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Avoiding the Approach Trap: A Response Bias Theory of the Emotional Stroop Effect

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In the laboratory, people classify the color of emotion-laden words slower than they do that of neutral words, the emotional Stroop effect. Outside the laboratory, people react to features of emotion-laden stimuli or threatening stimuli faster than they do to those of neutral stimuli. A possible resolution to the conundrum implicates the counternatural response demands imposed in the laboratory that do not, as a rule, provide for avoidance in the face of threat. In 2 experiments we show that when such an option is provided in the laboratory, the response latencies follow those observed in real life. These results challenge the dominant attention theory offered for the emotional Stroop effect because this theory is indifferent to the vital approach–avoidance distinction.

Keywords: emotional Stroop effect, approach–avoidance, in vivo testing, attention bias

When negotiating the busy traffic of downtown, a sports car does not yield at a stop sign and unexpectedly crosses your path. Virtually all of your attentional resources are recruited to thwart the danger of collision at that moment of emergency. This common occurrence of modern life illustrates the extent to which attention is affected by threat and emotion. In the laboratory, the most popular tool for assessing attention to negative or threat stimuli has been the so called emotional Stroop paradigm. Negative and neutral words are presented singly for view, and the participant names, while timed, the ink color in which each item appears. It is typically found that it takes people longer to name the color of emotion items than to name that of neutral items, the emotional Stroop effect (ESE). The source of this slowdown with the emotion items has been debated in the literature, especially as attention typically facilitates rather than impedes reaction to features of the target stimulus. In everyday life, the signature of reaction to threat is swift action. In this study, we attempt to reconcile this putative contrast between the laboratory (sluggish reaction to threat stimuli) and everyday experience (fast reaction to threat stimuli). We do so by introducing a response variable, approach–avoidance, which has hitherto been ignored in large portions of the research on the emotional Stroop phenomenon.

The approach–avoidance distinction is one of the oldest ideas in the analysis of behavior (Elliot, 2006), often subsumed under the term, *the fundamental hedonistic principle* (Higgins, 1997). People approach positive stimuli (food, partners) and avoid negative stimuli (pain, poison) because these reactions are vital to survival via reproduction and averting sickness and death (Wilkowski & Meier, 2010). The association of an approach tendency with positive stimuli and of an avoidance tendency with negative stimuli is so strong that definite motor movements are usually involved (e.g., Zajonc & Markus, 1985; Chen & Bargh, 1999). Positive stimuli often invite arm flexions (pulling the object toward the self), whereas negative stimuli often invite arm extensions (pushing the object away from the self). This hard interface between muscular action and stimulus valence has been tapped in several studies (see Wilkowski & Meier, 2010, for a review). It is also notable that the pertinent responses to negative stimuli in particular are very speedy. Sustained by a long evolutionary process, all incoming stimuli are subject to affective evaluation (good versus bad). This evaluation is accomplished in a fast and automatic fashion, possibly before full semantic analysis of the stimulus is accomplished (Bargh, 2006; Chen & Bargh, 1999). It is probably for this reason that people and other organisms respond to threat in a swift fashion more than they do to any other class of stimuli (the propensity often subsumed under the proverbial flight or fight). The well known orienting reflex documented in physiology (Sokolov, 1963; see also Barry, 2009; Lubow, 1973) is a potent demonstration of the organism's instantaneous reaction to (potential) threat.

How does the notion of approach–avoidance help in explaining the slowdown with negative items observed in the laboratory? Our hypothesis implicates the counterinstinctual response demands imposed in the laboratory as the root cause of the inconsistency with everyday life. In the laboratory, the participant responds to the negative stimulus by pressing the appropriate key on a response device. This seems innocuous enough until one realizes that touching the keyboard is actually an approaching response to the threatening stimulus. People reflexively avoid such stimuli, but they are denied this option in the emotional Stroop experiment. The slowdown observed in the laboratory is the likely cost wrought about by an experimental request that violates the natural propensity to avoid threat (even when the threat comes in the form of a world presented in the sealed environment of the laboratory). In some

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studies, researchers have used a vocal response rather than a manual response. However, the vocal response also constitutes an unnatural, if not a counternatural, reaction in the face of threat. One does not first react to the snake in the grass or to the attacking dog by calling aloud its color or other characteristics. To recap, we hypothesize that the slowdown documented by the ESE is not genuine but mainly reflects the cost of the unnatural experimental demand to approach a negative stimulus.

