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RESEARCH ARTICLE

Generalized Approach/Avoidance Responses to Degraded Affective Stimuli: An Informational Account

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Authors' Note

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Abstract

Two studies tested whether affective stimuli presented auditorily spontaneously trigger approach/avoidance reactions toward neutral visual stimuli. Contrary to hypotheses, Exp.1 revealed that when the target was present, participants responded faster after positive (vs. negative) stimuli, and faster to the absence of the target following negative (vs. positive) stimuli, whatever the response modality (i.e., approach/avoidance). Instructions were to approach/avoid stimuli depending on whether a target was presented or not. We proposed that affective stimuli were used in this study as information about the presence/absence of the target. In Exp.2, we replicated the results of Exp.1 when participants responded to the presence/absence of the target, whereas an Approach/Avoidance compatibility effect was observed when each response modality was associated with a target. These results indicate that affective stimuli influence approach/avoidance across perceptual modalities and suggest that the link between affective stimuli and behavioral tendencies could be mediated by informational value of affect.

Keywords: Affect, Approach/avoidance tendencies, Affect-as-Information

Generalized Approach/Avoidance Responses to Degraded Affective Stimuli: An Informational Account

The idea that a main function of emotions is to prepare action is at the heart of theories linking affect and behavior (e.g., Arnold, 1960; Frijda, 1988; Plutchik, 1980; Zajonc, 1980; Zeelenberg, Nelissen, Breuglemans, & Pieters, 2008). In accordance with this idea, it has been proposed that the mere perception of affective stimuli (i.e., stimuli that possess an affective value) would trigger approach/avoidance tendencies, considered as among the most basic behavioral reactions, according to theorists (e.g., Frijda, 2016; Zajonc, 1980). Consistent with this proposal, studies have demonstrated that individuals respond faster by approach movements to positive than to negative stimuli, whereas the reverse is true for avoidance movements (e.g., Chen & Bargh, 1999; Rougier et al., 2018; Solarz, 1960), this pattern being referred here as the approach/avoidance (AA) compatibility effect. However, it is still unclear whether these triggered behavioral tendencies are specifically directed toward the affect-inducing stimuli, or whether they can be more general and potentially directed toward any other object, irrespective of its role in their elicitation. That is, may positive/negative stimuli trigger approach/avoidance tendencies directed toward an object totally disconnected from them? The present studies were aimed at testing this possibility.

The AA Compatibility Effect: Evidence And Theoretical Explanations

The existence of the AA compatibility effect is supported by numerous studies (see, for meta-analyses, Laham, Kashima, Dix, & Wheeler, 2015; Phaf, Mohr, Rotteveel, & Wicherts, 2014). However, the theoretical interpretation of this effect is still a matter of debate. Three main explanations have been offered. A first explanation proposes the existence of a direct link between evaluation and approach/avoidance movements (Cacioppo, Priester, & Berntson, 1993; Chen & Bargh, 1999). According to this position, the perception of an object leads to its automatic evaluation that in turn activates the action with which it is associated in memory (e.g., arm flexion for a positive stimulus vs. arm extension for a negative stimulus). Such an interpretation of the AA compatibility effect has been challenged by studies showing that the link between perception and muscle activation is much more malleable than initially proposed (e.g., Eder & Rothermund, 2008; Markman & Brendl, 2005). A second explanation is that the evaluation of an object does not lead to a specific action (e.g., arm flexion vs. extension) but motivates individuals to either increase (if the object is negative) or decrease (if the object is positive) the distance between the self and the object (e.g., Krieglmeyer & Deutsch, 2010; Strack & Deutsch, 2004). As a result, positive stimuli would facilitate arm flexion, as any other movement, as long as this movement produces a decrease in the distance between the self and the affect-inducing object (Markman & Brendl, 2005).

A third explanation, the evaluative coding account (Eder & Rothermund, 2008; Lavender & Hommel, 2007), proposes a radically different interpretation of this effect. On the basis of the theory of event coding (Hommel, Müsseler, Ashersleben, & Prinz, 2001), this position holds that actions are represented as either positive (approach) or negative (avoidance), as are objects toward which the action is required. On the basis of a S-R compatibility principle, individuals should be faster to execute an action that shares the same code as the object. As a result, they should be faster to respond by an approach movement (which is coded as positive) to a positive stimulus and by avoidance (which is coded as negative) to a negative stimulus. Consistent with this view, Eder and Rothermund (2008) showed that participants produced an AA compatibility effect when they had to respond to positive and negative stimuli with the approach response coded as positive (“toward”) and the avoidance response coded as negative (“away”) whereas the effect was reversed when the approach response was coded as negative ("downwards") and avoidance as positive ("upwards").

It seems fair to assume that at the present time no definitive evidence allows to favor either the motivational approach or the evaluative coding account. Although some data support the evaluative coding account (Eder & Rothermund, 2008; Laham et al., 2015), other results are difficult to interpret with this theory, and are more consistent with an explanation in terms of distance regulation (e.g., Krieglmeyer, Deutsch, De Houwer, & De Raedt, 2010; Rougier et al., 2018). This has led researchers to suggest that AA compatibility effects could be underlain by different processes depending on features of the measurement context (Eder & Hommel, 2013; Laham et al., 2015; Rougier et al., 2018).

Can Approach/Avoidance Tendencies Be Triggered Unintentionally?

In this line of research, one still debated question is whether approach/avoidance tendencies can be triggered by affective stimuli even when individuals are not instructed to process the evaluative meaning of the stimuli (i.e., unintentionally). These processes can be said unintentional as no evaluation goal is (at least explicitly) activated and evaluative information is irrelevant for the task at hand.[1] The three main theoretical positions of the AA compatibility effect do not make diverging prediction regarding this issue. All of them consider that affective information can be extracted automatically (in the absence of an evaluation goal). This information could then activate a specific motor response (Chen & Bargh, 1999), a motivation to regulate self-object distance (Krieglmeyer et al., 2013) or facilitate the execution of an action sharing the same evaluative code (Eder & Rothermund, 2008). However, this is of importance here since we proposed to test whether behavioral tendencies toward neutral objects (i.e., that do not generate strong affective reactions) could

[1] We concede that it is possible for an evaluative goal to be activated in the absence of specific instructions and unconsciously, although such a possibility is not easy to demonstrate (Moors & De Houwer, 2006).

be influenced by the prior processing of task-irrelevant affective stimuli. Empirical support to this assumption was provided by Chen and Bargh (1999; Exp. 2). They observed that participants instructed to push (pull) a lever as fast as possible when a word appeared on a screen (without any explicit instructions regarding the valence of the words) were faster to answer when the movement was compatible with the valence of the word (positive/pull and negative/push) than when it was incompatible (positive/push and negative/pull). However, other researchers failed to replicate these findings and questioned the unintentionality of the AA compatibility effect (e.g., Rotteveel et al., 2015).

Two meta-analyses revealed diverging conclusions on this issue. The meta-analysis conducted by Phaf et al. (2014) leads to the conclusion that the AA compatibility effect is observed only when instructions explicitly require participants to evaluate the target (e.g., move toward positive stimuli and away from negative stimuli). In contrast, the meta-analysis by Laham et al. (2015), including a larger number of studies, revealed no significant difference as whether the task requires or not evaluation, suggesting that the compatibility effect may occur even when participants are not explicitly instructed to process the valence of the stimuli.

Interestingly, the two meta-analyses revealed strong heterogeneity in the effect sizes of the AA compatibility effect. This probably reflects the high variability in the procedures used to measure approach/avoidance tendencies (Krieglmeyer & Deutsch, 2010). Moreover, it is important to note that many studies included in these meta-analyses relied on measures of approach/avoidance that emphasize its motor component, and especially arm flexion/extension (e.g., Chen & Bargh, 1999; Rotteveel & Phaf, 2004). As already mentioned, this conception has been criticized. Arm movements are indeed rather ambiguous regarding approach and avoidance tendencies. Although arm flexion can be interpreted as an approach movement (e.g., to bring something closer to the self; Chen & Bargh, 1999), it can also be executed to avoid something (e.g., avoiding touching an unpleasant or dangerous object; Paladino & Castelli, 2008; Vaes, Paladino, Castelli, Leyens, & Giovanazzi, 2003). The same is true for arm extension: One can extend the arm to push something away from the self (i.e., an avoidance movement) or to reach something pleasant (i.e., an approach movement).

Studies using measures that do not rely on the motor component have revealed results suggesting the plausibility of an AA compatibility effect when evaluation was irrelevant for the task at hand (e.g., Arnaudova, Krypotos, Effting, Kindt, & Beckers, 2018; De Houwer, Crombez, Baeyens, & Hermans, 2001; Fini, Fischer, Bardi, Vrass, & Moors, 2020; Krieglmeyer & Deutsch, 2010; Krieglmeyer et al., 2010; Rougier et al., 2018). For instance, Krieglmeyer and Deutsch (2010; Exp. 2a) asked participants to respond to words presented on a computer screen by moving a manikin toward, or away, from them as a function of whether the word was an adjective or a noun. Though irrelevant for the task at hand, valence of the words influenced the speed with which participants responded: AA compatible responses were faster than incompatible responses. Elaborating on this issue, Rougier and colleagues (Rougier et al., 2018) designed a measure of approach/avoidance tendencies (i.e., the Visual Approach/Avoidance by the Self-Task; VAAST) that simulates the most prototypical sensorimotor information experienced when approaching/avoiding, yet minimizing the importance of the motor component. They argued that in order to simulate (and thus measure) approach/avoidance tendencies, a task should present two main features. First, approach/avoidance typically implies movement from the whole body, which is far less ambiguous than arm movements. Then the measure should simulate a movement of the self toward or away from the object rather than a movement of the object toward or away from the self. Indeed, if we can in some occasions bring desirable objects to the self (e.g., a glass of beer), this is not possible in many situations (e.g., bringing closer a person, a house or a car).

