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ORIGINAL ARTICLE

The structure of affective action representations: temporal binding of affective response codes

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Abstract Two experiments examined the hypothesis that preparing an action with a specific affective connotation involves the binding of this action to an affective code reflecting this connotation. This integration into an action plan should lead to a temporary occupation of the affective code, which should impair the concurrent representation of affectively congruent events, such as the planning of another action with the same valence. This hypothesis was tested with a dual-task setup that required a speeded choice between approach- and avoidance-type lever movements after having planned and before having executed an evaluative button press. In line with the code-occupation hypothesis, slower lever movements were observed when the lever movement was affectively compatible with the prepared evaluative button press than when the two actions were affectively incompatible. Lever movements related to approach and avoidance and evaluative button presses thus seem to share a code that represents affective meaning. A model of affective action control that is based on the theory of event coding is discussed.

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Introduction

In a world full of opportunities and danger, agents need to respond quickly to take advantage of their environment. This idea is captured in the notion of behavioral dispositions of approach and avoidance that are spontaneously activated by affective stimuli: appetitive stimuli induce a behavioral tendency to approach and aversive stimuli engage a behavioral disposition to avoid. In support of this central idea, numerous studies have shown a directive function of affective valence on simple reflexes (e.g., Bradley, Codispoti, Cuthbert & Lang, 2001) and on a variety of motor actions (e.g., Krieglmeyer & Deutsch, 2010; Solarz, 1960).

Swift and automatic responses to affective stimuli are, however, adaptive only as long as they comply with adequate action strategies. A defensive blink of the eye might be instrumental to avoid intrusion of an approaching fly, but it is of little help to avoid collision with an approaching car. In confrontation with a myriad of emotional challenges in different situations, an affective behavior repertoire restricted to a few reflexes and habitual responses might thus not suffice to cope with these challenges. Instead, these situations frequently demand novel combinations and flexible configurations of movements and action sequences in the pursuit of approach and avoidance goals—affective actions rather than reflexes.

In line with this reasoning, a number of studies have shown that the impact of affective stimuli on responses is by no means reflexive but, rather, is influenced by the agent's current intentions and action goals (e.g., Bamford & Ward, 2008; Eder & Rothermund, 2008; van Dantzig, Pecher, & Zwaan, 2008). For instance, in tasks that relate actions to the body of the agent, positive stimuli prime a lever pull and negative stimuli a lever push (e.g., Chen &

Bargh, 1999), whereas tasks that emphasize the relation between the action and the stimulus, the exact opposite of this priming pattern is obtained (e.g., Lavender & Hommel, 2007; Markman & Brendl, 2005; Seibt, Neumann, Nussinson & Strack, 2008). Obviously, the affective value of a stimulus does not trigger a particular muscular or movement pattern but, rather, a goal-directed action that considers the affective implications of that stimulus for the agent in the situation at hand.

To provide a theoretical account of the planning and control of affective actions, Eder and Klauer (2007, 2009) have extended the theory of event coding (TEC; Hommel, Müsseler, Aschersleben, & Prinz, 2001) to affective perceptual and action events (for a related approach, see Lavender & Hommel, 2007). According to TEC, both perceptual events and action plans are cognitively represented by networks of distributed feature codes that specify their perceivable features. An action plan would thus consist of codes of the planned action's anticipated sensory effects (Elsner & Hommel, 2001), such as (anticipated) kinesthetic feedback from extending one's arm for a lever push or (anticipated) visual feedback about the hand's end position. Considering that emotions may also be to some degree derived from bodily sensations (James, 1884; Laird & Strout, 2007), it makes sense to assume that these feature networks also comprise of codes representing the affective value of actions, that is, the positivity or negativity of the perceived consequences of actions. Indeed, once participants have learned to associate a particular action with an affect-laden consequence, such as an aversive shock, they are faster to respond with that action to stimuli with the same affective value, such as words with a negative meaning (Beckers, De Houwer & Eelen, 2002). This suggests that the affective consequences of an action become an integral part of its cognitive representation.

