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Common valence coding in action and evaluation: Affective blindness towards response-compatible stimuli

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A common coding account of bidirectional evaluation–behaviour interactions proposes that evaluative attributes of stimuli and responses are coded in a common representational format. This assumption was tested in two experiments that required evaluations of positive and negative stimuli during the generation of a positively or negatively charged motor response. The results of both experiments revealed a reduced evaluative sensitivity (d') towards response-compatible stimulus valences. This action–valence blindness supports the notion of a common valence coding in action and evaluation.

Much evidence for a bidirectional relationship between perception and action has accrued in cognitive psychology. On the one hand, feature correspondence between stimuli and responses affects action-planning processes. On the other hand, characteristics of action-control processes have a selective influence on basic perceptual processes. This perception–action crosstalk is paralleled by a research tradition in emotion psychology: An evaluative match between stimuli and responses can affect action preparation as well as stimulus evaluations. The purpose of this article is to bridge both research lines within a more general perspective on perception–action crosstalks. Specifically, a common coding account of bidirectional evaluation–action relationships is tested that proposes a coding of evaluative attributes of stimuli and responses in a common representational format.

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Influence of stimulus processing on action preparation

In behaviour research the observation that some reactions are performed more efficiently in response to specific stimuli than other assigned reactions is captured by the notion of *stimulus–response (S–R) compatibility*: Reaction planning benefits from a perceptual, conceptual, or structural similarity between the response set and the stimulus set, and the greater this similarity the greater is the size of the S–R compatibility effect supposed to be (Eimer, Hommel, & Prinz, 1995; Kornblum, Hasbroucq, & Osman, 1990). For example, a left key is typically pressed faster in response to an arrow pointing to the left than to the right, and the reverse pattern is typically obtained with right-button presses. Such a feature correspondence of stimulus and response representations is in no way restricted to "natural" response dimensions like spatial orientation. Basically, any conceptual, structural, or perceptual similarity between stimulus and response sets can form the basis for S–R compatibility effects (Kornblum et al., 1990). A particular interesting type of conceptual S–R overlap is created in *affective S–R compatibility* paradigms (e.g., Chen & Bargh, 1999; De Houwer & Eelen, 1998; Fazio, Sanbonmatsu, Powell, & Kardes, 1986). Here stimulus and response sets vary in their positive and negative meaning, and response assignments establish either valence-compatible (same valence) or valence-incompatible (different valence) S–R relations. In affective variants of the so-called Simon task, for example, response selection is affected by a task-irrelevant correspondence between stimuli and responses on the evaluative dimension (e.g., De Houwer & Eelen, 1998). Evaluative responses (e.g., the pronunciation of "good" and "bad") are selected on the basis of a nonevaluative feature (e.g., the grammatical category of words) of clearly valenced stimuli (e.g., words with positive and negative meaning). A typical finding is an improved response selection when the response valence matches the stimulus valence, whereas response planning is hampered by a valence mismatch. Like other types of compatibility effects, affective S–R compatibility effects are predicted by cognitive coding accounts that assume that both stimuli and responses are cognitively represented by means of codes (e.g., by the affective codes "positive" and "negative"), and that response selection is facilitated by a code match and misled by a code mismatch (e.g., Eimer et al., 1995; Kornblum et al., 1990).

Influence of action preparation on stimulus perception

Compatibility effects between stimuli and responses reveal a selective influence of stimulus processing on subsequent action preparation. However, recent research has also shown a reverse influence of action preparation on perceptual processes that challenges linear stage models of stimulus–response translations. In an experiment by Wohlschläger (2000; see also Ishimura & Shimojo, 1994), for example, participants were to turn a knob either in a clockwise or counter clockwise direction. During the turning movement a circular motion display was continuously shifted about a constant angle, so that the motion direction (clockwise vs. counter clockwise) of the display was ambiguous to the perceiver. The results showed that unseen rotational hand movements primed the perception of rotational motion in the direction of the hand movement. Importantly, this effect was even obtained when movements were merely planned during the display presentation rather than executed, showing that action planning is sufficient for visual motion priming. Converging evidence for a crosstalk between action and perception on a common, cognitively specified dimension (e.g., spatial direction or amplitude) was found in several studies that differed in the specifics of perceptual and motor requirements (e.g., Müsseler & Hommel, 1997a, 1997b; Schubö, Prinz, & Aschersleben, 2004; Viviani & Stucci, 1992).

This cognitive research is paralleled by a long-standing interest of emotion psychologists in influences of motor patterns on basic evaluative processes that can be traced back to early ideas of the James–Lange theory on the groundings of emotional experience in physiological and bodily patterns (James, 1884), and to experimental research examining the facial feedback hypothesis that posits an influence of facial expressions on emotional experiences and judgements (Adelman & Zajonc, 1989). An intriguing line of research employed isometric movements of arm extension and flexion that are presumed to be associated with negative and positive outcomes, respectively (e.g., Cacioppo, Priester, & Berntson, 1993; Neumann & Strack, 2000). In several experiments arm flexion induced a positive shift in evaluative judgements of stimuli and arm extension a negative shift in stimulus ratings. Experiments employing arm postures and other types of body movements (e.g., Tom, Pettersen, Lau, Burton, & Cook, 1991; see also Centerbar & Clore, 2006; Cretenet & Dru, 2004) corroborate the claim that actions and their representations can impact on basic evaluative processes.

Common valence coding in action and evaluation

Cognitive research into the influence of action preparation on perception on the one side and affective research into the impact of body movements on evaluations on the other side converge on the conclusion that mental representations of actions and motor movements can influence basic processes of stimulus elaboration. Both lines of research developed fairly independently of each other, and different models were proposed to account for the bidirectionality between stimulus and motor processing in both research areas (e.g., Hommel, Müsseler, Aschersleben, & Prinz, 2001; Neumann, Förster, & Strack, 2003). In the present research we intend to bridge both research traditions within a more general framework on perception–action interactions. Specifically, a common coding assumption is tested that proposes a coding of stimulus and response features in a common representational format.

The assumption of a common coding of stimulus and response features is a key principle of the theory of event coding (TEC; Hommel et al., 2001). The TEC is designed to explain interactions between products of perceptual processes and the first steps of action planning, and rests on three core assumptions. First, an *ideo-motor* or *effect-based view of action control* proposes that motor responses become activated through the anticipation of the responses' sensory consequences (e.g., Beckers, De Houwer, & Eelen, 2002; Elsner & Hommel, 2001; Greenwald, 1970). Second, this effect-based view of action coding is further specified by the *common coding assumption* that suggests that perceived events and anticipated action events are coded in a common representational format (Prinz, 1997). Third, in line with the common coding hypothesis the TEC rejects the assumption of separate sensory and motor codes at the perception–action interface, and replaces it with the notion of *event coding*: Perceived features of objects and planned features of motor actions are cognitively represented through structurally identical event codes, with the effect that stimulus and action features may prime each other on the basis of their overlap in the common representational domain. In consequence the TEC not only predicts biases in action preparation as a consequence of stimulus processing (with S–R compatibility effects serving as prime examples), but it also predicts a reverse influence of action planning on perceptual processes.