The ESE: A Brief Review of Current Research and Models

The canonical experimental setup of the emotional Stroop task is well known. People simply name the ink color of words. Notably, the words are not color words. They are drawn from two lists, negative (threat, emotion) words and neutral words. When testing clinical populations, words associated with the particular pathology replace the generic threat or negative words. Again, the ESE is defined by the difference in color naming performance between the emotion words and the neutral words. It has become the tool of choice for fine-tuned diagnosis in a gamut of pathologies from generalized anxiety (e.g., Mathews & MacLeod, 1985; Mathews, Mogg, Kentish, & Eysenck, 1995; Mogg & Bradley, 2005) to trait anxiety (e.g., Mogg, Kentish, & Bradley, 1993; Rutherford, MacLeod, & Campbell, 2004), obsessive-compulsive disorders (e.g., Paunovic, Lundh, & Ost, 2002; Constans, McCloskey, Vasterling, Brailey, & Mathews, 2004), depression (e.g., Mogg & Bradley, 2005; Mitterschiffthaler et al., 2008), social phobia (Amir, Freshman, & Foa, 2002; Andersson, Westöö, Johansson, & Carlbring, 2006), and posttraumatic stress disorders (e.g., Paunovic et al., 2002; Constans et al., 2004). The common pattern observed in these as well as in other studies (see Algom et al., 2009; Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van Ijzendoorn, 2007; Williams, Mathews, & MacLeod, 1996, for reviews) is the selective slowdown, at test, with items associated with threat, emotion, or pathology.

Whence the slowdown? It is well known that emotion stimuli grab attention, but the particular direction of the effect observed in the laboratory is neither trivial nor readily understood. Given that threat is such a potent attractor of attention, one would expect rapid reaction rather than sluggish reaction to its attributes. In an early study, Pratto and John (1991) were indeed surprised to find the emotional slowdown. The demand on attention does not convincingly explain the delayed response to color. After all, a single word in view hardly exhausts human attention resources. We also note that there are laboratory tests of attention under emotion in which the responses are faster rather than slower to the target attribute (Bar-Haim et al., 2007; MacLeod, Mathews, & Tata, 1986).

Nevertheless, the most widely accepted theory of the ESE implicates processes of attention (e.g., Dalgleish, 2005; Williams et al., 1996). Its point of departure is the common inference that people inadvertently read the task-irrelevant words, thereby compromising exclusive attention to the target ink colors. Notably, attention theory argues that the negative words command attention more than do the neutral words. The ESE thus is the cost exacted on color performance by the enhanced attention to the threatening content of the word. Note that this attention bias account lacks reference to the natural reflex of avoidance or of freezing in the face of threat stimuli.

An alternative view attributes the ESE precisely to such response tendencies. The constraints on behavior imposed in the laboratory (one can react to the negative stimulus only by pressing a key or naming a color) engender a temporary disruption of the response. This freezing, if for a fraction of a second, is known as the ESE (Algom, Chajut, & Lev, 2004; Fox et al., 2001; McKenna & Sharma, 2004; see also, De Houwer, 2003; Öhman, Flykt, & Esteves, 2001). Such a freezing in the face of threat is a quite natural reaction under the circumstances. However, freezing is gratuitous when further response options are available. For instance, if the option of avoidance is provided, freezing might well be replaced by a swift (backing) response to negative stimuli. Under such settings, the responses to negative stimuli might well be faster than those to neutral stimuli, producing a reverse ESE.