To meet these requirements, the VAAST simulates visual (instead of motor) information associated with approach/avoidance. With this task, these authors obtained a significant compatibility effect in conditions where participants did not seem to be aware of the affective stimuli presented just before the target on which the approach/avoidance reactions were measured (Rougier et al., 2018, Exp. 5). Thus, it appears that approach/avoidance responses can be triggered by affective stimuli which are irrelevant for the task at hand, provided that the approach/avoidance measure does not rely solely on the motor component but on sensorimotor information more closely related to approach/avoidance behaviors.

Are The Triggered Approach/Avoidance Specifically Directed Toward The Inducing Affective Stimuli?

Evidence that affective stimuli may trigger approach/avoidance reactions comes from studies in which behavioral tendencies were measured toward the stimuli that were inducing the affective reactions. In such studies, the movement is executed with reference to the source of the affective stimulation. Therefore, these studies can be considered as indicative that affect induces behavioral reactions toward the affect-inducing stimuli. However, it is also possible that affective stimuli trigger such reactions in an incidental way. As reactions in these studies are only measured toward the inducing stimuli (e.g., Krieglmeyer & Deusch, 2010), it is not clear whether the behavioral tendencies could be thus addressed to other objects. For instance, imagine that you hear positive or negative words while a neutral object or person is in the focus of your visual attention. Would these auditory stimulations, independent of the target object or person, be able to trigger approach/avoidance reactions toward this object or person? This question is of importance since a positive answer would suggest that approach/avoidance would not be directed exclusively to the stimulus that elicits the affective reactions but could be transferred to other (e.g., neutral) stimuli.

Although they do not always directly address this issue, several theoretical positions are compatible with such proposals. For instance, Murphy and Zajonc (1993) proposed that early affective reactions (or 'core affect') are "diffuse, and their origin and address are unspecified" (Murphy & Zajonc, 1993, p. 736). Then, these reactions may be attached to other (neutral) stimuli, producing a change in evaluation of these stimuli as a function of the valence of the elicited affect (for a similar reasoning, see Payne, Cheng, Govorun, & Stewart, 2005). If these affective reactions are sufficient to trigger primitive behavioral reactions of approach/avoidance which address is unspecified, such behavioral reactions should similarly be likely to be directed toward other stimuli that are in the focus of attention.

In a similar vein, the motivational explanation proposes that the approach/avoidance orientation triggered by the affective stimuli would lead to a readiness to decrease/increase the distance "between the person and an aspect of the environment" (Strack & Deutsch, 2004, p. 231). This suggests that these tendencies are relatively general and could be applied to any object that is in the focus of attention. Finally, the evaluative coding account predicts that the AA compatibility effect results from the common codes between the stimulus and the action. Thus, the extraction of the valence of an object could facilitate the execution of the behavior that is afforded by the situation, whatever the target, as long as the behavior shares the same evaluative code as the object.

A few studies provide relevant results regarding this issue. In one of them, Rougier et al. (2018; Exp. 5), reported that participants responded faster by approaching and avoiding meaningless series of letters (e.g., 'nlkjdsOaq') when these series were closely preceded by a positive and a negative degraded word, respectively. Thus, approach/avoidance tendencies were observed toward neutral stimuli that were preceded by degraded irrelevant affective stimuli. However, as the affective stimuli and the neutral targets were presented in close succession at the same location, it is possible that the action (i.e., approach/avoidance) was directed toward the inducing stimuli that closely preceded the target. In another line of research, Yamaguchi, Chen, Mishler and Proctor (2018) found that participants responded faster by approaching/avoiding neutral stimuli (color frames) that contained irrelevant positive/negative stimuli (i.e., flowers vs. insects). However again, the affective and the neutral stimuli were presented at the same location. It could thus be argued that the behavioral reactions were directed to the affective stimuli. Finally, Yamaguchi and Chen (2019) recently demonstrated that approach/avoidance tendencies toward neutral stimuli appearing on either the left or right side of a screen could be facilitated by the presentation of positive vs. negative pictures, respectively, presented in the center of the screen. Thus, these results suggest that incidental affect could indeed trigger approach/avoidance tendencies toward neutral stimuli. However, in this study, targets and affect-inducing stimuli were presented for a long duration, making possible the operation of strategic processes.

In order to provide a more direct test of the hypothesis, we relied on a procedure in which affective stimuli were presented to one perceptual modality (i.e., auditorally) whereas we tested their impact on behavioral reactions to unrelated neutral series of objects (i.e., letters and geometric shapes) presented visually. In such conditions, it seems difficult to argue that the movements are executed toward the affective stimuli. Moreover, we chose to expose participants to affective stimuli presented in a degraded way. We have done so because we wanted the participants to be less likely to identify the source of their affective reactions (e.g., Murphy & Zajonc, 1993), making the affect relatively diffuse and the effects less open to strategic processes. Though there is no direct evidence of such cross-modal effects on behavioral tendencies, research suggests that they are at least plausible. In related domains, studies have indeed demonstrated that auditory stimuli can influence reactions to unrelated visual stimuli. For instance, auditory words facilitate the identification of congruent visual targets (Mahr & Wentura, 2018), even for masked stimuli (Lupyan & Ward, 2013), and can influence the pleasantness of targets (Higgins, Rholes, & Jones, 1977; Marin, Gingras, & Bhattacharya, 2012; Staats & Staats, 1958).

We hypothesized that exposure to affective words would trigger faster behavioral reactions when their valence would be compatible with the movement (approach/positive; avoidance/negative) than when they would be incompatible (approach/negative; avoidance/positive). To test this, we adapted the Visual Approach Avoidance by the Self-Task (Rougier et al., 2018) so that participants in our studies were asked to respond by moving toward or away from neutral stimuli (series of letters in Exp. 1 and geometric shapes in Exp. 2) that were preceded by positive vs. negative auditory stimuli. These auditory stimuli were degraded following a procedure designed by Degner (2011; Exp. 3; adapted from Kouider & Dupoux, 2005). With this procedure, Degner observed that affective auditory stimuli facilitated categorization of congruent words in an affective priming task (Fazio, Sanbonmatsu, Powell, & Kardes, 1986). Participants were faster at categorizing positive words presented visually as positive when they heard a positive (vs. negative) word just before the onset of the target, and were faster at categorizing negative words as negative when the target was preceded by auditory negative (vs. positive) words. We reasoned that if positive/negative stimuli trigger global approach/avoidance tendencies, such behavioral tendencies could be directed toward any object (e.g., series of letters) that would be in the focus of attention at that time.

Experiment 1

The first experiment tested the impact of the incidental presentation of positive/negative stimuli on behavioral reactions of approach and avoidance to unrelated neutral stimuli. We hypothesized that the presentation of degraded auditory stimuli would activate approach or avoidance tendencies as a function of their valence, which would facilitate movements of approach or avoidance toward neutral visual stimuli. In line with current practices promoting transparency, we provide all the data, stimuli and RScripts related to the present studies at https://osf.io/2s9qj/?view_only=18ae1e8383074a6d806517673a60dd34.

Method

Participants and design

Degner (2011; Exp. 3) reported an effect size of $d_z = 0.47$ for the effects of masked auditory stimuli on evaluative categorization whereas Rougier et al. (2018; Exp. 5) reported a compatibility effect of $d_z = 0.33$ regarding the impact of masked visual affective primes on approach/avoidance tendencies, measured with the same task as in the present study. Thus, we based our sample estimation on the mean effect size (i.e., $d_z = 0.40$) for which a minimum sample size of $N = 52$ was required to reach a statistical power of $1 - \beta = .80$. By the recruitment procedure, we came up with 80 participants ($M_{age} = 21.46$, $SD = 3.18$; 47 women). Three participants were excluded due to a low rate of correct responses in the VAAST (< 70%). All participants had normal or corrected-to-normal vision, and none of the participants declared suffering from hearing problems. We used two questions to evaluate participants' knowledge of French language (Rougier et al., 2018). Participants had to indicate whether French was their native language. If it was not, they were asked to evaluate their own skills in French (1 = *excellent fluency* to 7 = *very bad fluency*). All the participants reported having the expected skills (i.e., a score lower or equal to 2). The experimental design included two within-participant variables: movement (approach vs. avoidance) and valence of the stimuli (positive vs. negative).

