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Running head: DEVALUATION THROUGH BEHAVIORAL INHIBITION

When approach motivation and behavioral inhibition collide: Behavior regulation through stimulus devaluation

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In the present article a theory is outlined that explains why and when behavioral inhibition alters stimulus evaluations. In addition, some initial evidence is presented that supports the theory. Specifically, results of three experiments show that refraining from responding to stimuli results in devaluation of these stimuli, but only when these stimuli are positive. These findings suggest automatic behavior-regulation, in terms of devaluation of positive stimuli, in situations in which environmental cues triggering approach (because of the positive valence of the stimulus) run counter to situational demands (cues that elicit behavioral inhibition). Relations of the present research to self-perception, cognitive dissonance, and psychological reactance are discussed.

The idea that pleasurable objects spontaneously elicit approach tendencies is ubiquitous in behavioral science. At the same time, it is relatively easy to think of situations in which approach of a pleasurable object is undesired because of situational constraints. In the present research, we theorize about the interplay between stimuli that trigger approach tendencies on the one hand, and environmental cues that instigate behavioral inhibition on the other, and we examine affective consequences of this interaction. We argue that in conflicting situations in which a stimulus is positive (e.g. you see a big glass of beer) while approach is undesirable (e.g. it is not yours) inhibition of the approach reaction will lead to devaluation of the positive stimulus. We tested this prediction in three experiments. Specifically, we tested whether behavioral inhibition elicited by a contextual cue in the presence of a positive stimulus results in devaluation of this stimulus.

Evaluative processes serve to guide behavior (Fazio & Towles-Schwen, 1999; Lang, 1995; Strack & Deutsch, 2004; Winkielman, & Berridge, 2004). For instance, participants are more likely to be motivated to pursue a behavior when that behavior is linked to positive affect (Custers & Aarts, 2005). Furthermore, it is easier to physically approach something positive and avoid something negative than vice versa (Chen & Bargh, 1999; Solarz, 1960). However, even though evaluation may constitute an efficient tool to guide behavior in many situations, it is not always suitable to act accordingly. Specifically, we often encounter situations that contain positive stimuli to which we should not respond because of situational constraints. The question we are concerned with is how we deal with these inherently conflicting circumstances.

Consistent with a number of theories we assume that the valence of stimuli is processed faster or more efficiently than other, non-affective characteristics of stimuli or situations (Anderson & Phelps, 2001; Damasio, 1994; de Gelder, 2006; LeDoux, 1996; Murphy & Zajonc, 1993; Zajonc, 1980). In addition, and in line with the research discussed above, we argue that, upon encountering a stimulus with positive valence, we get ready to respond. Before responding however, the demands of the situation are processed (de Gelder, 2006; LeDoux, 1996). These demands may be consistent (i.e. approach is desirable) or inconsistent (i.e. approach is undesirable) with the positive valence of a stimulus. In the latter case a response conflict arises. Because the desirability of a response concerning a stimulus will ultimately depend on situational constraints and not on the hedonic value of a stimulus, situational constraints will (in most cases) prevail in this conflict and direct behavior by inhibiting approach. The process just described can account for the fact that we do not immediately approach everything that is positive, but only do so when it is appropriate. But how do we proceed after the occurrence of such a response conflict? To prevent permanent freezing, approach, or continuous oscillation between an approach tendency and inhibiting the approach tendency, an additional mechanism is required that explains how to move on after encountering such a response conflict.

One mechanism that could solve the response conflict between an approach tendency and subsequent behavioral inhibition, is that, whenever a response conflict arises, negative affect is spontaneously tagged to the approach eliciting stimulus. This negative affect would make the stimulus less desirable, and hence decrease the approach tendency. Support for this idea comes from work on goal priming effects. Specifically, research has shown that pairing an initially desired goal (e.g. socializing) with negative affect ensures that such a goal becomes less desirable and is less likely to elicit goal directed behavior (Aarts, Custers, & Holland, 2007). Thus, negative affect can serve as an inhibitory (or stop) signal to prevent an initially positive stimulus (or goal) from eliciting behavior. So, when behavioral inhibition directed at an approach eliciting stimulus would spontaneously lead to devaluation of this stimulus (i.e. by attaching a negativity tag to it), we would have a powerful mechanism for behavior regulation.

The question now arises whether behavioral inhibition can generate negative affect that can be attached to a positive stimulus. Although there is no direct evidence to this issue, this idea can be supported indirectly. Previous research has namely shown that upon presentation of negative stimuli, behavioral inhibition is instigated, suggesting a direct relation between negative affect and behavioral inhibition (Wilkowski & Robinson, 2006). Other research has shown that there are bi-directional relations between motor programs and evaluative processes. Particularly, research has shown that upon presentation of affective information related motor programs are activated (e.g. Chen & Bargh, 1999), and other research has shown that motor processes (e.g. flexing or extending the arm) can directly affect evaluations of stimuli that are presented during these motor movements (e.g. Cacioppo, Priester, & Berntson, 1993; for an overview see Neumann, Förster, & Strack, 2003). Combining these insights renders the possibility that behavioral inhibition can generate negative affect plausible.