Given that actions are represented by means of distributed feature codes, TEC claims that planning an action requires the selection, activation, and integration of the codes that characterize the features that action is supposed to have (Hommel et al., 2001; Stoet & Hommel, 1999). If so, one would expect that planning and executing a given action is facilitated through stimuli it shares features with. Indeed, this has been observed for both non-affective and affective stimulus (and response) features: for instance, people carry out left and right responses faster when signaled by spatially corresponding stimuli (Simon & Rudell, 1967) and utter the words "positive" and "negative" faster when signaled by affectively corresponding stimuli (De Houwer & Eelen, 1998).

A less obvious and more unique implication of TEC and its affective extension is that planning an action and integrating the codes of its features leads to the "occupation" of these codes (Stoet & Hommel, 1999), which effectively blocks them temporarily from participating in other feature-code bindings or at least makes this participation more difficult. Assume, for instance, an agent is planning to approach a stimulus by means of a hand movement or by pushing a lever. According to our reasoning, this action would have a positive affective connotation, which would be cognitively represented by a corresponding <positive> code. If action planning involves the binding of the codes that are representing its features, the <positive> code would be integrated with other codes into the action plan and stay integrated until the planned action is executed. During that time, the <positive> code would thus be less accessible and less available for other bindings, so that it should be difficult to fully represent other positive perceptual or action events before the action is carried out (Eder & Klauer, 2007, 2009).

Conclusive evidence for the occupation of affective codes through action planning was provided by Eder and Klauer (2009). They had participants prepare an approach-related lever pull (assumed to be coded as positive) or avoidance-related lever push (assumed to be coded as negative) in every trial and asked them to indicate whenever they were ready by pressing a button. The button press triggered the presentation of a briefly flashed positive or negative stimulus, which participants were to identify. Hence, the stimulus appeared after the planning of the lever action was completed but before it was carried out. If the planning would involve integrating a <positive> or <negative> code, participants would be expected to have difficulties identifying a stimulus that shares this particular code. In other words, planning a "positive" action should impair the identification of positive stimuli, while planning a "negative" action should impair the identification of negative stimuli. Indeed, Eder and Klauer (Eder & Klauer, 2007) consistently observed this outcome pattern in several experiments: identifying affectively response-compatible stimuli was more difficult than identifying response-incompatible stimuli. This effect, referred to as action-valence blindness, is even observed with responses that were affectively neutral originally but became extrinsically associated with a positive or negative meaning through task procedures (see also De Houwer, 2003).

This kind of impact of action planning on perception is not restricted to affective action–stimulus relationships but has also been observed for spatial (Müsseler & Hommel, 1997) and meaning-related (Hommel & Müsseler, 2006) action–stimulus relationships. Apparently, then, action–planning processes treat affective codes just like any other feature code and integrate them into action plans whenever an action has, or is associated with a particular valence. In the present study, we sought for converging evidence for this possibility by looking into interactions between two concurrent action plans. Integrating an affective code into an action plan should not only impair perceptual coding processes, as demonstrated by Eder and Klauer (2007, 2009), but also the planning of other actions. For instance, the integration of the <positive> code into a given action plan A should make it more difficult to integrate this code into another action plan B before plan A has been carried out.

For non-affective features, interactions of that sort have indeed been observed by Stoet and Hommel (1999). In their experiments, participants first planned a left or right finger movement (plan A), and then performed another left–right choice reaction (plan B) before executing the planned action (plan A). As expected, planning a left action (A), say, impaired the planning and execution of another left action (B) if B was executed before A. This suggests that maintaining an action plan keeps the codes it comprises integrated and, thus, "in check", so that other planning processes are impaired to the degree that they rely on the same codes. Along the lines of Eder and Klauer (2009), this would suggest that planning an affective action and maintaining the plan for later execution impairs the planning of another action of the same valence. This was the hypothesis that we tested in two experiments.