Materials and procedure

Participants took part in the experiment on a voluntary basis. They filled in a consent form and were then seated in front of a 16” monitor (60 Hz) to complete the VAAST (Rougier et al., 2018). The screen displayed a simulated street background on which the visual stimuli were presented (see Figure 1). Participants were instructed that their task was to move toward or away from series of letters (e.g., ‘sethOrty’) as fast and as accurately as possible depending on whether the series contained vs. not a capital letter. They completed two blocks (order counterbalanced). In one block, they were instructed to move toward (i.e., approach) series that contained a capital letter and away (i.e., avoid) from series that did not contain such a letter. In the other block, the instructions were reversed (i.e., toward series that did not contain a capital letter). When the series contained a capital letter, this letter appeared randomly on the 3rd, 4th, 5th or 6th position. In each block, the sequence was the same. First, participants were asked to press a starting key (key ‘5’) and to maintain it pressed until the appearance of a series of letters at the center of the screen (1000 ms). As they pressed the starting key, a fixation cross appeared at the center of the screen and a background sound was presented in the headphones. An affective word was then presented to the left ear just before the display of the series of letters. The words were 10 positive and 10 negative words selected on the basis of a pretest and paired on pronunciation time (pretest results are presented in Supplemental Materials; Table S1), created and/or modified with Audacity software (Version 2.1.0). The words were recorded with a neutral prosody and were presented through full-size headphones with a frequency response between 10 and 24,000 Hz, an impedance of 51Ω, and a sensibility of 105 dB. The words were degraded by compressing their pronunciation time to 50% of their original length. In the right ear, participants heard a background noise of non-emotional sounds (Capilla, Belin, & Gross, 2012) that started 500 ms before the presentation of the affective stimulus and stopped at the same time as the affective word. To reduce word detection, the background noise was +5dB higher than the stimulus word. On average, the words were pronounced in 589 ms (*SD* = 75 ms).

A series of letters appeared in the center of the screen immediately after the presentation of the auditory stimulus. Participants then had to respond as fast and as accurately as possible by moving toward vs. away from the series of letters by pressing one of two keys (key '8' to move toward and key '2' to move away). When participants responded, the street and the stimulus were zoomed in or out, providing the illusion of moving toward or away from the stimulus, respectively.

Each block was composed of 10 practice and 80 experimental trials. In each block, half of the series contained a capital letter and half did not. Fifty percent of each series category was preceded by a positive word, whereas the other half was preceded by a negative word presented in a randomized order. The main dependent variable was the latency between the presentation of the target and the corresponding key press.

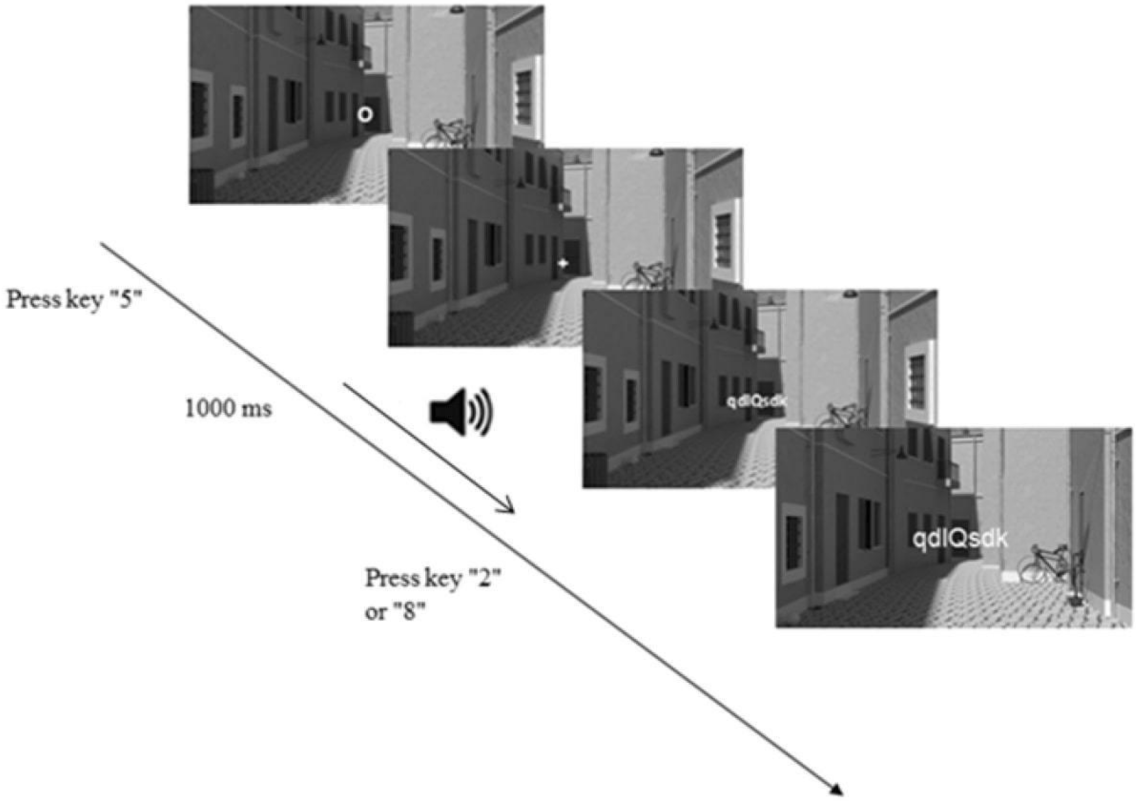

Figure 1. Presentation of the sequence of events in the VAAST (Experiment 1)

When the main task was over, participants completed a forced-choice task that was aimed at evaluating their ability to consciously perceive the affective words. The task was similar to the main task, but participants were instructed that words were presented through the headphones and that they have to guess for each trial which of two words, presented visually on the computer screen, had been presented. The stimuli were the 20 words presented in the main task, and 20 words matched on phonological resemblance, each presented twice. Then, participants were probed for awareness and suspicion (i.e., funneled debriefing; Bargh & Chartrand, 2000)[2]. Finally, they were fully debriefed and thanked for their participation.

Results

[2] The funnel debriefing questions are presented in Table S5 in Supplement Materials.

Prime awareness check

In the post-experimental interviews, none of the participants mentioned having heard any word during the main phase of the experiment (see Table S5 in Supplemental Materials), suggesting that they were at least *subjectively* not aware of the presentation of the affective words. Objective awareness of the primes was evaluated using the signal detection theory approach. For each participant, we computed a *d'*, an index of participants' ability to distinguish signal from noise. In both studies, *d'* was computed by subtracting the z-transformed false alarm rate from the z-transformed hit rate, with emotional words considered as signals and phonologically close words as noise. Results revealed that mean detection was above chance level, $d' = 0.78$, $t(76) = 17.80$, $p < .001$, 95% CI[3] [0.69; 0.86], indicating that participants were able to discriminate the targets in these conditions. We had no strong hypotheses regarding the role of (un)consciousness in the operation of these effects. Therefore, we computed the analyses without taking this factor into account in the first series of analyses. Then, for exploratory purposes, the analyses were again computed with awareness centered on chance level ($d' = 0$; Greenwald, Klinger, & Schuh, 1995).

Response times

Only RTs for correct responses were analyzed (errors = 3.32%). Reaction times < 300 ms and > 1500 ms (see Krieglmeyer & Deutsch, 2010; Rougier et al., 2018) were excluded (5.67%). The data were then inverse-transformed (-1000/RT) to normalize the distribution of the RTs (see Ratcliff, 1993)[4] and were analyzed with the use of mixed-model analyses (Westfall, Kenny & Judd, 2014). We estimated a model with valence of stimuli, movement, instructions, block order, and all the products of these variables as fixed effects, and we estimated the random intercepts and slopes for participants, stimuli and their interaction

[3] All confidence intervals are 95%.
[4] These filters and transformations were chosen on an a priori basis. Other filters and transformations were tested with relatively similar results for both studies (see Supplemental Materials; Tables S4 and S9).

(Bates, Kliegl, Vasishth, & Baayen, 2018; Judd, Westfall, & Kenny, 2017; see Supplemental Materials, Table S2). Effect sizes (d_z) were estimated on the basis of classical ANOVA, as there is still no consensus about the calculation of effect sizes with mixed models (Rougier et al., 2018)[5]. For the sake of readability, we report untransformed means in the text.

The data were submitted to a 2 (Movement: approach vs. avoidance) X 2 (Valence: positive vs. negative) X 2 (Instructions: approach capital letters vs. avoid capital letters) mixed-model analysis.[6] The analysis revealed a main effect of movement, $t(76.3) = 3.75$, $p < .001$, CI [0.0084; 0.027], $d_z = 0.43$, and of instructions $t(75.14) = 5.86$, $p < .001$, CI [0.055; 0.11], $dz = 0.67$. Participants were faster to approach (M = 817 ms, SE = 13) than to avoid (M = 839 ms, SE = 14) the series of letters. In addition, they responded faster when the instructions were to approach capital letters (M = 803 ms, SE = 13) than they were to avoid capital letters (M = 855 ms, SE = 14). We also noted a Movement X Instructions interaction, $t(74.52) = -5.21$, $p < .001$, CI [-0.069; -0.031], $d_z = 0.60$.

The predicted interaction between movement and valence was nonsignificant, $t(76.1) = 1.31$, $p =.19$, CI [-0.0017; 0.0088], $d_z = 0.13$. However, this interaction was moderated by the instructions, $t(75.2) = 4.52$, $p < .001$, CI [0.014; 0.035], $d_z = 0.55$ (see Figure 2). This interaction was not predicted. However, given its potential theoretical significance, we decided to further examine the Movement X Valence interaction under the two sets of instructions.

When the instructions were to move toward the series with a capital letter (away from the series with no capital letter), the results reflected an AA compatibility effect, $t(76.5) = -2.28$, $p = .02$, CI [-0.016; -0.0012], $d_z = 0.26$ (see Figure 2A). More precisely, participants were faster to approach the series after hearing positive than negative words $t(76.1) = -2.50$, p

[5] For both studies, we also computed the rate of participants and stimuli for which the effect was in the direction of the reported effects (see Supplemental Materials, Tables S3 and S8).
[6] The block order was also entered as a factor in a preliminary analysis. No effect implying this factor (main or interaction) reached significance. Thus, data were collapsed across this factor.