How can we test the assumption that affective attributes of stimuli and responses are coded in a common representation format? Assumptions about representation can only be tested in conjunction with assumptions about processes operating on these representations. The TEC incorporates a two-stage model of the dynamics of event coding that allows for specific predictions of a common coding account. In a first *activation stage* distributed stored feature codes of perceived or to-be-produced events are activated, with the effect that they become *more* accessible for other temporally overlapping events. For example, the planning of a left-button press may benefit from the prolonged activation of the feature code "left" in the perceptual encoding of a left-pointing arrow, thus explaining spatial S–R compatibility effects. However, code activation alone is not sufficient for event coding because an additional mechanism is needed to "bind" the information to the relevant events and to distinguish it from information pertaining to other events (Hommel, 2004; Treisman, 1996). This binding is accomplished in a subsequent *integration stage* in which the activated features codes are bound together into a coherent (but not unitary) event code, with the effect that they become *less* accessible to temporally overlapping events. Accordingly, benefits of code or feature overlap are expected only for the activation phase, whereas costs of code compatibility are predicted for the integration phase of event coding. This prediction of compatibility costs (i.e., better task performance in incompatible trials) due to feature encapsulation in action planning was extensively tested in a series of studies conducted by Müsseler and colleagues (see Müsseler, 1999, for an overview).

In their studies Müsseler and colleagues (e.g., Müsseler & Hommel, 1997a) were specifically interested in the influence of action planning upon perceptual processes. The basic procedure involves two temporally overlapping tasks that have a conceptual correspondence on the spatial dimension: A primary *reaction task* requires left and right button presses and a secondary *identification task* demands the identification of the spatial direction of an arrow. Starting with the reaction task participants had unlimited time to prepare a left or right button press (R_1) to a response-specifying stimulus (S_1). The self-paced planning time was to ensure that the integration of (spatial) action features was completed at the time when the to-be-identified arrow was presented. When the participant felt ready for the execution of the response, he or she first performed an initiatory double key press that was immediately followed by the speeded execution of the well-prepared button press (R_1). Importantly, the double press additionally initiated the identification task with the brief presentation of a to-be-identified arrow (S_2) whose direction (left vs. right) was indicated after a fixed delay with another left or right button press (R_2). The crucial manipulation consisted in the R_1–S_2 relation on the spatial dimension that was either compatible (i.e., left–left, right–right) or incompatible (i.e., left–right, right–left). As predicted the results revealed poorer identification of response-compatible arrows than of response-incompatible arrows. This *action–effect blindness* was attributed to an impaired access of perceptual encoding processes to (spatial) feature codes that were already occupied by well-prepared action plans. Furthermore, the very finding that a feature overlap between actions and perceptions produces selective impairments strongly suggests that the coding of percepts and acts draw on commensurably formatted representations.

Subsequent studies corroborated the basic finding and extended it to other variants of the paradigm. Impaired identification of response-compatible stimulus features was found in detection tasks (Müsseler & Hommel, 1997b), with timed-responses (Wühr & Müsseler, 2001), or with speeded responses (Wühr & Müsseler, 2002). These studies investigated the time course of the blindness effect and showed that the effect is somewhat weaker in the planning phase, greatest at the beginning of the response execution, and absent after the execution of the response. Furthermore, blindness effects of equal size were obtained with spatial reactions performed with crossed and uncrossed arms (Kunde & Wühr, 2004), strengthening the assumption of a distal coding of spatial action features in this task. A particularly strong case for the top-down control of action–effect blindness was made in an experiment by Stevanovski, Oriet, and Jolicoeur (2002) who introduced the same arrow (<) as a left-pointing arrow in one condition and as a right-beaming headlight in another condition. Even though the identical stimulus was presented, left key presses selectively impaired the identification of "arrows" pointing to the left but not the identification of "headlights" beaming to the right. Cost-benefit analyses (Müsseler & Wühr, 2002; Oriet, Stevanovski, & Jolicoeur, 2003) showed that the action-induced blindness effect is indeed caused by costs of feature overlap and not by a benefit of code incompatibility. Finally, Kunde and Wühr (2004) generalised action–effect blindness to the colour domain, showing that the pronunciation of colour words (e.g., "red") selectively impaired the identification of corresponding (e.g., red) colour patches.

Extensive research was also done to rule out alternative accounts of action–effect blindness that may arise from $S_1 - S_2$ and $R_1 - R_2$ relationships. Stevanovski, Oriet, and Jolicoeur (2003), for example, obtained a symbolic blindness effect without any action planning with the mere repeated presentation of an arrow within a short time range. This finding is reminiscent of perceptual impairments that became known as repetition blindness effects (e.g., Park & Kanwisher, 1994), and is well within the explanatory scope of event coding that encompasses S–S interactions as well as S–R and R–R couplings (e.g., Stoet & Hommel, 1999; see also Hommel, 2004). However, a particular rigorous exclusion of an $S_1 - S_2$ contribution to action-induced blindness effects was done in an experiment (Müsseler, Wühr, & Prinz, 2000) that included no presentation of a response-imperative S_1 at all. In this experiment participants were to select a left or right button press on their own in a predefined order; nevertheless a blindness effect emerged. Another alternative account of action–effect blindness is that action planning induced a judgement bias (i.e., R_1–R_2 relationship) that biases the selection of the arrow pointing in the direction opposite to that of the planned spatial response. Such a contrasting judgemental strategy mimics a worse identification of response-compatible attributes but does not reflect a perceptual impairment. Müsseler, Steininger, and Wühr (2001) subjected action–effect blindness to signal detection analyses, however, and found a genuine perceptual impairment in the discrimination indices (d') but no judgement bias. In sum, action–effect blindness describes a decreased perceptibility of overlapping stimulus features during the maintenance of a (nearly) completed central movement command. This specific perceptual impairment is assumed to originate from feature coding of action and perception in a common representational domain.

EXPERIMENT 1

On the basis of the TEC we hypothesised that evaluative attributes of stimuli and responses might be also coded in a commensurable representational format. If the planning of affectively charged actions like saying "good" or "bad" encapsulates valence codes, simultaneous evaluations of stimuli with the same valence should be impaired. Accordingly, we predicted an affective variant of the action–effect blindness in a dual task situation that requires evaluations of clearly positive and negative stimuli right before the execution of affectively charged actions. In a first experiment, participants had unlimited time to prepare a left or right button press (R_1) according to the positive or negative meaning of a word (S_1). In line with previous research on affective S–R relations (e.g., De Houwer, 2003), we assumed that this evaluative S–R assignment would impose a positive meaning on the positive classification response (e.g., a right button press) and a negative meaning on the negative classification response (e.g., a left button press). Right before the execution of the well-prepared evaluative response, a target word (S_2) was presented on the screen whose valence was either compatible (i.e., the same valence) or incompatible (i.e., a different valence) with the meaning of the classification response (R_1). In analogy to the findings of action–effect blindness we expected a worse identification of response-compatible stimulus valence than of response-incompatible valence (an effect further referred to as *action–valence blindness*).