It is worth pausing to examine the role of color-word interplay when considering this alternative, response bias view of the ESE. On this view, too, the meaning of the task-irrelevant word is engaged in the emotional Stroop task. Had people ignored the carrier words, there would not have been a content-dependent difference in color naming (=ESE). Observing an ESE therefore shows that it was the word rather than the nominal color that determined the (speed of the) response. Colors per se do not mandate differential responding across hue (e.g., one does not respond to a green rectangle faster than one does to a blue or a brown one given equal salience); only when the colors write words of differing valence do systematic differences in responding emerge. People's responses thus depend on word content and not on the incidental color presented (assigned typically in a random fashion). The unique contribution of the response bias account is that it predicts the direction of the differences in responding. Responding to the color of a negative stimulus is relatively slow when the response entails approaching (or not retreating from) the stimulus (ESE). However, the same response is relatively fast when it entails backing away from the stimulus (reverse ESE).

One must be a bit circumspect when applying approach–avoidance analysis. The need for caution comes from a somewhat inconsistent literature regarding the frame of reference or the origin of the movements: self versus stimulus (cf. Markman & Brendl, 2005). Pulling a lever is an approach response with respect to the self, but an avoidance response vis-à-vis the stimulus. In the vast physiological literature on the orienting response, as well as in the great bulk of the behavioral studies on coping with danger, the point of reference is the threatening stimulus. We espouse this frame of reference and consider it to be the valid one from an ecological point of view. Therefore, pressing a key in the face of a negative stimulus is an approach behavior incurring performance costs (cf. Wentura, Rothermund, & Bak, 2000).

Finally, a word is in order to clarify our use of the term *attentional-attraction*, or *attentional-capture*, whether in the attention or in the response account. According to one view (e.g., Pratto & John, 1991; Williams, Mathews, MacLeod, 1996), emotion stimuli are noticed earlier (preattentively?) than are neutral stimuli. According to another view (Fox et al., 2001; McKenna & Sharma, 2004), emotion stimuli hold attention longer than do neutral stimuli (e.g., it is difficult to disengage attention from threat). Our current discussion does not speak to this issue. Consequently, we use the terms in a theoretically neutral fashion to mean that task-irrelevant information (emotion content) impacted performance with respect to the target dimension (color).

To recap, the attention view is insensitive to the type of response involved, approach or avoidance. On that view, the ESE is the product of the disproportionate amount of attention captured by negative words. In contrast, the response-based view does appreciate the role of the behavioral options available when facing threat. On this view, whether one observes an ESE or a reverse ESE depends on the type of response made. The question at issue is then the nature of the ESE: Does the slowdown reflect an attentional bias or a response bias?

The Present Study

In a pair of experiments, we used the standard ESE stimuli. Words in color were presented singly for view, and the task for the participant was to identify the ink color. However, two notable features distinguished our experiments. First, we did provide avoidance as well as approach response options (Bamford & Ward, 2008). Second, the testing was in vivo, observing the natural movement of the entire body under realistic conditions. The participant was simply walking toward the monitor displaying the stimulus or walking away from it. These conditions provided for a powerful tool for theoretical resolution.

Experiment 1

The participant was standing in the middle of the room. A word in color, emotional or neutral, was displayed on a screen facing the participant at one end. The participant was instructed to respond to certain colors by stepping forward, thus approaching the stimulus on the screen. She or he was instructed to respond to other colors by stepping backward, avoiding the stimulus on the screen. Figure 1 illustrates the experimental setup, stimuli, and responses.

If the slowdown observed with emotion items is response contingent, it is expected to emerge only with the approaching responses (=ESE). In this case, the slowdown is the cost of imposing a gesture that runs counter to the instinctual one of retreating from negative stimuli. However, a full reversal of the pattern is expected with the avoidance responses. For these responses, reactions to negative stimuli are predicted to be faster than those to neutral stimuli (commensurate with everyday behavior). A reverse ESE was expected for avoidance.