Accordingly, we propose that whenever a response conflict arises between stimuli that trigger an approach reaction and cues that signal that approach is unwanted, behavioral inhibition and the stimuli interact, resulting in adaptive tuning of the valence of stimuli. We call this the Behavior Stimulus Interaction (BSI) theory. This tuning is the result of two interacting processes. More specifically, whenever a positive stimulus is encountered the approach system ensures that we get ready to respond. Because affective information is processed faster than other aspects of stimuli (see above) this approach tendency is always activated first. Next, the demands of the situation are processed. In circumstances where situational cues signal that approach towards the stimulus is unwanted, a response conflict is detected and the response will be inhibited. To solve this conflict then, the positive stimulus is devalued (i.e. negative affect is attached to it) to release the approach tendency, and tune its valence in line with the demands of the situation. As a result, the unwanted stimulus will be evaluated as less positive when it is subsequently encountered compared to a stimulus that did not give rise to a response conflict. (Of course, it may be that under some circumstances, e.g. when the stimulus becomes available again, the devaluation is cancelled.) The process just outlined may be functional because devaluation resulting from inhibition of the approach tendency ensures that a specific positive stimulus that first prompted a behavioral approach tendency will stop doing so, leaving room for other stimuli to take over guidance of behavior (Aarts et al., 2007).

It is important to note that BSI theory pertains to inhibition of approach behavior, and not to avoidance or withdrawal behavior. In accordance with several theories, we view approach and avoidance as two distinct systems with separate neurological correlates and behavioral repertoires (e.g. Cacioppo, Gardner, & Berntson, 1997; Harmon-Jones, 2004; Lang, 1995; Sutton & Davidson, 1997). In the case of positive stimuli the default response tendency is approach, and behavioral inhibition is inconsistent with this tendency. However, in the case of negative stimuli the situation is less straightforward (Fanselow, 1994). More specifically, negatively valenced stimuli might elicit fight (an approach reaction; see Harmon-Jones, 2004), or avoidance behavior, in the form of flight, or behavioral inhibition (as in freezing; Wilkowski & Robinson, 2006). Consequently, the response tendency that is activated by a negative stimulus is not necessarily inconsistent with behavioral inhibition. Therefore, behavioral inhibition cannot serve the same basic tuning function as it does in the approach system. Hence, we do not expect that withholding a response towards a negative stimulus is sufficient to alter the evaluation of a negative stimulus. Finally, and more on a general level, it can be argued that attaching an affective tag to a stimulus is most effective in the case of positive stimuli, as it is easier to change evaluations of positive stimuli than of negative stimuli (cf. negativity bias; Cacioppo, et al., 1997; Shook, Fazio, & Eiser, 2007).

In the present research we do not intend to study all implications of BSI theory, but we aim to test one specific hypothesis. Specifically, we aim to show that presentation of a positive stimulus together with a cue that signals that a response should be withheld, leads to devaluation of the positive stimulus. Furthermore, we expect that such inhibition induced devaluation occurs only with positive stimuli and not with neutral and negative stimuli, albeit for different reasons: In the case of neutral stimuli because there is no response tendency in the first place (and hence withholding a response requires no inhibition), and in the case of negative stimuli because behavioral inhibition is not necessarily inconsistent with negative stimuli, and negative stimuli are more resistant to affective tuning.

Overview of experiments

In all experiments participants first received a go/no-go task. Participants' task was to press the spacebar whenever a go cue was presented, and not to press the spacebar whenever a no-go cue was presented. We manipulated this task in such a way that some stimuli (pictures) were consistently paired with a go cue and other stimuli consistently with a no-go cue. After this task we asked participants to evaluate the stimuli that were consistently paired with a go cue (i.e. the go stimuli), stimuli that were consistently paired with a no-go cue (i.e. the no-go stimuli), and new stimuli that were not shown before. In Experiment 1, using highly positive pictures as stimuli, we hypothesized overall lower attractiveness ratings to no-go stimuli compared to both go and new stimuli. In Experiment 2, we used both highly positive and neutral pictures as stimuli in a within subjects design and hypothesized devaluation of positive no-go stimuli only. Finally, in Experiment 3, employing a between subjects design, we used highly positive and negative pictures and expected devaluation for positive no-go pictures only.

Experiment 1

Method

Participants and design. Experiment 1 included 33 participants. In all experiments participants were students from Radboud University Nijmegen and received 1 euro (approximately $1.40) for their participation. We employed a 3(stimulus status: go, no-go, new) one factorial within subjects design.