Judging the valence of target words under ambiguous presentation conditions is a two-alternative decisional process that might be affected by the strength of evidence as well as by decision rules. We used a signal detection model to disentangle effects on participants' ability to discriminate stimulus valence from possible shifts in response criteria induced by the action planning. The response frequencies from the action planning conditions and targets were analysed jointly by means of the signal detection model shown in Figure 1. For estimation of the response bias measure c we added noise trials to the evaluative signal trials in our experimental design that involved the presentation of meaningless consonant strings instead of words with positive and negative meaning (cf. Müsseler et al., 2001). We selected consonant strings because of the profound difficulties of finding words consistently rated as neutral in valence.

For each response planning condition a response criterion was calculated to model the possibility that the planning of evaluative responses differentially biases the judgements "positive" or "negative" (see Figure 1). The relative position of the response criteria c_{positive} and c_{negative} on the strength-of-evidence axis can be used to determine which judgement strategies are used by the decision maker (cf. Müsseler et al., 2001). First, decision makers might adopt a *contrast strategy* when uncertain about the valence of stimuli,

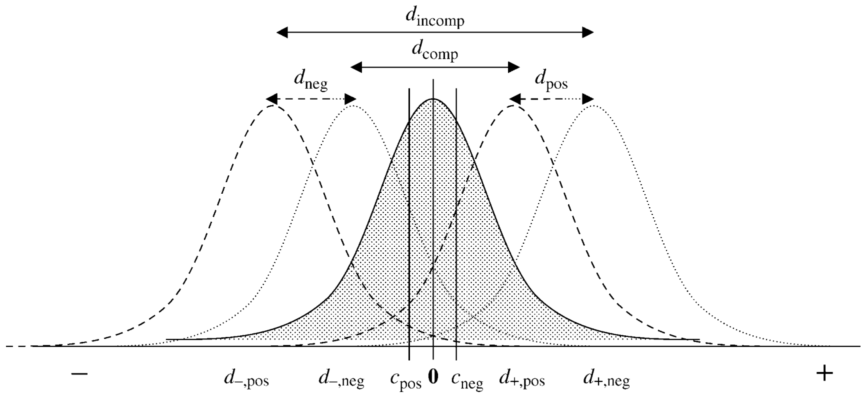

Figure 1. Graphical representation of the signal detection model and its parameters. The shaded distribution in the middle indicates the noise distribution. Positive and negative action planning conditions are indicated by the subscripts $_{\text{pos}}$ and $_{\text{neg}}$, respectively. Positive and negative target signals are specified by the subscripts $_{+}$ and $_{-}$, respectively.

that is, they might prefer the valence opposite to that of the response valence (i.e., a judgemental bias for "positive" after a negative button press and vice versa). A contrast bias increases the hit rate for target words with response-incompatible valence and the miss rate for target words with response-compatible valence without any concomitant changes in perceptibility, thus overestimating action–valence blindness in percent correct measures. Second, and exactly the opposite of a contrast strategy, is an *assimilation strategy* that is reflected in the tendency to choose the valence that is congruent with the response valence (i.e., more judgements of "negative" and "positive" in conditions with the planning of negative and positive button presses, respectively). In percent correct measures an assimilation bias underestimates action–valence blindness with more hits in response-compatible trials and more misses in the response-incompatible trials. In sum, the proportion of correct valence identification might result in a systematic overestimation (contrast bias) or underestimation (assimilation bias) of action–valence blindness, necessitating signal detection analyses to separate perceptual sensitivity (d') from judgement preferences (c).

Following standard scaling assumptions of signal detection analyses (Wickens & Hirshman, 2000) six model parameters were defined by crossing target valence (S_2: positive vs. neutral vs. negative) and evaluative action (R_1: positive vs. negative): Two response criteria, c_{positive} and c_{negative}, and four d'-values for the means of the distributions of positive and negative targets $(+,-)$ preceded by the two evaluative classification responses (positive, negative), $d_{-,\ \text{negative}}$, $d_{-,\ \text{positive}}$, $d_{+,\ \text{negative}}$, $d_{+,\ \text{positive}}$. The distribution of neutral targets, shown as the shaded area in Figure 1, was given a zero mean, independently of the kind of prior response planning. Parameter values were estimated from each participant's data, using an iterative search algorithm that maximised the likelihood of the observed data. The effects of evaluative action planning on target valence perception are modelled by shifts of the target distributions: Negative classification responses (R_1) are assumed to induce a small shift of negative targets to the right of average size d_{negative} thereby making an erroneous positive response somewhat more likely. This shift is measured relative to the distribution of negative targets preceded by positive responses. Analogously, positive classification responses are assumed to produce a small shift of each positive target to the left of average size d_{positive} making an erroneous negative response more likely. This shift is measured relative to the distribution of positive targets preceded by negative responses. Action–valence blindness can be assessed for each kind of target valence on the basis of these parameters by computing $d_{\text{negative}} = d_{-,\ \text{negative}} - d_{-,\ \text{positive}}$ and $d_{\text{positive}} = d_{+,\ \text{negative}} - d_{+,\ \text{positive}}$, or alternatively by the aggregation of discrimination estimates to perceptibility indices of the valence of response-compatible targets ($d_{\text{compatible}} = d_{+,\ \text{positive}} - d_{-,\ \text{negative}}$) and response-incompatible target words ($d_{\text{incompatible}} = d_{+,\ \text{negative}} - d_{-,\ \text{positive}}$). Finally, an overall index of action–valence blindness is computed by the subtraction of response-compatible target perceptibility from the sensitivity index for response-incompatible targets (i.e., action–valence blindness $= d_{\text{incompatible}} - d_{\text{compatible}}$).

Method

Participants. A total of 20 students (7 men, 13 women) with different majors participated in fulfilment of course requirement or for payment. All participants had normal or corrected-to-normal vision and were fluent in German. Two participants were dropped from data analyses because their percentages of correct R_1 within the time limit ($M = 61.5\%$ and $M = 62.1\%$, respectively) was several standard deviations below the mean correct rate of the rest of the sample ($M = 91.9\%$, $SD = 5.1$; $n = 18$).

Apparatus and stimuli. In a dimly lit experimental chamber participants were seated at a distance of 50 cm from a 17-inch VGA colour monitor with 70 Hz refresh rate. Stimulus presentation and measurement of response latencies were controlled by a software timer with video synchronisation (Haussmann, 1992). To respond, the participants had to press the two buttons of a computer mouse with the index and middle fingers of the dominant hand (15 right-handed, 3 left-handed).