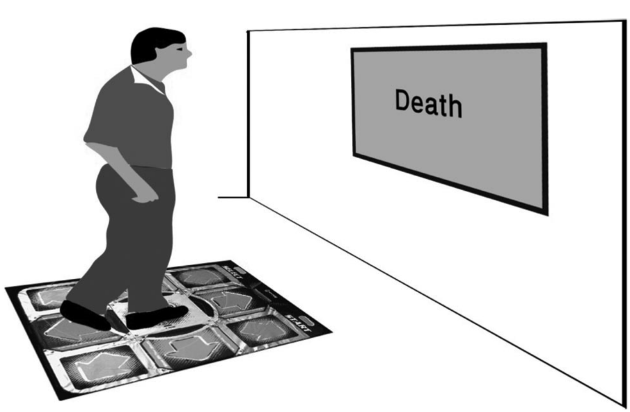

Figure 1. The setup of Experiment 1: The participant stepped forward or backward in response to the ink color of emotion or neutral words.

Method

Participants. Thirty-five undergraduate students from the Open University of Israel with normal or corrected-to-normal vision participated. They were naïve concerning the purpose of the experiment.

Apparatus, stimuli, and procedure. We used a commercial dance mat for an electric platform (110 cm × 90 cm, Dance-Dance-Revolution Super Deluxe Pad product). The pad was hooked up with a Dell Pentium computer through its game port with synchronization (and all other event timing) governed by a directRT Precision Timing Software (Version 2008.1.0.11). Time resolution of this system was 8 ms, on average (on a par with the typical resolution for standard key pressing), The stimuli were displayed on the grayish background of a 17 in. (43.18 cm) flat-screen color monitor (with an 85 Hz refresh rate, set at a resolution of 1,024 pixels × 768 pixels). The participant stood at the central position of the pad, facing the screen placed at the longer end of the rectangular pad. The screen was placed at the participant's eye level, approximately 1.2 m from the face. A word in color appeared on the screen and remained present until the participant's (dominant) leg touched the pad at the adjacent position in front of the starting position or behind it. This duration (from stimulus onset to completion of the stepping) served as the main dependent variable. The participant then returned to the starting position, and the next trial began after 2 s.

The stimuli were 16 negative words, the Hebrew equivalents of *suicide, terrorist, danger, horror, destruction, death, war, choking, injured, sabotage, poison, attack, burn, pus, panic,* and *murder*, and 16 neutral ones, *shirt, glove, hat, scarf, vest, shoe, sweater, coat, umbrella, overall, boots, dress, skirt, tie, sandal,* and *sock*, of approximately equal frequency.[1] The words appeared in a relatively large font size (Arial 78 point type) to make them easily visible from the distance of 1.2 m. They were presented in four colors, red, green, blue, and brown (calibrated to appear prototypical and of equal salience through a Deluxe Paint II palette). For each participant, two ink colors were assigned an approach response (stepping forward upon detecting that color), and the remaining two were assigned an avoidance response (stepping backward upon detecting the color). The assignment of colors to the approach and avoidance responses was random and different across participants.

Each of the 32 words was presented in each of the four colors twice, making for a block of 128 stimuli in all. The order of stimulus presentation was random and different for each participant.

Results

Errors amounted to a minuscule 1.9% and did not differ across conditions ($F < 1$). For reaction times, the four columns of Figure 2 give the respective means for correct identification of the ink colors. The left-hand half of Figure 2, presenting the approach responses, reproduces the typical laboratory result of a slowdown, of 11 ms on average, with the emotion items, $t(34) = 1.92$, $p < .05$, $d = 0.33$. However, there is a wholesale reversal of this

[1] The words in original Hebrew are available upon request from Eran Chajut.