Experiment 1

Experiment 1 provided a first test whether planning an action with positive or negative valence would impair the planning and execution of an action sharing this valence. Figure 1 illustrates the basic setup and the sequence of events in an experimental trial. In each trial, participants were first to prepare a button press in response to the valence of a positive or negative picture, but to withhold this response until another response (lever movement) was performed. In line with previous research on the extrinsic affective Simon effect (De Houwer, 2003), we assumed that preparing a button press assigned to a positive picture involves the integration of a <positive> affective code, whereas preparing a response to a negative picture involves the integration of a <negative> code. After several seconds that warranted sufficient time for preparing the button press, a word was presented that required a speeded choice between a lever pull towards the body—an action that we considered to be positively coded—and a lever push away from the body—that we considered to be negatively coded (Eder & Rothermund, 2008). Thus, approach- and avoidance-related lever movements were initiated after having planned an action with extrinsic positive or negative valence, and this valence could be congruent or incongruent with the intrinsic affective meaning of the lever response. Next to the execution of the lever response, an acoustic Go-signal was delivered that demanded the speeded execution of the prepared button press.

In line with the code-occupation hypothesis derived from TEC and Eder and Klauer's (2009) affective extension, we expected feature overlap (i.e., congruence) between the two movements to impair planning the lever movement and, thus, to increase reaction times for that response. Note that this outcome is not expected from either a motivational account or by any other associative account that assumes a facilitatory spread of activation from affective stimuli to congruent approach and avoidance reactions (e.g., Chen & Bargh, 1999; Neumann, Förster, & Strack, 2003). Thus, a selective interference

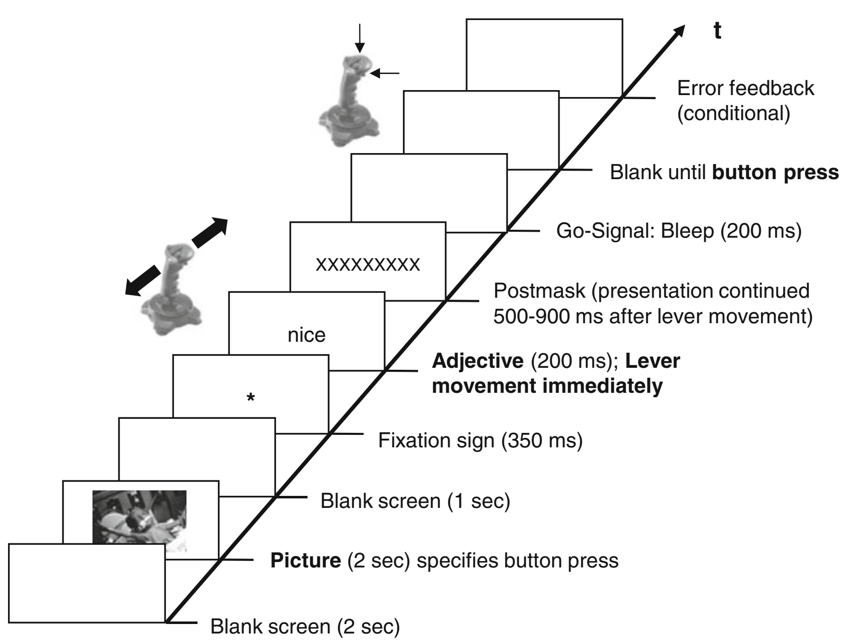

Fig. 1 Sequence of events in an experimental trial of Experiment 1. Word classifications with lever movements were embedded in picture evaluations with button presses

between affectively congruent lever movements and button presses would provide distinctive support for TEC and its affective extension.

Method

Participants

Fifteen students (10 women) volunteered for participation in the experiment. All participants were native speakers of German and naïve as to the purpose of the experiment. All but one participant was right-handed.

Apparatus and stimuli

In a dimly lit experimental chamber, participants were seated at a distance of 60 cm from a 17″ VGA color monitor that displayed words and pictures in a 1,024 × 768 resolution with a 70 Hz refresh rate. An IBM-compatible joystick was connected to the game port of the computer and placed between the monitor and the participant. The participant was asked to grip the lever of the joystick with the dominant hand and to perform the lever movement until the dead stop was reached. The button at the front of the lever was tinted red and introduced to the participant as button 1; the button at the top of the lever was tinted yellow and described as button 2. Stimulus presentation and measurement of response latencies were controlled by a software timer with video synchronization (Haussmann, 1992).