As response-specifying stimuli (S_1) served 72 strongly positive ($M = 1.1$, $SD = 0.22$) and 72 strongly negative nouns ($M = -1.4$, $SD = 0.29$) selected from a standardised word pool on the basis of their evaluative norms (Schwibbe, Röder, Schwibbe, Borchardt, & Geiken-Pophanken, 1981). Twenty additional nouns (10 positive, 10 negative) served as practice stimuli. All nouns comprised between 3 and 12 letters and were presented in upper case in white-on-black at the centre of the computer screen. Target stimuli (S_2) were 48 clearly positive ($M = 2.1$, $SD = 0.45$) and 48 clearly negative adjectives ($M = -2.1$, $SD = 0.53$) taken from the same standardisation study as the nouns were. The subsets of positive and negative adjectives did not differ in valence extremity, frequency of usage, or number of letters (range: 4–9), with all Fs < 1. Ten additional positive and ten negative adjectives were selected for practice trials. All adjectives were presented in lower case letters in grey-on-black at the centre of the computer screen. Finally, 6 consonant strings (e.g., "ysvw") of ascending length (range: 4–9) were constructed as "noise" stimuli that shared no letter with the test or practice adjectives on a specific letter position.

Design. The experimental design was a crossed 2 (R_1 planning: positive vs. negative) $\times$ 3 (S_2 target: positive vs. neutral vs. negative) factorial design. Each block consisted of three trials from each of the six conditions of the design, resulting in 18 trials per block that were presented in random order. Each participant worked through 16 experimental blocks. In total there were 96 response-compatible, 96 response-incompatible, and 96 response-neutral assignments.

Procedure. Each experimental session consisted of an adjustment phase and an experimental phase. In the adjustment phase the presentation duration of the target words was individually adjusted to avoid ceiling or floor effects in the identification task of the test phase. Participants performed 8 blocks with 12 trials each that involved the presentation of a positive or negative adjective with equal probability. Target words were the same adjectives that were later used as targets in the experimental phase, and they were randomly drawn from the word pool without replacement. Each trial started with the brief presentation (100 ms) of an asterisk (*) as a fixation mark in the middle of the screen. After an additional interval of 100 ms, a white premask (XXXXXXXXX) was presented for one refresh cycle (14 ms), immediately followed by the adjective that stayed on the screen for an individually set presentation time (starting with 114 ms in the first block). The target word was followed by a white postmask (XXXXXXXXX) for 1 s, followed by a blank screen for 257 ms. An identification screen then appeared that asked the participant for his or her valence judgement with a corresponding left or right mouse button press. An arbitrary time limit of two seconds was set for the judgement but no emphasis was put on the speed of the response. To counteract systematic valence–response associations, the assignment of the classification response to the mouse button was random, and each of the two assignments appeared with equal probability in each block. At the end of each trial participants were informed about false valence judgements or time-limit violations if any. The next trial started after one second.

After each block the word presentation time was adjusted using a staircase procedure to achieve a correct valence identification rate between 59% and 84% (cf. Müsseler & Hommel, 1997a). The presentation time was decreased by 14 ms when the error rate was equal or lower than 16%. It was increased by 14 ms when the error rate was equal or above 41%. The final presentation time was computed by averaging across presentation times of the last three blocks (rounded up or down to the next multiple of the refresh cycle).

After the adjustment phase participants were informed that the valence identification task would now become more complicated with the simultaneous handling of an additional simple "reaction task." The sequence of events in the test phase is shown in Figure 2. For the reaction task a single mouse button press (R_1) was prepared according to the valence of a noun (S_1) presented at the beginning of each trial for 500 ms. A negative noun dictated a left button press and a positive noun a right button press. In the

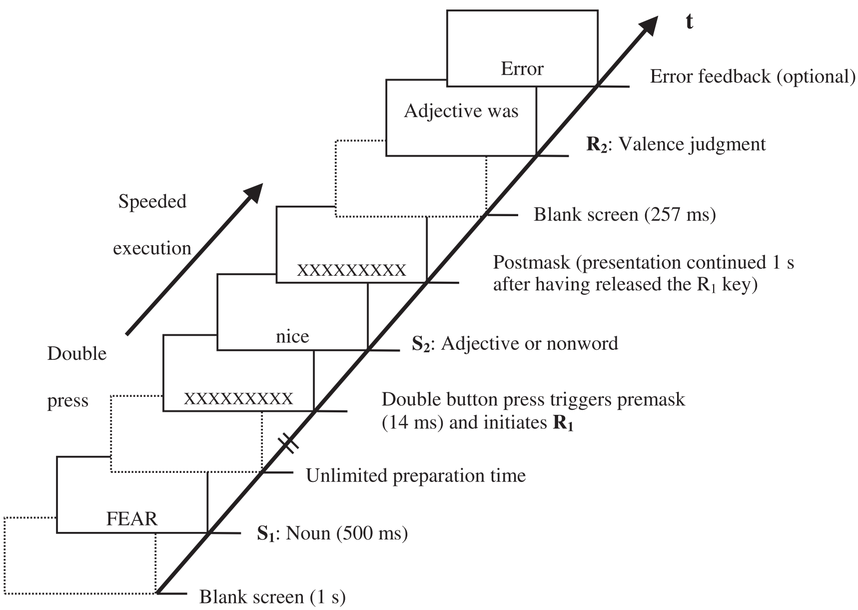

Figure 2. Sequence of events in an experimental trial of Experiment 1. The subscripts $_1$ and $_2$ refer to Task 1 (reaction task) and Task 2 (identification task), respectively.

instructions strong emphasis was put on the unlimited planning time of the mouse button response that was purported to greatly improve the task performance. When the participant felt ready for the execution of the left or right button press, he or she first pressed both mouse buttons simultaneously and then the appropriate single mouse button (R_1) as quickly as possible. A time limit of 600 ms was set for the execution of the single button press after the double press to ensure a thorough planning of the response. The double button press additionally initiated the valence identification task the sequence of events of which paralleled that of the identification task in the adjustment phase, except for the omission of a fixation mark and the presentation of neutral target stimuli. The presentation time of neutral targets was fixed to a brief 42 ms, and a wrong S_2 identification was reported in half of the noise trials in each block to maintain the illusion of word presentations. The postmask stayed on the screen for one second after the release of the R_1 button, adding up to a minimum R_1–R_2 delay of 1257 ms. A single trial ended with an optional error feedback that reported a wrong R_1, a false identification of S_2, and violations of the time limits of R_1 and R_2. In addition, a detailed performance summary was given at the end of each block.

Participants worked first through 20 practice trials with 10 response-compatible and 10 response-incompatible assignments (i.e., no neutral stimuli were presented in the practice block), followed by the 288 experimental trials. The final S_2 presentation time of the adjustment phase set the presentation duration of S_2 in the practice block, but was still adjusted (if necessary) after each experimental block according to the staircase procedure detailed above.

Results

The mean adjusted presentation duration for S_2 across all participants was 67 ms ($SD = 21$ ms). Trials with wrong R_1 (4.8% of all trials) and/or R_1 exceeding the time limit of 600 ms (4.3% of all trials) were excluded from further data analyses, thereby eliminating 8.1% of all trials. Error rates did not interact with the compatibility factor nor did the number of valid trials, all $F\text{s} < 1$.