= .01, CI [-0.024; -0.0030], d_z = 0.28, with no effect on avoidance movement, $t(76.1) = 0.69$, $p = .49$, CI [-0.006; 0.014], d_z = 0.09. However, when the instructions were to move away from the series with a capital letter (and toward the series with no capital letter), the interaction presented a reversed pattern $t(76.5) = 4.10$, $p < .001$, CI [0.0082; 0.023], $d_z = 0.51$ (see Figure 2B). In this condition, participants were faster to approach the series of letters after hearing a negative than a positive word, $t(76.1) = 2.28$, $p = .02$, CI [0.0016; 0.023], d_z = 0.25, and the effect was reversed for avoidance movements, $t(76.1) = -3.52$, $p <.001$, CI [-0.030; -0.0085], d_z = 0.41.

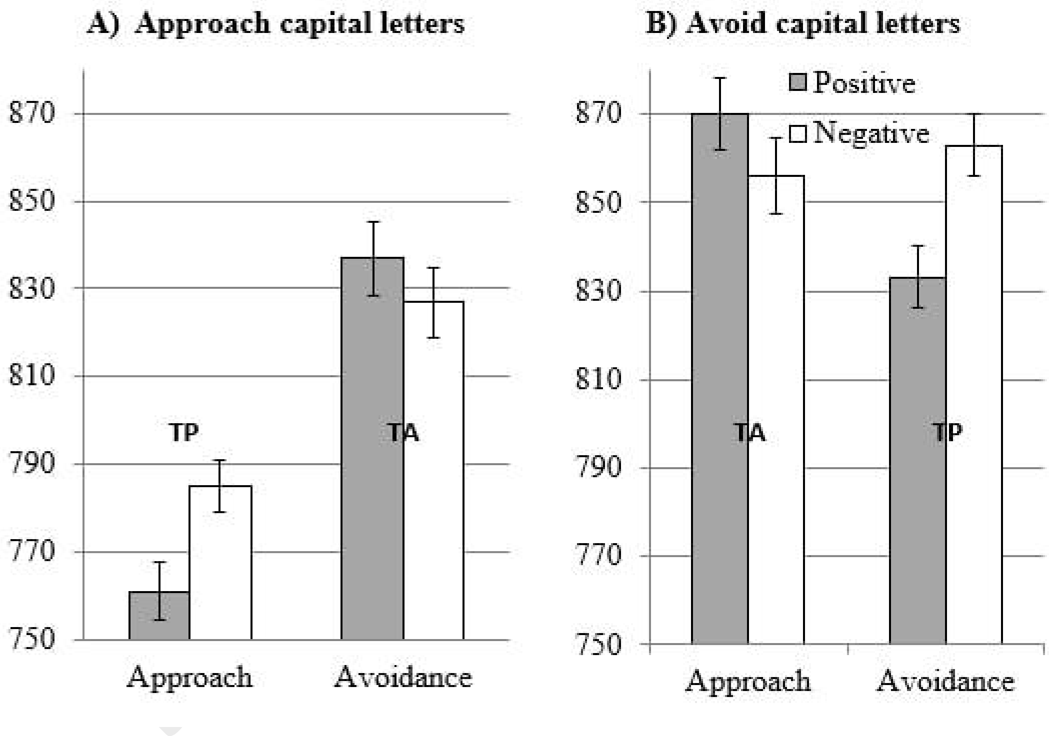

Figure 2. Means and standard errors for untransformed response time (in milliseconds) as a function of valence and movement for the two instructions sets: Approach (avoid) in the presence (absence) of a capital letter (panel A) and approach (avoid) in the presence (absence) of a capital letter (panel B). TP refers to conditions in which the movement was required

when the target was present, and TA to conditions in which the movement was required in the absence of the target.

For exploratory purposes, we also tested whether the effects would still stand when participants were objectively unable to discriminate the words in the forced-choice task. To do so, we run the same analysis but this time including *d'*, crossed with all the factors, in the equation. The Valence X Movement X Instructions interaction was still significant, $t(74.7) = 2.32$, $p = .02$, CI [0.0044; 0.052], $dz = 0.28$.

Discussion

The results observed in this study indicate that the presentation of degraded affective auditory stimuli can influence the execution of approach/avoidance behaviors toward visually presented targets. Interestingly, these effects remain significant, though of smaller size, in conditions in which participants were unable to report the meaning of the words.

However, the pattern of results differs to a large extent from what was expected, as the Movement X Valence interaction was moderated by the instructions. When participants were instructed to approach series of letters containing a capital letter (avoiding those that did not contain such a target), the results were consistent with the compatibility effect. In contrast, when participants had to approach series of letters that did not contain a capital letter, the effects were totally reversed. As the effect of affective stimuli on behavioral tendencies was totally reversed as a function of instructions, these results are at odds with the claim that affective stimuli automatically trigger approach/avoidance tendencies as a function of their valence, and suggest that the link between affective stimuli and behavioral reactions of approach/avoidance is less direct than sometimes assumed.

The results are particularly intriguing as they cannot be easily accounted by the main theoretical explanations of the AA compatibility effect. According to the motivational approach, participants should have been motivated to decrease (or increase) the distance between the series of letters and the self as a function of the valence of the affective stimuli to the same extent whether the instructions were to approach the series with a capital letter or to approach series without such a letter. Thus, this position does not provide an explanation for the fact that instructions moderate the Movement X Valence interaction.

The results are also difficult to reconcile with the evaluative coding account. Based on this account, it can be proposed that the presence of the target (i.e., capital letter) is coded as positive whereas its absence is coded as negative.[7] However, it seems hard to explain the three-way interaction with such a position. In particular, it is unclear how it would explain the reversed AA compatibility effect observed when participants were instructed to avoid capital letters. All the cells in this instructions condition (see Figure 2B) present the same number of common codes. For instance, in the condition where participants had to approach (coded 'positive') in the absence of the target (coded 'negative'), the presentation of a positive or a negative word activates the same code as either the movement or the absence of the target, respectively (the same is true for the avoidance condition). Thus, it is unclear why latency would differ in such a way in these conditions.

This led us to propose another interpretation of these effects on the basis of the informational theories of affect, and more specifically on the 'mood-as-input' (Martin, Ward, Achee, & Wyer, 1993) and the 'affect-as-cognitive feedback' models (Huntsinger, Isbell, & Clore, 2014; Ray & Huntsinger, 2017). According to these positions, basic affective reactions that can be triggered by unconscious appraisals of the situation (e.g., Russell, 2003) "are almost always experienced in response to whatever is in the focus at the moment (…) and convey information about the value of cognitively accessible mental content, including accessible thoughts and processing inclination" (Huntsinger et al., 2014, p. 603). The experience of a positive affect is interpreted as a validation of the content of one's thoughts (a

[7] We are grateful to one of the reviewers for this suggestion.

“go-signal”) whereas a negative affect is interpreted as a signal that invalidates this content (a “stop signal”). For instance, Martin and colleagues observed that participants in a positive mood spent more time on a task than participants in a sad mood when they were instructed to ask themselves as a stop rule, 'Do I feel like continuing with this task?.' However, they spent less time doing the same task if instructed to ask themselves, 'Do I think it is a good time to stop?.' For both questions, a positive affect was interpreted as a positive answer (to enjoyment in the first condition, and to stop in the second condition), whereas a negative affect was interpreted as a negative answer (thus, no enjoyment and not stopping).

In the current context of our experiment, it is thus possible that the affective reaction triggered by the words was interpreted here as an indication of the likely presence (vs. absence) of the target. Indeed, the instructions emphasized the presence of a capital letter as the main event to deal with, and for which a direct action was required. In such conditions, participants had to ask themselves whether a capital letter was present or not. As a result, hearing a positive word could have been interpreted as a positive answer (‘yes’; Martin et al., 1993), that is a signal that the target would be present, making the participants expect this event, ready to detect it and to respond fast in its presence (TP conditions in Figure 2), whatever the response means (i.e., approach or avoidance; e.g., Clore et al., 2001; Huntsinger et al., 2014). Similarly, hearing a negative word would have been interpreted as a signal that the target would not be present (‘no’), facilitating response (whatever the movement) in its effective absence (TA conditions in Figure 2), and interfering with the response when the target (i.e., capital letter) was present. Thus, the reversal observed in the two blocks could be due to the specific instructions used in this study for which the affective stimuli, though presented in a highly degraded manner and objectively irrelevant for the task at hand, could have been used by the participants to anticipate the response. If this interpretation is correct, the moderating impact of instructions should no longer be present if the response does not refer to the presence (vs. absence) of a given target.