Stimuli for the picture evaluation task were 48 positive and 48 negative pictures that were taken from the IAPS (Lang, Bradley, & Cuthbert, 2005). For the word evaluation task, sets of 48 positive and 48 negative adjectives that were matched in word length and valence extremity were selected from a standardized word pool according to their valence norms (Schwibbe, Röder, Schwibbe, Borchardt, & Geiken-Pophanken, 1981). Additional 32 pictures and words were selected for task practice. The pictures were presented at the center of the screen at a visual angle of about 11.2° (±3.1°) in the horizontal and 11.4° in the vertical dimensions. The words were presented in white-on-black at the center of the screen.

Procedure

Participants were to classify affective stimuli in two tasks: (1) a button-pressing task that required evaluative picture classifications with presses of button 1 and 2, and (2) a lever-movement task that demanded evaluative word classifications with pushing and pulling lever movements. Importantly, the lever task was embedded into the button-pressing task: The picture was always presented before the word, but the cued button press had to be executed only after the lever response to the word. Thus, participants were instructed to prepare the evaluative button press as soon as the picture appeared, to wait for the word and to respond to it as fast as possible with a lever movement, and then to carry out the prepared button press as quickly as possible following a Go-signal.

Figure 1 illustrates the sequence of events in an experimental trial. Each trial started with the presentation of a picture (2 s.) that was followed by a blank period for 1 s. Participants were instructed to utilize these time periods for the preparation of the evaluative categorization response, with button 1 assigned to positive pictures and button 2 assigned to negative pictures. A white fixation sign then appeared 350 ms at the centre of the screen, followed by a word that was replaced by a mask (nine X's in a row) after 200 ms. Participants were instructed to respond to positive words with a lever pull and to negative words with a lever push as fast as possible within a time limit of 1 s. After registration of a lever movement, the mask remained on the screen for additional 500 ms plus a random interval up to 400 ms. Simultaneously with mask offset, a bleep (600 Hz) was emitted for 200 ms by the internal loudspeaker of the computer that served as a Go-signal for the evaluative button press; participants were to press the prepared button as rapidly as possible within a time limit of 1 s. A trial ended with an error feedback reporting, when appropriate, wrong picture and word classifications, premature lever movements and button presses, and violations of the time limits for the lever movement and the button press. The next trial started after 2 s.

Design

The experimental phase started with 24 practice trials divided into two blocks that were followed by 16 blocks with 12 trials each. Each combination of the 2 (lever movement: pull vs. push) × 2 (button press: positive vs. negative) design was repeated three times in each block in random order. Erroneous trials were repeated at the end of the experimental session in random order and divided into blocks of up to 12 trials.

Results

Trials with premature responses (0.6% of all trials) and with wrong responses (11.5% of all trials) were discarded from reaction time analyses. In addition, individual Tukey (1977) outlier thresholds were computed for each reaction task to identify response latency outliers; this truncation removed 0.9% of all lever movement latencies and 3.7% of all button press latencies.

Lever movements

For each participant, mean reaction times and percentages of error were computed as a function of affective response–response congruency (congruent: lever pull-positive button press, lever push-negative button press; incongruent: lever push-positive button press, lever pull-negative button press).[1] The analysis of lever movement latencies yielded a significant effect of affective R–R congruency, $t(14) = 3.09$, $p < 0.01$. Participants responded slower to valenced words when the lever movement was affectively congruent with the prepared evaluative button press ($M = 750$ ms, $SE = 16.1$) than when both responses were affectively incongruent ($M = 738$ ms, $SE = 16.0$). The error rates revealed a similar congruency disadvantage with more lever movement errors in congruent trials ($M = 8.7\%$, $SE = 1.2$) than in incongruent trials ($M = 7.5\%$, $SE = 1.2$); however, this difference failed to reach significance, $t < 1$.

Button presses

Reaction times of the prepared button presses were measured from the onset of the acoustic Go-signal and were analyzed for an influence of the affective R–R congruency relation. This analysis did not yield a reliable speed difference between congruent ($M = 284$ ms, $SE = 20.8$) and incongruent button presses ($M = 291$ ms, $SE = 23.6$), $t(14) = -1.56$, $p = 0.14$. An analogous analysis of the mean error rates reached marginal significance, $t(14) = -2.10$, $p = 0.055$, indicating that erroneous button presses were more frequent in incongruent trials ($M = 3.3\%$, $SE = 1.0$) than in congruent trials ($M = 1.5\%$, $SE = 0.3$).