Proportion correct identification. The percentages of correct valence identifications were separately calculated for each condition of the 2 (R_1: positive vs. negative) $\times$ 2 (S_2: positive vs. negative) matrix, as listed in Table 1, and subjected to a repeated measures analysis of variance (ANOVA) with Valence (positive vs. negative) and Compatibility (compatible vs. incompatible) as within-participants factors. The analysis revealed a better valence identification of response-compatible words ($M = 73.6\%$, $SE = 0.6$)

than of response-incompatible words ($M = 68.1\%$, $SE = 1.5$), $F(1, 17) = 10.3$, $p < .01$, but as indicated by a significant interaction, $F(1, 17) = 14.5$, $p < .01$, the effect was restricted to negative words. The identification rate of negative words was, however, not different from that of positive words across both planning conditions ($M = 70.4\%$ vs. $M = 71.2\%$, $F < 1$). The presence of a response bias was tested in an additional repeated-measures ANOVA of the "negative" judgement rates in each cell of the 2 (R_1: positive vs. negative) $\times$ 3 (S_2: positive vs. neutral vs. negative) design. Beside the trivial main effect of the S_2-factor with more frequent negative-judgements after negative adjective presentations than after nonword and positive word presentations, $F(2, 34) = 226.2$, $p < .001$, the main effect of the planning condition R_1 became significant showing more frequent negative judgements after negative planning ($M = 57.2\%$, $SE = 1.3$) than after positive response planning ($M = 49.1\%$, $SE = 1.2$), $F(1, 17) = 20.1$, $p < .001$. The interaction between both factors was also significant, $F(2, 34) = 11.7$, $p < .001$. The joint impact of action planning and S_2 valence on response bias and identification rates that is expressed in this interaction is disentangled in the signal detection analyses presented next.

Signal detection analyses. Table 1 shows mean perceptual sensitivity d' for each cell of the 2 (R_1) $\times$ 2 (S_2) matrix, and the estimates of the response criterion c for each action-planning condition. The positive scores of the response bias indices c reveal that participants did generally prefer to choose "negative" over "positive" when uncertain about stimulus valence.

TABLE 1

Mean percent correct, sensitivity d', and response criterion c for affectively charged words in evaluative action planning conditions of Experiments 1 and 2 (Standard Deviations in parentheses)

	Percent correct			*Sensitivity d'*		
Action plan	*Positive S_2*	*Neutral S_2*	*Negative S_2*	*Positive S_2*	*Negative S_2*	*Response criterion c*
Experiment 1						
Positive R_1	70.0 (5.2)	53.6 (10.5)[a]	63.6 (8.4)	0.63 (0.27)	−0.51 (0.26)	0.10 (0.28)
Negative R_1	72.4 (7.5)	66.9 (12.2)[a]	77.3 (6.2)	0.82 (0.37)	−0.30 (0.31)	0.47 (0.37)
Experiment 2						
Positive R_1	70.2 (6.3)	49.8 (9.4)[a]	68.6 (7.8)	0.53 (0.23)	−0.62 (0.37)	0.00 (0.24)
Negative R_1	72.3 (8.2)	61.6 (10.5)[a]	74.6 (7.4)	0.80 (0.23)	−0.37 (0.27)	0.31 (0.30)

Note. Positive values on the response criterion c signify an inclination towards the decision "negative" and negative values a tendency to decide "positive". For the sensitivity index d' greater deviations from zero indicate a better discrimination performance. Sensitivity indices were estimated relative to neutral S_2-judgement distributions in each planning condition.

[a]Proportion of judgement "negative" in percent.

More importantly, this judgement preference was significantly influenced by the prior action-planning condition. Participants were more inclined to decide "negative" after the planning of a negative button press ($c = 0.47$, $SE = 0.09$) and less so after the planning of a positive button press ($c = 0.10$, $SE = 0.07$), $t(17) = 4.31$, $p < .001$, revealing a strong assimilation bias in evaluative decisions. To test for action–valence blindness, mean scores of perceptual sensitivity d' were analysed that were uncontaminated by the assimilation bias in valence judgements. As predicted, perceptual sensitivity (d') to the valence of response-compatible words ($d'_{\text{comp}} = 0.92$, $SE = 0.09$) was on average significantly lower than the sensitivity to the valence of response-incompatible words ($d'_{\text{incomp}} = 1.34$, $SE = 0.10$), $t(17) = 2.54$, $p < .05$. This action–valence blindness was of moderate size ($\Delta\ d' = 0.42$) and equally strong for positive and negative R_1–S_2 compatibility relations, as there was no interaction with the valence factor, $F < 1$ (see Table 1).

Reaction times. Reaction times of R_1 were measured from the onset of the double button press to the onset of the single mouse button press. An overall t-test revealed that reactions overlapping with neutral S_2 ($M = 304$ ms, $SE = 16.7$) were executed significantly faster than reactions that concurred with the presentation of evaluative S_2 words ($M = 307$ ms, $SE = 17.4$), $t(17) = -2.45$, $p < .05$. This small difference was not due to a trade-off in the accuracy of the reactions, $F < 1$. To our surprise, the execution of R_1 was also selectively affected by an evaluative overlap with the S_2 word. In signal trials S_2-compatible button presses ($M = 306$ ms, $SE = 17.4$) were performed significantly faster than affectively incompatible button presses ($M = 309$ ms, $SE = 17.5$), $t(17) = -2.12$, $p < .05$. A further decomposition of R_1 latencies in release times for the double button press and single button press latencies revealed that the compatibility effect is mainly located in the latencies of the R_1 button presses [compatible: $M = 113$ ms, $SE = 10.3$, vs. incompatible: $M = 115$ ms, $SE = 10.4$, $t(17) = -1.86$, $p < .05$], whereas the release times of the buttons after the double button press did not differ with compatible ($M = 193$ ms, $SE = 11.9$) and incompatible R_1–S_2 assignments ($M = 194$ ms, $SE = 12.1$), $t(17) = -1.14$, $p = .27$. Of course, the performance difference of 3 ms is very small but it is significant and it cannot be explained by a trade-off in response accuracy or time-limit violations (all Fs < 1). Finally, latencies of the unspeeded valence judgements (R_2) were measured from the onset of the identification screen to the onset of the classification response. For reaction time analysis, latencies exceeding the time limit of 2000 ms were dropped from analysis (0.3% of all trials). There were no differences in judgement speed between noise ($M = 640$ ms, $SE = 32.7$) and signal trials ($M = 636$ ms, $SE = 31.1$), $F < 1$. Furthermore, a compatibility effect approached significance with faster response-compatible judgements ($M = 629$ ms, $SE = 30.7$) than incompatible decisions ($M = 643$ ms, $SE = 31.9$) in signal trials, $t(17) = -1.71$, $p = .11$, presumably reflecting an assimilation bias in judgement latencies.