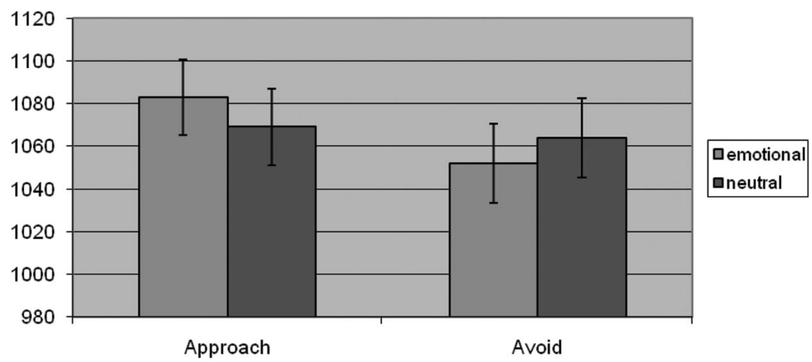

Figure 2. The results of Experiment 1: Mean reaction times for walking forward or backward in response to the ink color of emotion and neutral items. The bars signify one standard error around the mean.

pattern in the right-hand half of Figure 2, when the participants identified the colors via avoidance responses. For avoidance, responses to emotion items were faster by 9 ms, on average, than responses to neutral items, $t(34) = 2.4$, $p < .05$, $d = 0.46$. The interaction of word valence (negative, neutral) and type of response (approach, avoidance) documented further the full reversal in the pattern of responding, $F(1, 34) = 7.392$, $p < .01$, $\eta_p^2 = 0.194$.

Discussion

The human instinct is to freeze or retreat when facing threat or negative information. When an approach response is imposed in the laboratory, the inevitable outcome is a slowdown in responding (the ESE). Jettisoning this counterinstinctual demand reproduces in the laboratory the evolution-honed reflex of speedy avoidance of negative stimuli. To provide cross validation support for these conclusions, in the next experiment, we presented the same stimuli but changed the response options to those of pushing or pulling a joystick (Chen & Bargh, 1999; Eder & Rothermund, 2008).

Experiment 2

Method

Participants. An independent group of 33 participants from the Open University of Israel performed in this experiment.

Apparatus, stimuli, and procedure. The participant was sitting at a distance of 60 cm from the screen and responded to the ink colors by pushing a joystick forward with both hands or by pulling the joystick back, away from the screen. We used an IBM compatible analogue joystick, Logitec-Attack 3, under the control of directRT software with the same time resolution as in Experiment 1 (cf. Eder & Rothermund, 2008). Because the participants activated the joystick with both hands, the approach and avoidance responses engaged their entire torso in addition to their hands. The size of the font was set smaller, at Arial 32 point type. In all other respects, we used the procedures of Experiment 1.

Results

Errors were negligible again, amounting to 2.1% overall. They did not differ across conditions ($F < 1$). The respective latencies for correct responses are shown in Figure 3 for the four conditions. The pattern of results for the joystick responses reproduced fully the results observed for the walking responses of Experiment 1. An emotional slowdown of 17.3 ms, $t(32) = 2.1$, $p < .05$, $d = 0.37$, was recorded for the approach responses, but a speedup of 22.7 ms favoring the same emotion items was recorded for the avoidance responses, $t(32) = 3.3$, $p < .005$, $d = 0.58$. The interaction of stimulus valence and type of response, $F(1, 32) = 8.96$, $p < .01$, $\eta_p^2 = .22$, confirmed the full reversal of the reaction time pattern with the opposing responses.

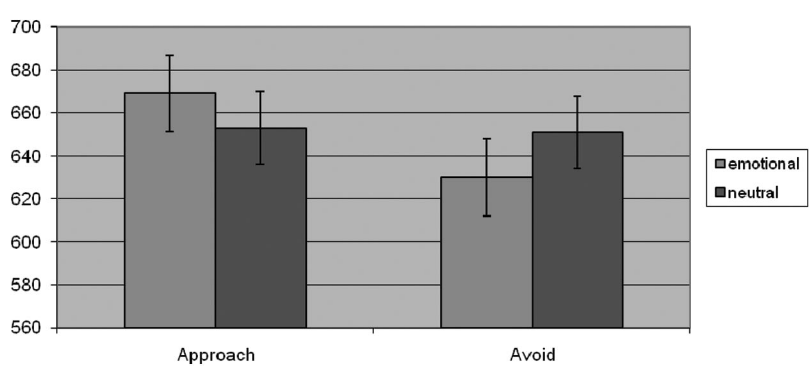

Figure 3. The results of Experiment 2: Mean reaction times for pushing a joystick forward or pulling it backward in response to the ink color of emotion and neutral items. The bars signify one standard error around the mean.