To test this explanation, we designed another experiment in which we varied the alternatives for responding. In one condition (similar to Experiment 1), participants were asked to move toward vs. away from a stimulus depending on whether a target was present vs. absent. In this condition, we expected to replicate the findings of Experiment 1. Participants should ask themselves whether the target is present or absent. In response to this question, a positive stimulus would signal a 'yes' answer whereas a negative stimulus would signal a 'no' answer, facilitating the corresponding response regardless of the response modality (i.e., approach/avoidance). In the other condition, participants were asked to move toward vs. away from a stimulus depending on the type of target displayed. As the alternatives for responding (i.e., approach/avoidance) in this latter condition were not referring to the absence/presence of a target but to two different targets, affective information could not be used as a signal for the presence (vs. absence) of the target. The question being related to which response (approach vs. avoidance) has to be made instead of whether the target was present (vs. not), affective information would be used to determine whether they should approach or avoid. A positive stimulus would favor a positive movement (i.e., approach) whereas a negative stimulus would lead to prepare a negative movement (i.e., avoidance; see Eder & Rothermund, 2008). Thus, in this condition, we expected to replicate the compatibility effect observed in previous studies. This second experiment (including design, materials, hypotheses and analytic plans) was preregistered on OSF (https://osf.io/ucmgb/?view_only=fdf98785f49243f09fb6944069013d47).

Experiment 2

This second experiment was aimed at testing our interpretation of the results of Exp. 1. We changed the stimuli to which participants had to respond in Exp. 1 in order to make the two conditions (one-target vs. two-target) more comparable. To do so, we used series of geometric shapes instead of letters. In the one-target condition, participants had to move toward the series that contained a specific shape (e.g., a square) and to move away from the series that did not contain this specific geometric shape. In the two-target condition, the movements were associated with two different geometric shapes. In this condition, participants had to move toward the series containing a square (and away from series containing a diamond), or toward the series containing a diamond (and away from series containing a square). If our explanation of the results of Exp. 1 is correct, we should observe in this condition the expected interaction between movement and valence (i.e., a compatibility effect), whatever the instructions.

Finally, in order to increase the generalizability of our results, as well as to decrease effects due to repeated exposure (e.g., habituation, detection), we increased the number of affective words participants were exposed to. Instead of 10 words of each type (positive vs. negative) used in the Exp. 1, we then relied on 55 affective words of each type.

Method

Participants and design

The relevant expected effect size being difficult to estimate, we chose to follow the sequential procedure proposed by Lakens (2014; Lakens & Evers, 2014). Considering the Valence X Movement X Instructions interaction observed in Exp. 1, d_z = 0.55, for a power of 1 - β = .80, we should have planned to collect 106 participants to detect this effect. However, as we hypothesized an attenuation of this interaction between the two ‘number of targets’ conditions (i.e., a decrease in d_z of the half, *d* = 0.225; Perugini, Gallucci, & Costantini, 2018), we estimated a sample size of 624 participants to reach a statistical power of 0.80. We planned two interim steps. For the first one, we chose to collect 120 participants, and to decide on this basis whether completion should be stopped (either because the alpha boundary would be reached or because the probability to attain a significant threshold when the completion would be finished would be too low; i.e., $d < 0.15$) or should be pursued to its end ($n = 624$). Applying the sequential procedure (Lakens, 2014) leads to an alpha boundary of 0.0096 at the first interim ($n = 120$), as calculated from the GrouSeq package in R (with an alpha boundary of $p = .0212$ with the full sample, alpha being controlled for sequential tests). By the recruitment procedure, we came up with 138 participants. Eight participants did not have the expected skills in French and were thus excluded from the analyses. Two other participants were excluded from the analyses due to a low rate of accuracy on the VAAST (<70%). The data from the remaining 128 participants ($M_{age} = 19.42$, $SD = 2.00$; 109 women) were analyzed. Since the p-value for the predicted interaction effect ($p < .001$) was less than the alpha boundary determined by the sequential analysis for this interim ($p = .0096$), we stopped data collection at this stage (Lakens, 2014). All participants had normal or corrected-to-normal vision, and none of the participants declared suffering from hearing problems. This experiment included three within-participant variables, valence, movement, instructions, and one between-participant variable, number of targets (one vs. two).

Materials and procedure

The procedure was similar to the one used in Experiment 1 with only a few changes. Approach/avoidance tendencies were again measured with the VAAST (Rougier et al., 2018). However, targets as well as words used to induce affect were slightly modified. Participants were asked to move toward or away from series composed of geometric shapes (see Figure 3). We selected only angular geometric shapes to prevent interactions between shapes and affective primes (e.g., Palumbo, Ruta, & Bartamini, 2015).

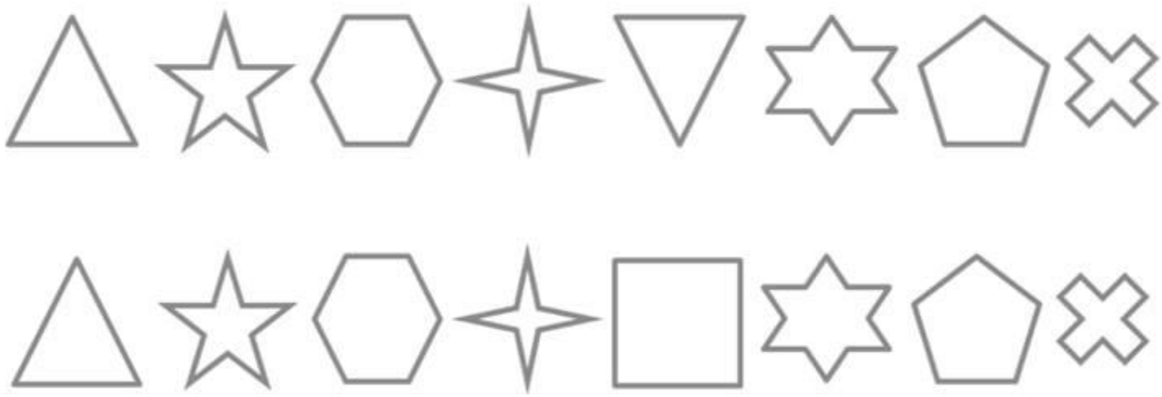

Figure 3. Examples of series of geometric shapes presented in the one-target condition. The series in the first row does not contain the target (i.e., the square), whereas it is contained in series in the 2nd row.

The series were composed of eight geometric shapes in order to maintain the same level of difficulty as in Experiment 1, especially when the target was absent in the one-target condition (see Figure 3). We also increased the number of words (55 positive and 55 negative words, see Supplemental materials, Table S6, for information regarding the characteristics of the words). The sounds were recorded with a neutral prosody. On average, the words were pronounced in 641 ms (*SD* = 37 ms).

Participants completed two blocks of the VAAST. In the one-target condition, participants were instructed to move toward series containing a specific geometric shape and to move away from series that did not contain this geometric shape. For half of these participants, the targeted geometric shape was the square, whereas it was the diamond for the other half. In the other block, the instructions were reversed. In the two-target condition, participants were instructed to move toward series containing a square and away from series containing a diamond, with instructions being reversed in the second block. As in Experiment

1, for the series containing a target, the target appeared randomly in 3rd, 4th, 5th or 6th position (approximately 25% in each position). For each trial, the other geometrical shapes (i.e., lures) were randomly selected with the constrain that a shape appeared only once in the series.

In the two conditions (one vs. two targets), the order of the instructions was counterbalanced. Each block was composed of 110 trials, each preceded by a series of 10 training trials. In each block, the 55 positive and the 55 negative words were randomly presented. After they had completed the two blocks of the VAAST, participants performed an auditory discrimination task (80 trials) similar to the one used in Exp. 1. In this task, they were exposed to 20 positive and 20 negative words randomly selected from the 110 words used in the main task, and to the same number of new words matched on phonological aspects, each presented twice. For each trial, participants had to indicate which of two words (presented visually) was just heard. Then, participants were probed for awareness and for suspicion (i.e., funneled debriefing)[8]. Finally, they were fully debriefed and thanked for their participation.

Results

Words awareness check

Post-experimental interviews revealed that none of the participants reported having heard any word during the experiment (results are reported in Table S10 in Supplemental Materials), suggesting that they were subjectively unaware of the presentation of the words. Objective awareness was estimated with *d'* as in Experiment 1. The analysis revealed that the level of detection of the words in the discrimination task was above chance level, $d' = 0.95$, $t(127) = 23.2$, $p < .001$, CI [0.87; 1.03].

Response times

[8] The funnel debriefing questions are presented in Table S10 in Supplement Materials.

Only correct responses were analyzed (errors = 4.07%). RTs < 300ms and > 3000ms were excluded (1.33% of the data).[9] As for Experiment 1, the data were inverse transformed in order to normalize their distribution (-1000/RT). Untransformed means are presented in the text to improve readability (see Figure 4).

The data were submitted to a 2 (Movement: approach vs. avoidance) X 2 (Valence: positive vs. negative) X 2 (Number of targets: one vs. two) X 2 (Instructions) mixed model analysis.[10] The analyses revealed the expected Valence X Movement X Number of targets X Instructions interaction, $t(124.7) = -5.30$, $p < .001$, CI [-0.055; -0.025], $d = 0.99$ (see Figure 4).[11] In order to explore this interaction, we further examined the Movement X Valence X Instructions interaction under the two ‘number of targets’ conditions (one vs. two targets).

As predicted, in the one-target condition, the Valence X Movement X Instructions interaction was significant, $t(124.2) = 8.52$, $p < .001$, CI [0.035; 0.056], $d_z = 0.80$, with no significant Valence X Movement interaction, $t(124) = -0.50$, $p = .75$, CI [-0.0063; 0.0039], $d_z = 0.05$. The Valence X Movement interaction was significant when the instructions were to move toward the series that contained the targeted geometric shape, $t(124.2) = -6.43$, $p < 001$, CI [-0.032; -0.017], $d_z = 0.58$, as well as when the instructions were to move away from the series that contain the targeted geometric shape, $t(124.2) = 5.63$, $p < .001$, CI [0.014; 0.030], $d_z = 0.53$. However, as can be seen in Figure 4A, these two interactions present different patterns of data, replicating the findings of Exp. 1.