Discussion

The results are in line with TECs code-occupation hypothesis: Lever movements that were congruent with the affective valence of a prepared keypress were initiated more slowly than lever movements that were affectively incongruent with the keypress. This congruence cost is in line with TECs general claim that planning an action is impaired if it shares features with another, already constructed action plan in memory, and it fits with Eder and Klauer's (2009) extension of this logic to affective codes. Thus, planning an affectively meaningful action seems to result in the binding of a corresponding affective code to the action plan, and this temporarily reduces the availability of this code for the binding to other action plans.

Note, however, that the design of Experiment 1 leaves room for an alternative interpretation of the interference effect. In the lever task, pulls and pushes were cued through positive and negative words, respectively, so that the valence of lever movements was always confounded with the valence of the movement cue. It might thus not have been the planning of the (affectively laden) lever movement that was impaired by the planning of the button press, but the processing of the cue. Given that Eder and Klauer (2007) have provided evidence that planning an affective action impairs the identification of affectively congruent stimuli, this is a plausible alternative that would render our observation much less interesting than intended. To rule out this possibility, we conducted Experiment 2, where we avoided a confound between cue and action valence.

Experiment 2

In Experiment 2, we not only replicated Experiment 1 but also presented affectively neutral letters instead of words as lever-movement cues in half of the trials. Participants were to respond to the letters A, B, and C with a lever pull directed towards the body and to the letters X, Y, and Z with a lever push away from the body, with the response assignment to the letters being counterbalanced across participants. If the interference obtained in Experiment 1 was due to the valence of movement cues rather than the valence of the planned action, planning the button press should impair affectively congruent lever movements with word cues but not with letter cues. Alternatively, if the interference really reflects the interaction between action plans, congruence costs should be obtained with both types of cues.

Method

Participants

Thirty students (24 women) volunteered for the experiment in fulfillment of course requirement or for payment. All participants were fluent in German; one participant was left-handed. The data set of one participant was dropped from analyses because she reacted erroneously in 45% of the trials.

[1] In supplementary analyses, direction of lever movement (toward vs. away) did not moderate the effects of the congruency factor. Therefore, data were collapsed across both congruent and incongruent movement-key sequences in Experiment 1 and 2.

Stimuli, design, and procedure

The same affective pictures and words were presented as in Experiment 1. In half of the trials, however, a capital letter appeared instead of a word in the lever movement task. One half of the sample was instructed to respond to the letters A, B, and C with a lever pull directed towards the body and to the letters X, Y, and Z with a lever push away from the body, the other half received the reverse assignment. To prevent button-press-related memorization strategies based on strategic finger placements (instead of true action planning), participants were instructed to hold both buttons depressed during the execution of the lever movement. The backward mask was a string of percentage signs to prevent confusion of movement cues with the mask.

The button press task was as in Experiment 1, with the following exceptions: (1) three green exclamation marks were presented as Go-signal (instead of a bleep), which remained on the screen until button press registration, so to highlight the need of a button press; (2) the Go-signal now appeared 750–1,150 ms after lever movement registration to give participants additional time to release the buttons that were pressed during the lever movement; and (3) the mapping of the buttons onto picture valence was counterbalanced across participants to control for response grouping as a possible source of reaction time differences.

After two practice blocks with 24 trials each, participants worked through 192 experimental trials divided into eight blocks. In each block, half of the trials required lever movements to affective words, the other half to capital letters. Trial order was completely randomized, and erroneous trials were repeated at the end of the session divided into blocks of up to 24 trials.

Results

Trials with premature responses (0.4% of all trials) or incorrect responses (8.1% of all trials), and trials without a double button press during lever movement (1.1% of all trials) were discarded from reaction time analyses. The Tukey (1977) procedure led to the removal of 0.8% of all lever movement latencies and 5.0% of all button press latencies.