Discussion

The results of Experiment 2 reinforce the contingent nature of the speed of reaction to threat. What counts is whether one approaches or retreats from the threat stimulus, not the means (walking, pushing, or pulling) by which one accomplishes those actions. This pattern generalizes across the gamut of muscular responses.

General Discussion

The present results reconcile the seemingly contradictory patterns of behavior in the face of a threat observed in the laboratory and everyday life. They demonstrate that the slowdown observed in the laboratory is an incidental byproduct of a stipulation that excludes avoidance as a permissible response. Our results invite a new perspective on the entire body of ESE research, in particular on the focal observation of slowdown. We show that the slowdown is a contingent outcome and, hence, of fairly limited applicability. Theories based on the phenomenon of slowdown should be revisited accordingly. For practice, an immediate corollary is that experiments should include both approach and avoidance responses for a full scrutiny of behavior under threat.

The present results undermine the traditional attention theory of the ESE. According to this theory, the extra amount of attention drawn by the negative word slows down the color response—regardless of the way that the color task is executed. Therefore, the responses to negative items are expected to be sluggish for both approach and avoidance. Attention theory does not make an appeal to the approach–avoidance distinction. Because this variable did make a difference, the present results are incompatible with attention theory.

The roots of attention theory lie in an association forged with the classic Stroop effect, the "gold standard" (MacLeod, 1992, p. 12) of all attention measures. However, the association is dubious. The classic Stroop task includes color words, not threat words. The hallmark of the classic Stroop task is the partition of stimuli into congruent (the word names its ink color) and incongruent (word and color mismatch) classes whose difference defines the effect. The ESE does not include congruent and incongruent items (the word *cancer* printed in red is neither more nor less congruent than the word *street* in red). In the classic Stroop task, the same item appears in congruent and incongruent combinations, a singularly potent control that excludes stimulus-based responding or biases. In the ESE, by contrast, different lists of words are compared, with responding determined by the respective values of valence (see Algom et al., 2004; Algom, Zakay, Monar, & Chajut, 2009; Larsen, Mercer, Balota, 2006; and McKenna & Sharma, 2004, for a discussion of these and further differences between the ESE and the Stroop effect). The ESE is essentially a threat- or emotion-related phenomenon, not an attention phenomenon (beyond the initial failure of selectivity to the ink color).

The present findings and conclusions fit well with recent conceptions that attribute cognitive-affective values not only to the stimuli but also to the responses of the individual. According to this view, approach and avoidance responses are subject to evaluative coding as positive or negative actions. These codes can then match or mismatch the valence values of the pertinent stimuli. Responses are faster when there is a match than when there is a mismatch (Eder & Rothermund, 2008). Again, our results are compatible with the evaluative coding view, so that they can also be considered an example of the affective Simon effect (De Houwer & Eelen, 1998). This much granted, our analysis in terms biologically evolved approach and avoidance might be more parsimonious.

The speedy avoidance responses observed in our study might well reflect a generic tendency of dealing with unwanted events, a tendency widely documented in the clinical psychology of everyday life (Hayes, Wilson, Gifford, Follette, & Strosahl, 1996; Karekla, Forsyth, & Kelly, 2004; Kashdan, Barrios, Forsyth, & Steger, 2006). Experimental avoidance thus is a measure of experiential avoidance. It reflects the unwillingness of anxious individuals, in particular, to remain in contact with negative stimuli. The modified test of the ESE introduced in the present study can form the base of a potent tool for accessing experiential avoidance in individuals with different levels of anxiety.

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