Discussion

The central finding of Experiment 1 is a decreased evaluative sensitivity (d') towards response-compatible stimuli that are presented during the generation of an evaluative classification response. A positive meaning of words was harder to detect when a positive classification response was planned than when a negative response was prepared. An analogous impairment was found for evaluations of negative words that overlapped with negative action plans. The impairment in valence discrimination (d') is likely to reflect a genuine perceptual impairment, as strategic factors like a contrast bias can be ruled out as an alternative explanation.

Proportion correct measures that exclusively consider hit-rates in valence identification proved not to be sensitive to perceptual impairments. These measures were contaminated by participants' tendency to align uncertain evaluative decisions to the valence of the foregoing action plan (and/or response-specifying S_1 noun), inflating the hit-rate (and false alarm rate) in response-compatible trials. Signal detection analyses revealed that the improved identification of response-compatible valences in percent correct measures reflect a strong assimilation bias and not a change in valence perceptibility. The assimilation bias itself comes as no surprise as many experimental studies have shown an affective priming of evaluative judgements on a conceptual level (e.g., Murphy & Zajonc, 1993). Valence becomes strongly activated in the course of S_1 elaboration and R_1 planning, and it is reasonable to assume that a residual activation survives the rather long R_1–R_2 delay, priming evaluative decisions in ambiguous judgemental situations in a subtle way. In addition, one might also construe the assimilation bias as a sort of manipulation check that reveals the effectiveness of the S_1–R_1 mapping to impose a positive and negative meaning on button presses.

The effects of S_2 processing on the execution times of the well-prepared button presses (R_1) were unexpected, especially in view of the short reaction times (range of mean latencies: 221–454 ms). The finding of slower button presses with the simultaneous processing of evaluative information points to mental capacity restrictions that are typical of dual task situations (e.g., Jolicoeur, 1999). The faster execution of S_2-compatible button presses, however, poses an explanatory challenge because it is very unlikely that response-selection processes are still affected after the long response preparation time ($M = 1322$ ms, $SD = 459$). Note, however, that this small-sized compatibility benefit was not replicated in Experiment 2 despite only minor task changes.

EXPERIMENT 2

In Experiment 1 we obtained first evidence that the planning of affectively charged actions like negative and positive button presses (R_1) selectively impairs simultaneous evaluations of stimuli (S_2) with the same valence. However, one can doubt this interpretation of an action-induced blindness in view of the perfect confounding of the action valence with the valence of the response-imperative noun (S_1). The mere presentation of the valenced words S_1 and S_2 in succession might be already sufficient to produce an impaired identification of stimuli with the same valence (Silvert, Naveteur, Honoré, Sequeira, & Boucart, 2004; Stevanovski, Oriet, & Jolicoeur, 2003). Therefore, we conducted a second experiment to rule out any remaining doubts that it is indeed the planning of evaluative actions that selectively interferes with evaluations of same-valenced stimuli. In Experiment 2 affectively neutral letters were used as response-imperative stimuli (S_1) to instruct the planning of positive and negative button presses (R_1). If action–valence blindness is still observed despite the use of affectively neutral S_1, emotional repetition blindness arising from the S_1–S_2 relationship can be ruled out as an alternative explanation.

Method

Participants. Twenty students (6 men, 14 women) with different majors participated in fulfilment of course requirement or for payment. All participants had normal or corrected-to-normal vision and were fluent in German. Six participants out of 20 reported left-handedness. None of the subjects had participated in Experiment 1.

Stimuli, design, and procedure. Experiment 2 was identical in design and procedure to Experiment 1 except for the following changes. Positive and negative nouns were now replaced by the letters *P*, *O*, or *S* specifying a positive (right) button press and the letters *N*, *E*, or *G* requiring a negative (left) button press. The letters (S_1) appeared in white-on-black on the centre of the screen for 500 ms. To ensure a positive and negative coding of the button presses, participants were additionally required to pronounce "positive" at the time of the positive button press and "negative" at the time of the negative button press. A female experimenter blind to the hypotheses was sitting beside the participant and controlled on-line timing and accuracy of the vocal responses. The pronunciations of the response valence were additionally recorded with an audio tape recorder. To avoid an intrusion of the vocal responses into the valence judgement phase, the R_1–R_2 delay was increased by extending the presentation of the postmask for additional

500 ms. The valence judgement screen thereby followed R_1-offset no sooner than 1757 ms.

Results

The mean adjusted presentation duration for S_2 was 63 ms ($SD = 27$ ms). Trials with wrong R_1 (1.6% of all trials) and/or R_1 exceeding the time limit of 600 ms (3.4% of all trials) were excluded from further data analyses, thereby eliminating 4.8% of all trials. Error rates did not interact with the compatibility factor (both $ps > .15$) nor did the total number of valid trials, $F < 1$.

Proportion correct identification. Table 1 shows the mean percentage of correct valence identifications in each condition of the 2 (R_1: positive vs. negative) × 2 (S_2: positive vs. negative) design. A repeated-measures ANOVA with Valence (positive vs. negative) and Compatibility (compatible vs. incompatible) as within-participants factors showed neither a main effect of valence ($M = 71.2$, $SE = 1.2$ vs. $M = 71.6$, $SE = 0.9$, for positive and negative words, $F < 1$) nor differences in the valence identification of response-compatible ($M = 72.4$, $SE = 0.8$) and response-incompatible adjectives ($M = 70.4$, $SE = 1.2$), $F(1, 19) = 1.19$, $p = .29$. The interaction between the factors valence and compatibility was, however, significant with a compatibility advantage in the discrimination of negative words and a compatibility disadvantage in the identification of positive words, $F(1, 19) = 4.7$, $p < .05$. An additional repeated-measures ANOVA of the "negative" judgement rates in each cell of the 2 (R_1: positive vs. negative) × 3 (S_2: positive vs. neutral vs. negative) design showed a main effect of the S_2 factor with more frequent negative judgements after negative adjective presentations than after nonword and positive word presentations, $F(2, 38) = 314.2$, $p < .001$, a significant main effect of the planning condition R_1 showing more frequent negative judgements after negative ($M = 54.6\%$, $SE = 1.4$) than positive response planning ($M = 49.4\%$, $SE = 1.0$), $F(1, 19) = 10.6$, $p < .01$, and a significant interaction between both factors, $F(2, 38) = 7.71$, $p < .01$. The joint impact of response planning and S_2 valence on response bias and identification rates that is expressed in this interaction is disentangled in the signal detection analyses presented next.

Signal detection analyses. Indices for evaluative sensitivity d' and response strategies c were separately calculated for positive and negative targets in each planning condition (see Table 1). Inspection of the response criteria applied by the decision makers revealed a strong assimilation of uncertain valence judgements (R_2) to the valence of the foregoing action plan (R_1), $t(19) = -4.15$, $p < .001$. Thus, after the planning of negative button presses participants were more inclined to judge "negative" than "positive" (mean $c = 0.31$, $SE = 0.07$). In contrast, the planning of a positive button press exerted no priming influence on valence judgements across all participants (mean $c = 0.00$, $SE = 0.05$). Most importantly, mean evaluative sensitivity d' was lower for response-compatible words ($d'_{\text{comp}} = 0.90$, $SE = 0.07$) than for response-incompatible words, $d'_{\text{incomp}} = 1.42$, $SE = 0.10$, $t(19) = -3.13$, $p < .01$, replicating action–valence blindness observed in Experiment 1. The perceptual impairment was of moderate size ($\Delta\ d' = 0.52$), and equally pronounced for the identification of positive and negative targets as was revealed by a lack of interaction between target valence and compatibility, $F(1, 19) = 0.4$.