Lever movements

For each participant, mean reaction times and percentages of error were computed as a function of affective response–response congruency (congruent vs. incongruent) and (lever) movement cue (word vs. letter). A mixed analysis of variance (ANOVA) with these factors as within-subjects factors and letter assignment and button assignment as between-subjects factor yielded a significant effect of movement cue, $F(1, 25) = 84.16$, $p < 0.001$, indicating slower responses to words ($M = 802$ ms, SE = 13.1) than to letters ($M = 700$ ms, SE = 14.94). The speed advantage with letter cues was more pronounced when A, B, and C cued a lever pull and X, Y, and Z cued a lever push than with the reverse assignment, $F(1, 27) = 4.58$, $p < 0.05$. The main effect of congruency reached significance, $F(1, 27) = 10.22$, $p < 0.05$. Participants responded faster to words and letters in incongruent trials ($M = 747$ ms, SE = 12.8) than in congruent trials ($M = 756$ ms, SE = 13.2). Notably, this incongruency advantage was not qualified by movement cue ($F < 1$). Congruent lever movements were delayed with word cues ($\Delta M = 10$ ms), $t(28) = 2.40$, $p < 0.05$, and with letter cues ($\Delta M = 10$ ms), $t(28) = 2.24$, $p < 0.05$. No other effect was significant ($ps > 0.10$).

An analogous ANOVA of the movement errors yielded a significant effect of movement cue, $F(1, 25) = 13.74$, $p < 0.05$, and a significant effect of letter assignment, $F(1, 25) = 5.14$, $p < 0.05$. Incorrect lever movements were more frequent with word cues ($M = 6.8\%$, SE = 0.7) than with letter cues ($M = 3.3\%$, SE = 0.8), and errors were less frequent when A, B, and C cued a lever pull and X, Y, and Z a lever push. Latter effect was qualified by a three-way interaction between movement cue, letter assignment, and button assignment, which was close to significance, $F(1, 25) = 4.07$, $p = 0.054$. More important, error rates did not reliably differ between congruent ($M = 4.8\%$, SE = 0.6) and incongruent trials ($M = 5.2\%$, SE = 0.6), irrespective of the type of movement cue (with both $F_s < 1$). The three-way interaction between affective congruency, letter assignment, and button assignment was significant, $F(1, 25) = 6.46$, $p < 0.05$, but all other effects were not (with all $p_s > 0.10$).

Button presses

Mean reaction times of prepared button presses and percentages of errors were analyzed for an influence of affective response–response congruency. An ANOVA with button assignment as between-subjects factor revealed a speed difference between affectively congruent ($M = 226$ ms, SE = 11.5) and incongruent button presses ($M = 230$ ms, SE = 11.1), $F(1, 27) = 6.42$, $p < 0.05$, especially when positive pictures required a press of the front button and negative pictures a press of the top button, $F(1, 27) = 3.90$, $p = 0.059$. The main effect of button assignment was not significant ($F < 1$). Analyses of the error rates corroborated the result pattern of the reaction times. Erroneous responses were less frequent in congruent trials ($M = 1.7\%$, SE = 0.3) than in incongruent trials

($M = 2.3\%$, SE $= 0.3$), $F(1, 27) = 5.51$, $p < 0.05$, when positive pictures required a press of the front button and negative pictures a press of the top button but not with the reverse assignment, $F(1, 27) = 15.01$, $p < 0.001$. The main effect of key assignment did not reach significance ($F < 1$).

Discussion

The results are clear-cut. Lever movements that were congruent with a prepared evaluative button press were initiated more slowly than incongruent lever movements, irrespective of whether the movement was cued by affective words or neutral letters. This result pattern rules out an account in terms of action–stimulus interactions (Eder & Klauer, 2007) but points to a direct interaction between two action plans.[2]

An unexpected finding is that keys were pressed faster when the evaluative button press was congruent with the embedded lever movement than when both actions were incongruent. This observation is in line with Stoet and Hommel (1999) who analogously observed shorter movement times when the prepared response shared a spatial feature with the embedded response. These authors reasoned that the execution of a prepared response might have benefited from a residual activation of a shared feature after the action plan of the embedded response has dissolved. Note, however, that a congruency benefit was observed only with a particular key mapping in the present experiment. Thus, it remains unclear for the present experiment whether the congruency benefit was produced by residual feature activation or by specifics of different response–response sequences.