[9] We pre-registrered the same cut-off as for Experiment 1. However, as the latencies in this experiment were much longer than in Experiment 1 (for Exp. 1, $M = 887$ ms, for Exp. 2, $M = 1041$ ms), we decided to include longer RTs. Note that the results remained unchanged if the preregistered cut-off (with an exclusion rate of 14%) was applied (see Supplemental Materials; Table S9).

[10] One participant has been identified as an outlier (on the basis of the Studentized Deleted Residuals — SDR > 4). However, the results remained unchanged if this participant was excluded. Thus, these data were maintained in the sample.

[11] The analysis also revealed other significant effects that are not of theoretical relevance and are thus not discussed further. However, for full transparency, we briefly report these effects. We observed main effects of movement and of instructions, as well as a Valence X Movement, a Movement X Instructions, a Number of Target X Instructions, a Movement X Valence X Number of targets, Valence X Movement X Instructions, and a Movement X Number of targets X Instructions interactions, all *p*s < .01.

In line with our hypotheses, when the target was present (TP conditions in Figure 4A) participants responded faster if the target was preceded by a positive than by a negative word, whatever the required action: approach, $t(125.7) = -5.56$, $p < .001$, CI [-0.041; -0.019], $d_z = 0.52$, or avoidance, $t(125.7) = 4.39$, $p < .001$, CI [-0.034; -0.014], $d_z = 0.39$ (see Figure 4A). When the target was absent (TA conditions in Figure 4A), participants responded faster when the series was preceded by a negative word than by a positive word, whatever the required action: approach, $t(125.7) = 3.57$, $p < .001$, CI [0.0087; 0.030], $d_z = 0.32$, or avoidance, $t(125.7) = 3.51$, $p < .001$, CI [0.008; 0.029], $d_z = 0.31$.

In the two-target condition, as expected, the Valence X Movement interaction was significant, $t(124.2) = -9.33$, $p < .001$, CI [-0.030; -0.019], $d_z = 0.83$ (see Figure 4B). Participants were faster to approach the geometric shape after hearing a positive than a negative word, $t(125.7) = -5.69$, $p < .001$, CI [-0.029; -0.014], $d_z = 0.48$, and the effect was reversed for avoidance movement $t(125.7) = 7.51$, $p < .001$, CI [0.021; 0.035], $d_z = 0.43$. Moreover, this interaction was not moderated by instructions, $t(124) = 1.11$, $p = .27$, CI [-0.005; 0.017], $d_z = 0.10$.

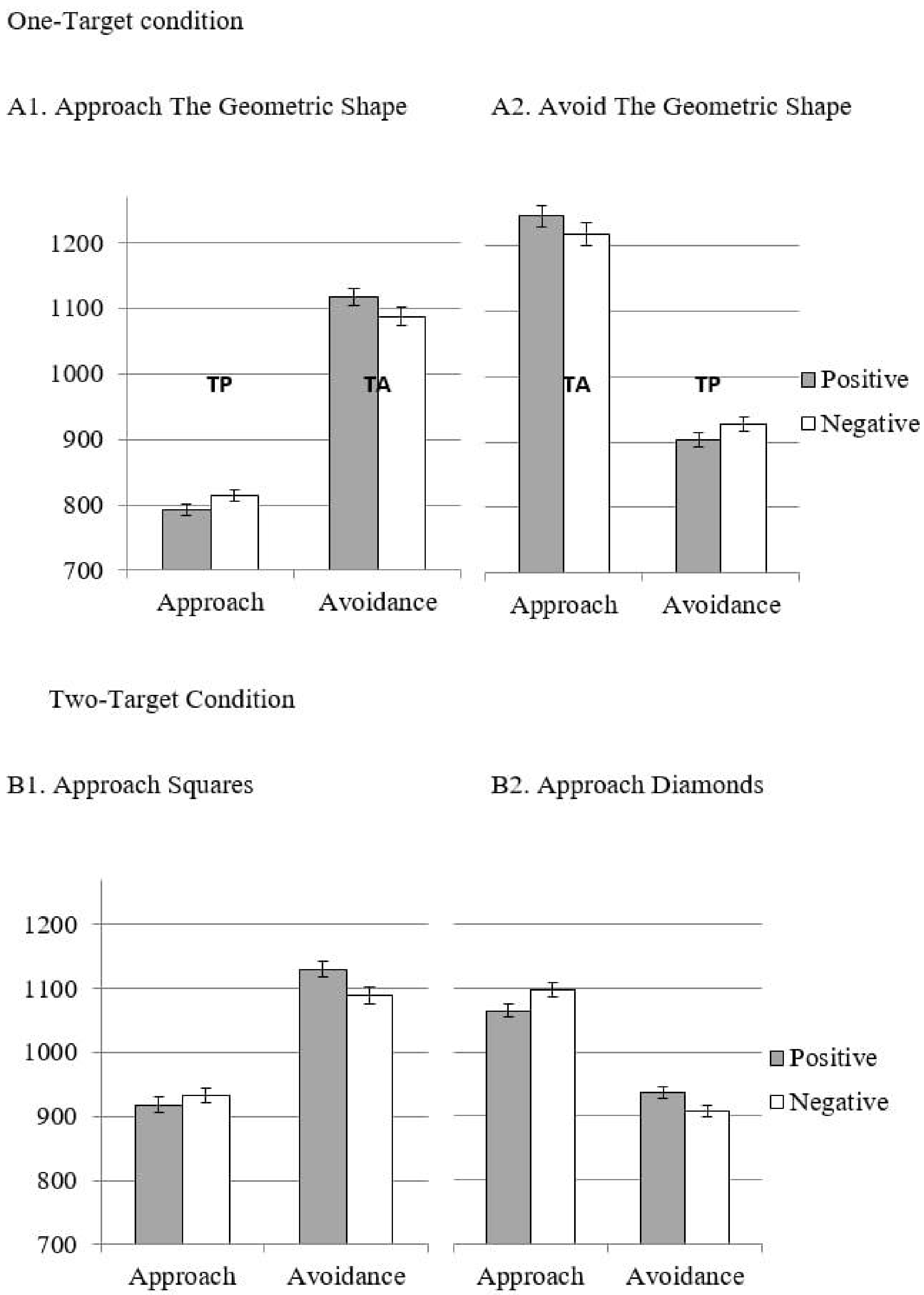

Figure 4. Means and standard errors for untransformed response time (in milliseconds) as a function of affective valence, movement, number of targets, and instructions. For the one-

target condition, TP refers to conditions in which the target was present and TA to conditions in which the target was absent.

For exploratory purposes, we assessed whether these effects would still stand in conditions in which participants were unable to discriminate the words heard, we computed the same analysis as above but with *d'* entered in the analysis as a factor (crossed with all the other factors). The hypothesized 4-way interaction was still significant, *t*(123) = -2.02, *p* = .04, CI [-0.071; -0.0010], *d* = 0.38. In the one-target condition, the three-way interaction Valence X Movement X Instructions was significant, *t*(124.2) = -2.72, *p* = .007, CI [0.012; 0.056], d_z = 0.28, with a similar pattern of results as described above. In the two-target condition, the Valence X Movement interaction was significant, *t*(124.2) = -3.62, *p* < .001, CI [-0.038; -0.011], d_z = 0.33. Participants were faster to approach the geometric shape after hearing a positive than a negative word, *t*(125.7) = -2.29, *p* = .02, CI [-0.041; -0.0033], d_z = 0.23, and the effect was reversed for avoidance movement *t*(125.7) = 2.83, *p* = .005, CI [0.0085; 0.047], d_z = 0.25. This interaction was not moderated by instructions, *t*(124.2) = -0.15, *p* = .88, CI [-0.029; 0.025].

Discussion

The results of this second experiment were consistent with our interpretation of the results of Exp. 1. As expected, in the one-target condition, we replicated the results of Exp. 1. When the participants were asked to respond as a function of whether the target was present or not, we observed faster responses in the presence of the target when it was preceded by a positive word than by a negative word, whatever the response modality (i.e., approach vs. avoidance). When the target was absent, participants responded faster if they have heard a negative than if they have heard a positive word.

In addition, in the two-target condition, we replicated the compatibility effect observed in previous studies (e.g., Chen & Bargh, 1999; Rougier et al., 2018). These results suggest that the AA compatibility effect can be replicated, even with the use of degraded affective stimuli, but that its occurrence is contingent to the presence of specific conditions. Taken together, these results are compatible with the informational explanation of the effects of affective stimuli on behavioral responses and difficult to reconcile with the idea that affective stimuli directly trigger behavioral tendencies of approach/avoidance.

