 19) = 10.57, p = .004, \eta^2 = .357$. Participants under avoidance, in contrast, showed no difference with regard to their recognition memory for positive and negative pictures, $F(1, 13) = .19, p = .67, \eta^2 = .014$. However, even though this pattern corresponds to the asymmetrical effects obtained for automatic attention allocation (Experiment 1) and secondary task performance (Experiment 2), the respective two-way interaction failed to reach the conventional level of statistical significance, $F(1, 32) = 1.97, p = .17, \eta^2 = .058$.

Mood Effects. Arm flexion and arm extension had no influence on participants' general mood states, $F(1, 32) = .004, p = .95, \eta^2 < .001$. Hence, positive or negative mood states cannot account for the obtained effects of arm flexion and arm extension on secondary task performance. This conclusion is also confirmed by an analysis of covariance (ANCOVA) using picture valence and motor action as fixed factors, mood ratings as a covariate, and discrimination sensitivity as dependent variable. Even though this analysis revealed a significant two-way interaction of mood and picture valence, $F(1, 31) = 4.82, p = .04, \eta^2 = .036$, controlling for mood did not affect the obtained interaction between picture valence and motor action, $F(1, 31) = 7.66, p = .009, \eta^2 = .198$.²

DISCUSSION

Results from Experiment 2 support the assumption that incongruency effects in automatic attention allocation correspond to congruency effects in the encoding of affective information. Specifically, we argued that the encoding of orientation-incongruent stimuli requires more attentional capacity than the encoding of orientation-congruent stimuli, thus leading to a stronger attention grabbing power of orientation-incongruent as compared to orienta-

2. Mood ratings revealed a congruency effect in the encoding of affective information, such that participants with a positive mood showed better performance in the discrimination between odd and even numbers when the pictures processed in the primary task were positive than when they were negative. In contrast, participants with a negative mood exhibited better discrimination performance when the pictures were negative than when they were positive.

tion-congruent stimuli. Consistent with this assumption, participants flexing their arms (approach) showed better performance in the discrimination of acoustically presented numbers when they had to attend to positive pictures than when they had to attend to negative pictures. In contrast, participants extending their arms (avoidance) showed a weak but recognizable tendency for better performance when they had to attend to negative pictures than when they had to attend to positive pictures. Importantly, approach/avoidance-related motor actions affected discrimination sensitivity but not general response tendencies, thus indicating that motor actions affected secondary task performance by differences in residual capacity during encoding, rather than by deliberate shifts in the strategy to solve the task. Moreover, even though incidental mood states showed corresponding effects on secondary task performance, the effect of motor actions was not mediated by positive or negative mood.

Interestingly, Experiment 2 revealed the same asymmetrical pattern already obtained in Experiment 1. In the present study, effects of approach/avoidance-related motor actions were particularly pronounced for positive stimuli and motor actions of approach. Negative stimuli and motor actions of avoidance, in contrast, showed only weak effects. This finding corroborates the functional considerations discussed in the context of Experiment 1, postulating a generally strong vigilance for negative stimuli (e.g., Pratto & John, 1991), and a stronger robustness of avoidance-related motor actions against attentional shifts to positive stimuli.

GENERAL DISCUSSION

The main goal of the present studies was to investigate the influence of approach/avoidance-related motor actions on processes of attention allocation. Drawing on Logan's (2002) instance theory of attention, we assumed that attention and encoding are strongly intertwined. Specifically, we argued that affective stimuli capture a perceiver's attention until they are sufficiently encoded. Hence, congruency effects in the encoding of affective information reported in previous studies (e.g., Förster & Strack, 1996, 1997, 1998; Neumann & Strack, 2000) were expected to be as-

sociated with incongruency effects in attention allocation, such that orientation–incongruent stimuli have a stronger grabbing power than orientation–congruent stimuli. Consistent with these assumptions, participants in Experiment 1 exhibited lower performance in the recognition of neutral pictures when these pictures were memorized in the context of orientation–incongruent distracter stimuli than when they were memorized in the context of orientation–congruent distracter stimuli. Relating these effects to differences in attentional capacity, Experiment 2 demonstrated lower performance in a secondary task when the stimuli encoded in a primary task were affectively incongruent than when they were affectively congruent with participants' motor actions. Together with previous research (e.g., Förster & Strack, 1996; Neumann & Strack, 2000), these results indicate that the influence of approach/avoidance–related motor actions on the processing of affective information is two-fold by leading to congruency effects in the encoding of affective stimuli, but to incongruency effects with respect to automatic attention allocation.

Interestingly, and somewhat to our surprise, the obtained influence of motor actions was much more pronounced for positive as compared to negative stimuli and for approach as compared to avoidance tendencies. This asymmetry consistently emerged for automatic attention allocation (Experiment 1), residual capacity in the encoding of affective stimuli (Experiment 2), and recognition memory for affective stimuli (Experiment 2). Even though we cannot rule out the possibility that this asymmetry is due to a methodological weakness of our avoidance manipulation, it might indicate a particularly strong vigilance for negative stimuli (e.g., Pratto & John, 1991) that is independent of motivational states or behavioral tendencies. From a functional perspective, such an asymmetry may be regarded as adaptive considering that it is often more difficult to reverse the negative consequences of harmful events than to reverse the consequences of failed opportunities (Cacioppo & Gardner, 1999). A high vigilance for negative stimuli may help to prepare for adequate and efficient responses to potential threats regardless of whether these threats are expected or not. From a theoretical perspective, these assumptions are consistent with recent theories of affect and emotion arguing that the underlying mechanisms that are responsible for bivalent action tendencies of approach versus avoidance are repre-

sented independently rather than reciprocally (e.g., Cacioppo & Berntson, 1994; Lang et al., 1990; Sutton & Davidson, 1997, Watson & Clark, 1992). Cacioppo and Berntson (1994), for example, argued that the affective system is characterized by a heightened sensitivity to negative stimuli (*negativity bias*) and a general tendency to approach at low levels of evaluative activation (*positivity offset*). Applied to the present findings, one could argue that these differences in offset and sensitivity lead to asymmetrical influences of approach/avoidance-related motor actions on automatic attention allocation, such that vigilance to negative stimuli is generally high regardless of perceivers' behavioral tendencies. In any case, future research may further clarify the underlying processes that are responsible for asymmetrical influences of approach/avoidance-related motor actions on automatic attention allocation.

Regardless of the obtained asymmetry for positive and negative stimuli, the present findings have important implications for the regulation of approach/avoidance-related behaviors. Specifically, one could argue that congruency effects in encoding and incongruency effects in attention allocation are both functional in their own right. Facilitated encoding of orientation-congruent stimuli, for instance, may promote goal pursuit by saving cognitive capacities for associated task requirements. Enhanced attention to orientation-incongruent stimuli, in contrast, may regulate behavior, such that current behavioral tendencies do not result in self-perpetuating feedback loops. Such feedback loops can have dysfunctional consequences when actors do not recognize environmental cues, suggesting a change of the current behavioral tendency. Most importantly, because the obtained influence on attention seems to be relatively automatic, processes of attention allocation may regulate behavior even before deliberation and executive control come into play. In this sense, processes of selective attention resulting from approach/avoidance-related motor actions can be regarded as highly adaptive because of their efficient regulative function.

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