Stimuli. We chose 12 pictures from the IAPS (Lang, Bradley & Cuthbert, 1999) with a high positive valence (M = 7.76 on a 9-point scale; range 7.36 – 8.28) as stimuli.[1] We constructed three sets of four pictures and varied the status (go, no-go, new) of these stimuli within a set across participants.

Procedure. Participants first received a go /no-go task. They were presented with pictures and were asked to press the space bar whenever a specific letter was displayed on a picture (i.e. the go cue) and refrain from responding whenever another specific letter was displayed on the picture (i.e. the no-go cue). The go/no-go cues were the letters “p” and “f’. We displayed the go/no-go cues on the pictures in black font type on a white background, so that they were clearly visible. The cues were randomly presented in one of four predetermined locations near the corners of the pictures. We counterbalanced both instructions (e.g. react to “p” and not to “f”) and pairing of each cue (“p” or “f”) to each stimulus set across participants. These factors did not interact with the results in any of the experiments.

The go/no-go task comprised 80 trials in which four pictures were consistently paired with a go cue and four pictures were consistently paired with a no-go cue. Presentation of the go and no-go trials was random with the constraints that a go or no-go trial could not be presented more than four times in a row, and each specific stimulus was presented once within eight trials. A trial started with the presentation of a picture together with a go or no-go cue. Following this presentation, a question mark in blue font type was presented for 1000 ms. We instructed participants to press the spacebar during the presentation of the question mark when the previous picture had been accompanied by a go cue, and refrain from pressing the spacebar when the stimulus letter had been accompanied by a no-go cue. Note that this procedure ensured that amount of exposure to go and no-go stimuli remained equal. The question mark disappeared after either a response or 1000 ms. After a correct (non) response a green circle was presented and after an erroneous (non) response a red cross was presented for 500 ms. The intertrial interval was 500 ms.

Next, participants received an ostensible unrelated task in which we informed them that we needed evaluations of how attractive pictures are for future research. Participants were presented with pictures from the go/no-go task and four new pictures and were asked to rate how attractive they thought these pictures were on 9-point scales (ranging from *not at all* to *very much*). We constructed two orders of stimulus status presentation (e.g. go, new, no-go, no-go, etc.) for this task and ensured that, within each order, specific pictures were randomly selected. This order did not interact with the results in any of the experiments. Finally, we asked participants to type in what they thought to be the idea behind the experiment. In all experiments, none of the participants guessed the hypothesis of the study.

Results and Discussion

Error percentages in the go/no-go task were low (1.0 % on go and 0.5% on no-go trials).

To test whether repeated pairing of specific stimuli (i.e. pictures) with a no-go response would cause devaluation of these no-go stimuli compared to both new stimuli and go stimuli we performed repeated measures analysis of variance (ANOVA) with one factor (stimulus status: go, no-go, new). This analysis revealed the predicted effect of stimulus status, $F(2,64) = 3.33$, $p < .05$, partial $\eta^2 = .09$. Simple effect analyses revealed that participants evaluated no-go stimuli ($M = 5.33$, $SD = 0.85$) reliably lower than both go stimuli ($M = 5.77$, $SD = 0.91$), and new stimuli ($M = 5.81$, $SD = 1.11$), respective comparisons $F(1,32) = 4.59$, $p < .05$, $\eta^2 = .13$ and $F(1,32) = 6.20$, $p < .05$, $\eta^2 = .16$. There was no reliable difference between go and new stimuli $F(1,32) < 1$.[2]

These results are in line with BSI theory: Specific positive stimuli are devalued when situational cues have repeatedly elicited behavioral inhibition upon encountering these stimuli. The fact that the no-go stimuli were rated as less attractive compared to the new stimuli is especially indicative of devaluation. The result that merely not responding to specific stimuli in a go-no-go task causes devaluation of these specific stimuli compared to new stimuli in a subsequent evaluation task is a novel finding. Nonetheless, an even more direct test of the theory would be to show that valence of stimuli and behavior interact, so that only behavioral inhibition to positive stimuli and not to neutral stimuli would result in devaluation of the no-go stimuli. This is what we aimed to show in Experiment 2 by including pictures in the go/no-go task that are of neutral valence.

Experiment 2

Method

Experiment 2 included 47 participants. The design is a 3(stimulus status: go, no-go, new) by 2 (valence: neutral, positive) within subjects design. The method of Experiment 2 is identical to that of Experiment 1 except for the following changes. The stimuli in Experiment 2 comprised of the positive pictures of Experiment 1 and in addition 12 neutral pictures. These pictures were selected for neutral valence from the IAPS (M = 5.04 on a 9-point scale; range 4.93 – 5.19). Three sets were constructed and each set included 4 positive and 4 neutral pictures serving as stimuli. The go/no-go task consisted of 80 trials in which eight pictures were consistently paired with a go cue (4 neutral and 4 positive pictures) and eight pictures with a no-go cue (4 neutral and 4 positive pictures). Each picture was presented five times. The rating task in Experiment 2 was identical to that of Experiment 1 with the exception that the neutral pictures were evaluated also. We constructed two orders of stimulus status presentation (e.g. go, new, no-go, no-go etc) for this task and ensured that, within each order, specific pictures were randomly selected.