General Discussion

The main aim of this research was to test the generality of the effects of affect on behavioral reactions. More precisely, our research was aimed at testing whether behavioral reactions of approach/avoidance triggered by the exposure to affective stimuli could be transferred to unrelated neutral objects. In response to this question, results of the reported studies indicate that the affective value extracted from a stimulus (e.g., word) presented to one perceptual channel (i.e., auditory) can impact behavioral reactions toward a neutral object (i.e., series of letters or geometric shape) presented to another perceptual channel (i.e., visual object). This result is of importance as it provides direct support for the idea that behavioral reactions triggered by the exposure to affective stimuli can, at least under specific conditions (e.g., when resulting from the exposure to highly degraded affective stimuli), be directed to any object that would be in the focus of attention at the time of its occurrence. This also means that behavioral reactions toward affective stimuli (Chen & Bargh, 1999; Krieglmeyer et al., 2010; Rougier et al., 2018) do not necessarily reflect evaluation of the object, but could be triggered incidentally through the context. In other words, the elicitation of the behavioral reactions and their applications to an object can be decoupled. Apart from their theoretical implications, these results could potentially be of interest for applied research, as they suggest that, in approach/avoidance training studies, coupling approach/avoidance with incidental positive/negative stimuli could make the training more efficient. For instance, Van Dessel, Hughes and De Houwer (2018) observed that coupling approach/avoidance training with positive/negative consequences enhanced the effects of training on subsequent behavior. On the basis of our results, it could be proposed that the inclusion of incidental affective stimuli would potentiate approach (avoidance) responses in the training phase. Making these responses more efficient could in turn increase the association between approach/avoidance and the targeted behaviors, with positive consequences on the effects of approach/avoidance training.

In addition, both studies provide converging evidence that affective stimuli can have an impact on approach/avoidance tendencies in the absence of an evaluation goal (e.g. Krieglmeyer & Deutsch, 2010), but also in the absence of awareness of these stimuli, replicating previous findings (e.g., Alexopoulos & Ric, 2007; Rougier et al., 2018). This is particularly visible in the two-target condition of Exp. 2, whose procedure replicates the one used in prototypical AA tasks (i.e., each movement is associated with a target). In this condition, we observed a significant AA compatibility effect in the absence of an explicit evaluation goal and when participants were unable to report the meaning of the affective stimuli. Interestingly, the effect size of the AA compatibility effect observed in this experiment (in the two-target condition), when controlling awareness of the affective words, is of the same magnitude as the one reported by Rougier et al. (2018; Exp. 5; $d_z = 0.33$)[12] who measured the approach/avoidance with the VAAST in reaction to degraded visual affective stimuli. Though the set of studies is limited, such results seem to indicate that the impact of degraded affective stimuli on behavioral reactions can be replicated and is relatively similar whatever the perceptual modality by which affective stimuli are presented.

[12] However, $d_z = .83$ when d' was not entered in the equation.

However, the direction of the effects was inconsistent with our original hypotheses. We initially expected the effects to be consistent with AA compatibility effect, whatever the underlying processes (i.e., distance regulation or common coding). That is, we expected participants to initiate approach movements faster after the presentation of a positive than a negative word, and to initiate avoidance movements faster after the presentation of a negative than a positive word. The results revealed instead that participants were faster to initiate any movement (i.e., approach or avoidance) in response to the presence of the target when this target was preceded by a positive word than by a negative word. They were also faster to initiate any movement in the absence of the target if they had heard a negative than a positive word just beforehand.

Such results indicate that affective stimuli do not unconditionally trigger behavioral reactions of approach/avoidance. They are also incompatible with the idea that affective stimuli trigger a motivation to increase/decrease the distance between the self and the object (e.g., Krieglmeyer & Deutsch, 2010; Strack & Deutsch, 2004), at least in the specific conditions of our experiments. According to the motivational (distance regulation) account, individuals should be motivated to reduce the distance between the self and the object when exposed to positive stimuli, and be motivated to increase it when exposed to negative stimuli. It is difficult to understand why a slight modification in the instructions (i.e., approach series containing vs. not a specific target) would lead to such a dramatic change in the pattern of data in the two experiments.

The results are not more compatible with the evaluative coding account (Eder & Rothermund, 2008). According to this position, the AA compatibility effect is due to the fact that stimuli and valence share vs. not common codes. It can be proposed that in conditions where participants answered as a function of the presence vs. absence of the target (Exp. 1, and the one-target condition of Exp. 2), evaluative codes were applied to the to-be-responded event (presence of the target = positive; absence of the target = negative). Following this reasoning, faster reactions should be observed in trials with common codes. When the target is present (positive code), participants should respond faster by an approach movement (positive code) after a positive stimulus (positive code) than after a negative stimulus (negative code). In the absence of the target (negative code), they should respond faster by avoidance (negative code) after a negative stimulus (negative code) than after a positive stimulus (positive code). Such a pattern of results is consistent with what was observed in the 'approach capital letters' condition of Exp. 1 (and the similar condition in the one-target condition of Exp. 2). However, the pattern observed in both experiments in the conditions in which participants had to approach the series that did not contain the target (and avoid series that contained the target) is difficult to accommodate with this explanation. Each cell of these conditions being characterized by two similar codes (and one opposite code), it is unclear why in both studies we observed of a reversed AA compatibility effect. Thus, it seems that the evaluative coding account does not provide a clear explanation of the present data.

To account for these effects, we relied on informational theories of affect (Huntsinger et al., 2014; Schwarz & Clore, 2007) and more especially on the 'mood-as-input' (Martin et al.,1993) and the 'affect-as-cognitive feedback' models (Huntsinger et al., 2014; Ray & Huntsinger, 2017; see also Briñol, Petty, & Barden, 2007). According to these models, affect can be used as a signal to prepare an adapted response to the current context. In a context in which participants are asked to detect whether a specific target is present vs. not, they can rely on the information provided by affective stimuli to anticipate its presence. The presentation of a positive stimulus would thus be interpreted as an indication of the presence of the target (i.e., a 'yes' answer, see Martin et al., 1993) whereas a negative stimulus would inform the participants of its absence (i.e., a 'no' answer). Anticipating the presence (absence) of the target would lead participants to execute the movement required by the instructions in response to the presence/absence of the target, whatever the movement (i.e. approach, avoidance or anything else). In other words, the Prime X Movement X Instructions interaction observed in Exp. 1 and in the one-target condition of Exp. 2 can be thought of as a Prime X Presence/absence of the target interaction (not moderated by movement). We manipulated the instructions in Exp. 2 on the basis of this reasoning, so that affect could be used as informative about the presence/absence of the target or not, depending on the instructions condition. When the affect could be used as a signal regarding the presence/absence of the target (i.e., in the one-target condition), the results of Exp. 1 were perfectly replicated. When it was not the case (i.e., in the two-target condition), only the AA compatibility effect emerged.

How can these results be reconciled with findings in the literature on the AA compatibility effect? A first possibility is that the results observed in Exp. 1 and in the one-target condition of Exp. 2 are restricted to conditions in which affective information is made highly relevant for the task at hand. The procedure used in our studies could have increased the informative value of affective information. First, in these specific conditions of our experiments, participants could have simplified the task so that it could be answered by 'yes' (target present) or by 'no' (target absent), making the affective information particularly relevant. Moreover, in typical AA tasks, participants are usually clearly aware of the presence of the affective stimuli (even when they are presented incidentally; Krieglmeyer & Deutsch, 2010; Reichardt, 2018) and, for some studies, they are explicitly instructed to process their valence (Aubé et al., 2019; Eder & Rothermund, 2008; Rougier et al., 2018). Therefore, in such studies, participants can clearly identify the source of their affective reactions and thus disregard its informational value (e.g., Schwarz & Clore, 1983; Murphy & Zajonc, 1993). In the present studies, no reference was made to evaluation or affect. Moreover, this information was presented in a degraded manner and delivered through a channel different from the one by which the to-be-responded target was perceived. All these conditions could have made the source of the affective information particularly difficult to identify, potentially coming from the inside, making this information particularly prone to be used for decision. In the absence of such conditions, the affective information would not be used to answer the question individuals have in mind, and the distance regulation or evaluative coding would apply (our results do not provide information regarding which position should be favored).

Alternatively, it can be proposed that the affective information was still perceived as relevant but used differently in conditions in which two targets were presented. Extending our reasoning to these conditions, affective information would be used to answer the question, “do I have to approach.” Indeed, approaching something dangerous is probably more problematic for the individuals than missing an opportunity (e.g., Pratto & John, 1991). Therefore, participants could have simplified the approach/avoidance instructions as whether they should approach the stimulus. A positive answer to this question (positive prime) would lead to prepare an approach movement whereas a negative answer (negative prime) would interfere with such a movement. If the movement to be executed is avoidance, a positive answer would interfere with it more than a negative answer. To sum up, the difference observed as a function of the instructions could be due to the change in the representation of the task due to modifications in instructions and consequently in the specific question participants had in mind while doing the task. The specific design used in the present experiments, with the movements being associated to either the presence or absence of the target, would have led participants to use affective information in a different way, making the observed pattern of results possible to emerge. Studies published so far, as they typically propose one target for each response movement, would thus, by design, be unlikely to distinguish between the two processes.

Interestingly, however, the specific three-way interaction revealed in the one-target condition (Exp. 1 and 2) was not observed in the study by Rougier et al. (2018; Exp. 5), although the response criterion was the same as in our studies (especially in Exp. 1). Two explanations can be proposed. A first possibility is that the instructions in the study by Rougier and colleagues focused more on the action to be carried out and less on the presence of the target than our instructions. As a result, the affective information would have been used to decide whether participants had to approach (yes vs. no) in the Rougier et al.'s study but to decide whether the target was present in our study. Another possibility would be that dissociating the affective information from the target by presenting them through two different perceptual channels would have changed the direction of the informational value of affect. In such conditions, the affect would be less likely to be attached to the target toward which the behavior is directed, and more likely attributed to the content of one's thoughts.