Reaction times. Reaction times of R_1 (speeded evaluative button presses) and R_2 (unspeeded valence judgements) were measured in the same way as was done in Experiment 1. There were no differences in R_1 execution times between signal ($M = 325$ ms, $SE = 23.8$) and noise trials ($M = 325$ ms, $SE = 24.3$), $p = .64$. Furthermore, S_2-compatible button presses ($M = 325$ ms, $SE = 24.1$) were executed on average with identical speed as S_2-incompatible button presses ($M = 325$ ms, $SE = 24.5$), $p = .97$. Valence judgement (R_2) latencies exceeding the time limit of 2000 ms were dropped from reaction-time analysis (0.1% of all trials). Evaluative decisions were made significantly faster for noise trials ($M = 555$ ms, $SE = 27.5$) than for signal trials, $M = 593$ ms, $SE = 30.5$, $t(19) = -2.49$, $p < .05$. There was only a tendency for response-compatible S_2 ($M = 590$ ms, $SE = 31.2$) to elicit faster judgements than response-incompatible S_2 ($M = 598$ ms, $SE = 30$), $t(19) = -1.48$, $p = .16$.

Discussion

Experiment 2 replicated action–valence blindness despite the use of affectively neutral letters (S_1) to instruct positive and negative action planning. Emotional repetition blindness due to the mere repeated presentation of valenced words (S_1–S_2) is consequently no longer a viable alternative explanation for action–valence blindness in this experiment, strengthening the attribution of action–valence blindness to the compatibility of the R_1–S_2 relationship. However, one might still uphold an S_1–S_2 interference account assuming that originally neutral letter symbols might have acquired a weak positive and negative valence due to consistent pairings with pronunciations of "positive" and "negative". In this case action–valence blindness should grow in size with the number of S_1–R_1 pairings as evaluative conditioning trials; we observed, however, no differences in the size of the specific evaluation impairment in the first and second half of the experimental blocks ($F < 1$). Furthermore, very long time intervals between the presentations of S_1 and S_2 (range of mean planning time: 522–2301 ms in Exp. 1 and 377–1687 ms in Exp. 2) are known to eliminate repetition blindness effects at a symbolic and perceptual level (Park & Kanwisher, 1994; Silvert et al., 2004; Stevanovski et al., 2003). Accordingly, we view a symbolic repetition blindness effect arising from the S_1–S_2 relationship as an implausible explanation of the blindness effects observed in our experiments.

For Experiment 2 we cannot decide whether evaluative sensitivity (d') was selectively reduced by the planning of positive and negative button presses, by the preparation of the pronunciation of their valence, or by the grouped planning of both responses. But whatever R_1–S_2 combination might have been responsible for the identification impairment, the conclusion is upheld that the planning of affectively charged *actions* is sufficient to produce selective impairments in evaluations of same-valenced stimuli.

GENERAL DISCUSSION

Two experiments consistently showed reduced sensitivity (d') for the valence of positive and negative stimuli during the execution of compatible positive and negative actions. This action–valence blindness was masked in proportion correct measures by a strong assimilation bias in valence judgements, presumably reflecting affective judgement priming on a conceptual level (e.g., Murphy & Zajonc, 1993). Nevertheless, in the d' metric of signal-detection models the mean magnitude of action–valence blindness observed in Experiment 1 ($\Delta\, d' = 0.42$) and Experiment 2 ($\Delta\, d' = 0.51$) are close to the mean effect sizes found in spatial variants of action–effect blindness (e.g., $\Delta\, d' = 0.46$ and $\Delta\, d' = 0.49$ in Experiment 1 and 2 of Müsseler et al., 2001). Furthermore, alternative accounts of action–valence blindness that arise from confoundings with S_1–S_2 and R_1–R_2 relationships were ruled out through the use of signal detection measures in both experiments and through the use of affectively neutral S_1 in Experiment 2. These experimental and data-analytic controls strengthen the assumption that the planning of positively and negatively charged actions interfered with simultaneous evaluations of same-valenced stimuli.

The empirical finding of action–valence blindness is of theoretical importance in several respects. First, it provides first evidence for an influence of discrete motor movements on evaluative processes. Previous research into action-evaluation influences mainly employed isometric arm positions (arm flexion and extension) that were manipulated between participants. The present research extends findings of action-evaluation interactions to trial-to-trial variations of valenced actions. Second, the impact of task-induced action valences on evaluations extends previous work on the influence of intrinsically valenced movements on evaluations. The bidirectional evaluation–behaviour link is accordingly not restricted to approach and avoidance movements but does also operate with rather artificially valenced actions like positive and negative button presses. In this respect it is interesting to note that Eder and Klauer (2004) also observed a reduced evaluative sensitivity towards positive and negative stimuli during the generation of (positive) arm flexing and (negative) arm extending lever movements, respectively. This finding suggests that similar processes might be involved in the control of explicitly valenced button presses and more implicitly valenced approach and avoidance movements (cf. Lavender & Hommel, 2007 this issue). Third, on the basis of the dynamic model of the TEC (Hommel et al., 2001) we predicted worse evaluation performance with affective code match than with code mismatch. Costs of affective compatibility pose a challenge to existing theories on the evaluation–behaviour link that uniformly expect a processing advantage given an affective or motivational correspondence between stimuli and responses (e.g., Lang, Bradley, & Cuthbert, 1998; Neumann et al., 2003). Moreover, findings of action–evaluation interactions are also beyond the explanatory scope of cognitive compatibility models commonly used in the explanation of affective S–R compatibility effects (e.g., the dimensional overlap model; Kornblum et al., 1990). The TEC makes the novel prediction of affective compatibility costs in action-evaluation interactions and is thereby capable of explaining the present data. Fourth, action–valence blindness clearly shows that a conceptual correspondence between action and stimulus features on the evaluative dimension is sufficient for the emergence of blindness effects. This and other findings of conceptually based blindness effects (e.g., Kunde & Wühr, 2004; Stevanovski et al., 2002) support the conclusion that blindness towards response-compatible stimuli is not restricted to perceptual or perceptually derived feature overlaps (see also Hommel & Müsseler, 2006), although this distinction between "perceptual" and "conceptual" features is blurred in the assumption of recent embodiment views that even abstract word-referents are grounded in concrete somatosensory states (see Duncan & Barrett, 2007 this issue).