General discussion

Many theories acknowledge the importance of goal-directed action in emotional behavior regulation, but little is known about how these actions are controlled and represented in the cognitive system. We have suggested a particular view on affective action control that is based on the theory of event coding (Hommel et al., 2001) and extends it to affective and evaluative representations (Eder & Klauer, 2007, 2009; Lavender & Hommel, 2007). According to this view, actions are cognitively represented through codes of their perceivable affective and non-affective features. The affective implications of an action become thus an integral part of the mental structure that characterizes the intended features of the action and controls its execution.

Integrating affective codes into an action's representation can have many side effects. One is that the action can now be primed through the processing of stimuli or other cognitive processes that activate the affective code bound to the action. Hence, coding an action as positive or negative as a consequence of either the task context (e.g., because the actions are carried out to communicate the valence of stimuli to the experimenter; De Houwer, 2003) or the affective consequences the actions were experienced to have (Beckers et al., 2002), or because of the action's functional meaning (as with approaching and withdrawing from a stimulus; van Dantzig et al., 2008), renders it "primable" by positively and negatively coded stimuli, respectively.

In the present study, we have emphasized another side effect of binding affective codes to action plans: In addition to making the action affectively primable, this binding is also able to impact other processes if they make use of the same affective code. As claimed by Stoet and Hommel (1999), integrating a feature code into an action plan interferes with planning another action that relies on the same code. In the present study, we have demonstrated that this code-occupation principle holds for affective < positive > and < negative > codes. In two experiments, preparing a button press that signals the affective value of a picture delayed the performance of an affectively congruent approach and avoidance movement. Importantly, this congruence cost was independent of whether this movement was cued by affective or non-affective stimuli, which excludes an account in terms of action-valence blindness (Eder & Klauer, 2007). At a representational level, lever movements with an intrinsic affective meaning and button presses with an extrinsic, task-induced affective meaning thus seem to share some ingredients that allow for an interaction between both reactions. This interaction, and its outcome of an incongruency advantage, is surprising and difficult to explain from the perspective of motivational theories that link specific behavioral responses, like lever pulls and pushes (but not any type of evaluative response), to motivational states of approach and avoidance. From a TEC-inspired perspective, however, the interaction between both

[2] One might wonder whether this apparent lack of impact of action planning (here: of the button press) on stimulus identification (here: of the affective words) should be considered a failure to replicate Eder and Klauer (2007). However, so far action-planning effects on the processing of affective (Eder & Klauer, 2007, 2009) and non-affective stimuli (e.g., Müsseler & Hommel, 1997) have been obtained with briefly flashed masked stimuli, in unspeeded tasks, and on accuracy measures only, which does not conflict with failing to obtain such an effect in a speeded reaction-time task with clearly identifiable stimuli. One (theoretically very interesting) possibility for this difference might be that identifying a perceptually degraded stimulus requires the binding of its features (a process that would be impaired by having just bound one of these features to an action plan), whereas responding to a clearly visible stimulus does not.

responses follows straightforwardly from the reference to a common code when representing affective action consequences or outcomes.

In summary, the present findings support the idea of an integration of affective codes into action representations. Lever movements, framed as distance-regulating actions, and button presses, framed as responses that signal a positive or negative stimulus event, derive affective meaning from the action goal they are in service for. The code representing this affective meaning is linked to the respective action plan and occupied by it until the plan is executed. One of the side effects of such code occupation is the delayed binding of the affective code to other action representations, as observed in the present experiments. Lever movements that are intrinsically associated with valence and button presses that are extrinsically associated with valence thus seem to be based on commensurably formatted representations that allow for a code interaction. However, as similar they are on a structural basis, as different they are in the functions they stand for. It remains to be shown in which ways and contents action representations serving approach and avoidance goals differ from other affective action representations. In our view, the idea of an integration of affective action consequences into action representations may serve as a promising departure point to answer these questions.

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