Finally, we acknowledge that this alternative explanation remains speculative and in need for further tests. This is our hope that the present studies will stimulate research exploring more extensively how affective stimuli influence behavior. This research could be of great interest for a wide range of psychological research areas, including basic processes, motivation, and emotion, as well as for applied research.

Open practices

All the data, the material and the RScripts for the two experiments can be found on Open Science Framework (OSF) at https://osf.io/2s9qj/?view_only=18ae1e8383074a6d806517673a60dd34.

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Supplemental Materials

Experiment 1

Characteristics of the words (Exp. 1). Table S1 presents characteristics of the words used in Exp. 1, as well as the relevant comparisons (*t* test with Welch-Satterwhaite correction). Valence (1 = negative; 7 = positive) and subjective frequency (1 = low frequency; 7 = high frequency) were pre-tested on 20 participants who did not take part in the main experiment.

Table S1. **Mean values (SD) for the words used in Experiment 1**

	Positive words	Negative words	*t*	*df*	*p*
Number of letters	6.6 (0.5)	6.6 (0.5)	0	18	1
Number of syllables	2.3 (0.5)	2.4 (0.5)	0.45	17.92	.66
Length of pronunciation	585ms (84)	593ms (70)	0.23	17.436	.82
Subjective frequency	5.72 (0.5)	5.82 (0.3)	0.56	15.644	.58
Valence	**6.12 (0.2)**	**1.8 (0.3)**	**-41.56**	**16.034**	**<.001**

Random effects of mixed model. In Table S2, we report the random effects of participants and stimuli, as a function of valence and movement.[13]

Table S2. **P-values of the random effects variability in Experiment 1**

	χ^2	*df*	*p*	*ICC*[14]
Stimuli	1.31	1	.25	.0004
*Movement	0.05	2	.98	.001
*Instructions	0.26	2	.88	.001
*Movement*Instructions	3.59	4	.46	< .0001
Participants	2664.3	1	< .001	.24
*Valence	0.039	2	.98	.17
*Movement	70.50	2	< .001	.17
*Instruction	298.1	2	< .001	.22
*Valence*Movement	2.76	4	.60	.08
*Movement*Instructions	94.4	4	< .001	.12
*Valence*Instructions	1.47	4	.83	.22
*Valence*Movement*Instructions	8.34	15	.91	.08
Stimuli*Participants	NE[15]	NE	NE	NE

We also estimated the percentage of the effects in the direction of the effects reported in the main text for Experiment 1 (Table S3).

Table S3. **Effect size and direction of the effects**

[13] The number of covariation possibilities between type of valence, type of movement, participants and stimuli was too important. Thus we excluded random effects that cannot be estimated.
[14] Intra-Class Correlation
[15] Not estimable

	Effect size (d_z)		Effects in the direction of the reported effects (in percentage)	
Effect	By participants	By stimuli	By participants	By stimuli
Valence*Movement*Instructions	0.56	1.68	71.4%	85%

Transformations and time cut-off. In Table S4, we report the results (valence*movement, valence*movement*instructions[16]) observed in Experiment 1 with the use different cut-offs and transformations. The results reported in the article appear reliable since the 3-way interaction reached significance for 6 out of the 7 tests.

Table S4. **P-values for the effects of interest as a function of various cut-offs and transformations (Experiment 1)**

	Excluded data	*t*	*p*
Raw data[17]			
No transformation			
Valence*Movement		1.55	.12
Valence*Movement*Instructions		4.82	< .001
1/RT			
Valence*Movement		-1.75	.08
Valence*Movement*Instructions		-4.82	< .001
Log(RT)			
Valence*Movement		1.64	.10
Valence*Movement*Instructions		5.30	< .001
[300; 1000] ms	24.38 %		
Valence*Movement		1.58	.12
Valence*Movement*Instructions		1.90	.06
[300; 1500] ms	5.67 %		
Valence*Movement		0.87	.38
Valence*Movement*Instructions		5.45	< .001
[300; 2000] ms	1.81 %		
Valence*Movement		1.67	.10
Valence*Movement*Instructions		6.17	< .001
[300; 3000] ms	0.33 %		
Valence*Movement		1.29	.20
Valence*Movement*Instructions		5.22	< .001
1.5 SD	5.33%		
Valence*Movement		0.92	.35
Valence*Movement*Instructions		3.23	.0012

[16] The same random matrix of effects as in the article was used to compute the analyses.
[17] Prior to these analyses, we removed 3 extreme data points, 16770 ms, 5219 ms and 5088 ms (<0.01% of the data) that appeared clearly out of range.

Funnel Debriefing

Table S5. **Funnel Debriefing Details (Experiment 1)**

Questions	% of "yes" answer
1. Have you encountered any difficulties during the experiment that you would like to mention? If it is the case, what are they?	2.6% (difficulties with instructions during the training phase)
2. Do you have any idea regarding the aims of the experiment? If it is the case, what would these aims be?	0%
3. Did you notice anything special in either of the two tasks? If you have noticed something special, what was it?	0%
4. Have you heard words during the video game task?	0%

Experiment 2

Pre-Test. Table S5 presents characteristics of the words used in Exp. 2, as well as the relevant comparisons (*t* test with Welch-Satterwhaite correction). The pre-test was based on 20 other participants. The measures were the same as for Experiment 1, except subjective arousal that was included here and measured with a 7-point scale (1 = low arousal, 7 = high arousal).

Table S6. **Mean values (SD) for the words used in Experiment 2**

	Negative words	Positive words	*t*	*df*	*p*
Number of letters	7.67 (0.9)	7.69 (0.8)	-0.11	103.6	.91
Number of syllables	2.84 (0.6)	2.87 (0.5)	-0.35	105.78	.73
Length of pronunciation	645ms (32)	637ms (42)	1.11	101.43	.27
Subjective frequency	5.89 (0.2)	5.92 (0.2)	-0.79	106.54	.43
Subjective arousal	3.59 (0.3)	3.49 (0.3)	1.725	107.78	.09
Valence	**2.04 (0.2)**	**5.96 (0.2)**	**-14.62**	**106.82**	**<.001**

Random effects of mixed model. Table S6 presents the random effects of participants and stimuli as a function of valence and movement. We also estimated the percentage of the effects in the expected direction for Experiment 2, for participants and for stimuli (Table S7).

Table S7. **P-values of the random effects variability in Experiment 2**

	χ^2	*df*	*p*	*ICC*
Stimuli	1.88	1	.17	.0001
*Movement	1.14	2	.56	.004
*Instructions[18]	0.10	2	.95	.002
*Movement*Instructions	5.23	9	.81	NE
Participants	10872	1	< .001	.31
*Valence	0.75	2	.69	.19
*Movement	132.47	2	< .001	.21
*Valence*Movement	2.28	4	.68	.09
*Instructions	939.35	2	< .001	.23
*Movement*Instructions	284.43	9	< .001	.19
*Valence*Instructions	2.36	9	.98	.10
*Movement*Valence*Instructions	23.72	24	.48	.05
Stimuli*Participants	NE	NE	NE	NE

[18] “Instruction” in this Table refers to the within-participant variable “Block of instruction”.

***Table S8.* Effect size and direction of the effects**

	Effect size (d_z)		Effects in the expected direction (in percentage)	
Effect	By participants	By stimuli	By participants	By stimuli
Condition One Target				
Valence x Movement x Target	0.80	1.14	87.3%	100%
Condition Two Targets				
Valence x Movement	0.84	1.28	87.7%	99.1%

Transformations and response time cut-off. We computed the analyses with the same cut-offs and transformations tested for Experiment 1 (Table S8). The 4-way interaction was significant in 7 out of the 8 tests conducted in these analyses.

***Table S9.* P-values for the effects of interest as a function of various cut-offs and transformations (Experiment 2)**

	Excluded data	*t*	*p*
Raw data[19]			
No transformation			
Valence*Movement*Type of Instruction*Block of Instructions		-2.51	.012
1/RT			
Valence*Movement*Type of Instruction*Block of Instructions		4.95	< .001
Log(RT)			
Valence*Movement*Type of Instruction*Block of Instructions		-3.93	< .001
[300; 1000] ms	39.3 %		
Valence*Movement*Type of Instruction*Block of Instructions		-6.04	< .001
[300; 1500] ms	13.8 %		
Valence*Movement*Type of Instruction*Block of Instructions		-4.21	< .001
[300; 2000] ms	5.30 %		
Valence*Movement*Type of Instruction*Block of Instructions		-3.22	< .001
[300; 3000] ms	1.33 %		

[19] Prior to these analyses, we excluded 11 extreme data points > 6000 ms (0.00041% of the data) that appeared clearly out of range for this study.

	Excluded data	*t*	*p*
Valence*Movement*Type of Instruction*Block of Instructions		-3.53	< .001
1.5 SD	9.72%		
Valence*Movement*Type of Instruction*Block of Instructions		-1.91	.06

Funnel Debriefing

Table S10. **Funnel Debriefing Details (Experiment 2)**

Questions	**% of "yes" answer**
1. Have you encountered any difficulties during the experiment that you would like to mention? If it is the case, what are they?	0%
2. Do you have any idea regarding the aims of the experiment? If it is the case, what would these aims be?	0%
3. Did you notice anything special in either of the two tasks? If you have noticed something special, what was it?	0%
4. Have you heard words during the video game task?	0%