Another consistent finding in both experiments is the strong assimilation bias in valence judgements (R_2) that was estimated from the trials with nonword presentations. Participants were more inclined to choose "negative" after planning a negative response than after the preparation of a positive button press. Note that peripheral R_1–R_2 associations cannot explain this judgement bias because the assignment of the valence to the mouse buttons was balanced in each block. A more plausible explanation offers a conceptual variant of affective priming that shows up in congruent shifts in preference ratings of neutrally valenced stimuli after presentations of positive and negative prime stimuli (e.g., Murphy & Zajonc, 1993). In one study (Rotteveel & Phaf, 2004) participants evaluated the connotation of Japanese ideographs with button presses labelled "positive" and "negative", and results revealed more frequent positive ideograph evaluations after presentations of happy facial expressions and more frequent negative judgements after presentations of angry facial expressions in conditions of working memory load. The similarity of this preference judgement task to the evaluative identification task of our experiments is obvious because in both tasks information about the target valence is missing or only weakly activated, opening irrelevant evaluative activations a gate to shift the weights in the decision process. It is remarkable, however, that participants were generally more inclined to judge "negative" in uncertainty about the word valence; in fact, collapsed across both planning conditions a response bias favouring "negative" was observed in both experiments. The bias was significant in Experiment 1 (mean $c = 0.28$, $SD = 0.27$), $t(17) = 4.47$, $p < .001$, and in Experiment 2 (mean $c = 0.15$, $SD = 0.21$), $t(19) = 3.2$, $p < .01$. This negativity bias in judgemental tendencies suggests that better hit rates for negative stimuli (e.g., Dijksterhuis & Aarts, 2003; see also Labiouse, 2004) can reflect judgemental bias rather than enhanced perceptual discriminability.

The present research adds a further piece to the puzzle of the bidirectional evaluation–behaviour link in suggesting that the valence of stimuli and responses is coded in a common representational format. The empirical finding that a valence overlap between stimuli and responses is detrimental to evaluation performance argues strongly for the assumption that valence coding of stimuli and responses draws on common resources. For the response selection stage common valence coding rejects a translation of "perceptual" valence codes in "motor" valence codes, or some sort of automatic spreading activation between distinctively coded valence representations; instead, it is assumed that actions are selected by their affective consequences, which are commensurably coded with the valence of perceived events (cf. Lavender & Hommel, 2007 this issue).

The TEC (Hommel et al., 2001) suggests a two-stage model of the dynamics of perceptual and action coding processes that can be easily adapted to explain well-established findings of affective compatibility benefits (e.g., sequential affective priming effects; Fazio et al., 1986; see Klauer & Musch, 2003, for a review) as well as novel findings of affective compatibility costs (e.g., action–valence blindness). Benefits of affective code match are attributed to valence activation in a common coding domain that "primes" access to matching feature compounds in response planning (e.g., S–R compatibility effects in affective priming) and target categorisation (e.g., S–S compatibility effects in affective priming; see Klauer, Musch, & Eder, 2005). Costs of affective code match are instead attributed to a feature integration process that binds (activated) feature codes belonging to perceptual objects and actions together to an event file so that single feature codes cannot be addressed anymore without activating the whole event file. It is assumed that valence codes once integrated are occupied by their respective feature compounds, rendering them less accessible for other event codes that need to bind the very same valence code (Hommel & Müsseler, 2006; Müsseler & Hommel, 1997a, 1997b). According to this view action–valence blindness is explained by an encapsulation of valence codes in affective action planning that impairs code access or code integration in overlapping evaluations of same-valenced stimuli. Similarly, valence-specific negative priming observed in sequential affective priming (Wentura, 1999) and in modified affective Simon tasks (De Houwer, Rothermund, & Wentura, 2001) can be explained by a time-consuming dissolution and rebinding process of automatically retrieved S–R episodes in ignored-repetition trials (cf. Rothermund, Wentura, & De Houwer, 2005). Note that the mere temporal co-occurrence of stimulus features, and of stimuli and responses, is considered to be sufficient to bind their codes (Hommel, 2005). However, which features are activated and integrated is assumed to depend heavily on their task-relevance and on the attentional set imposed by the specific task setting (Hommel & Colzato, 2004), explaining the evaluative task goal-dependency of affective S–R compatibility effects (e.g., Klauer & Musch, 2002; Lavender & Hommel, 2007 this issue).

Given the similar findings in cognitive and affective variants of blindness towards response-compatible stimuli one might ask whether we do not deprive affective meaning of its distinctiveness in deliberate evaluative classifications, treating valence just like any other semantic category in this specific experimental setup. First, note that the scope of the present research is restricted to (bidirectional) interactions between evaluation and action that are typical of affective S–R compatibility paradigms (e.g., sequential affective priming, affective Simon task) and to motor compatibility paradigms showing an influence of motor states on evaluations (e.g., Neumann & Strack, 2000). Accordingly, the fuzzy concept "affect" refers here to categorical evaluations in positive and negative that should not be confused with emotional and mood states. Just like many other researchers interested in affect and emotion we do however think that investigations of evaluative processing effects reveal important processes underlying many "hot" phenomena including feelings and emotions. Cacioppo, Larsen, Smith, and Berntson (2004), for example, claim fast and frugal evaluative categorisations as the operating system driving affect, emotion, and feeling. Duncan and Barrett (2007 this issue) similarly view hedonic valence (pleasure/displeasure) besides arousal as constituents of "core affect" that determines phenomenological outcomes including feeling states. In addition, many appraisal-theorists of emotion regard an evaluative categorisation stage as a separate and critical determinant in emotion generation (e.g., the *intrinsic pleasantness check* of Scherer, 1984). In sum, there is a broad consensus that evaluations are implicated in various "hot" processing functions including attitudes, emotional feelings and valenced action generation. The latter point is particularly well made in a study by Beckers and colleagues (2002) in which one of two movements of a throttle-like response key was consistently paired with an aversive electrocutaneous stimulus, thereby acquiring a negative valence. The throttle-movements were later on required as grammatical categorisation responses in an affective Simon task (without any shock applications), and the results showed faster responding to negative words than to positive words with the previously shock-followed movement. This finding that aversively conditioned responses interact with word valence in a similar manner like responses instructed to be "positive" and "negative" points to the generality of the principles involved in affective S–R compatibility paradigms.

To conclude, two experiments showed that evaluative attributes of stimuli and responses are coded in a common representational format. Theories drawing on approach and avoidance motivations to account for the bidirectional evaluation–behaviour link are not suitable to explain costs of affective compatibility and paralleling findings of action–effect blindness in cognitive research. Instead the TEC receives empirical support that is well-equipped to explain close interactions between evaluations and actions (cf. Lavender & Hommel, 2007 this issue). The cognitive modelling of the evaluation–behaviour link entails that evaluative information is treated in a similar manner as other types of information, arguing against a distinctive processing route of evaluative information in action preparation. However, a common architecture of cognitive and affective S–R interactions does not imply that there are no differences at all between different types of S–R bindings. The systematic exploration of such differences might be an exciting avenue for future research.

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