Results and Discussion

Two participants were excluded from the following analyses, because their error rates were greater than 2.5 SDs from the mean error rating, leaving 45 participants for analyses. Error percentages in the go/no-go task were again low (1.1 % on go and 0% on no-go trials).

To test whether repeated pairing of specific stimuli (i.e. pictures) with a no-go response would cause devaluation of these no-go stimuli only when these stimuli are positive we performed a 3(stimulus status: go, no-go, new) by 2(valence: neutral, positive) repeated measures analysis of variance (ANOVA). First of all, this analysis showed a main effect of valence $F(1,44) = 541.10$, $p < .05$, partial $\eta^2 = .93$. This effect shows that the neutral stimuli ($M = 2.76$, $SD = .98$) were evaluated lower than positive stimuli ($M = 6.69$, $SD = .85$). More importantly, there was a main effect of item status $F(2,88) = 4.56$, $p < .05$, partial $\eta^2 = .09$, which was qualified by an interaction with valence, $F(2,88) = 3.94$, $p < .05$, partial $\eta^2 = .08$. For the neutral stimuli, stimulus status had no reliable effect, $F(2,88) = 1.61$, $p = .21$, partial $\eta^2 = .04$, implying that there was no reliable difference between, neutral go ($M = 2.89$, $SD = 1.07$), neutral no-go ($M = 2.68$, $SD = 1.19$) and neutral new items ($M = 2.69$, $SD = 1.08$).

Replicating Experiment 1, the predicted pattern emerged reliably for the positive stimuli, $F(2,88) = 6.13$, $p < .05$, partial $\eta^2 = .12$. Simple effect analyses revealed that positive no-go stimuli ($M = 6.38$, $SD = 1.16$) were devalued compared to both positive go ($M = 6.75$, $SD = 1.06$), and positive new stimuli ($M = 6.94$, $SD = 0.94$), respective comparisons $F(1,44) = 5.34$, $p < .05$, $\eta^2 = .11$ and $F(1,44) = 11.75$, $p < .05$, $\eta^2 = .21$. There was no reliable difference between positive go and positive new stimuli, $F(1,44) = 1.34$, $p = .25$, $\eta^2 = .03$.

Results of Experiment 2 show that consistently not responding to specific positive pictures causes devaluation of these pictures, whereas consistently not responding to neutral pictures doesn't lead to devaluation of these pictures. This pattern of results is consistent with BSI theory postulated in the introduction by showing that only when a response conflict arises (i.e. positive stimuli suggesting a response that is incongruent with the demands of the situation) withholding a response affects evaluations.

We like to draw attention to two implications of the pattern of results of the neutral stimuli in Experiment 2. First of all, the fact that ratings concerning the neutral go stimuli were (unreliably) higher than the neutral no-go stimuli cannot be seen as an indication of devaluation of neutral no-go stimuli, because the mean rating to neutral no-go stimuli is practically the same as the mean rating of new neutral stimuli. We think a strong point of the design of both Experiments 1 and 2 is that we expected and found devaluation of positive no-go stimuli compared to both go *and* new stimuli. If anything a go response enhances evaluations of neutral stimuli, maybe because approach directed at a neutral stimulus signals that a stimulus is wanted. However, because such a process is not relevant to BSI theory (as it is not the result of behavioral inhibition), and the effect is unreliable we do not elaborate further on this issue.

Secondly, the fact that we did not obtain any devaluation of neutral no-go stimuli makes alternative explanations that would attribute our results to mere conditioning (i.e. not responding is associated with negative affect and this negative affect subsequently becomes associated with stimuli) or demand characteristics (i.e. participants think that they are required to devaluate no-go stimuli) less likely, because both these explanations would predict equal or even stronger devaluation of neutral no-go stimuli. At the same time, it should be noted that the evaluations of the neutral stimuli were quite low, probably as a result of the within subjects design, leaving limited room for an (unpredicted) devaluation effect.[3]

Experiment 3

In Experiment 3 we aimed to test the prediction, outlined in the introduction, that devaluation of no-go stimuli is specific for positive stimuli, and absent for negative stimuli. Furthermore, we explored what effect responding to negative pictures would have (i.e. the comparison between negative go with negative new pictures). To this end, we repeated Experiment 1, and added a condition (between subjects) in which participants were presented with negative pictures. We employed a between subjects design to prevent a floor effect of attractiveness ratings concerning the negative pictures.

Method

Experiment 3 included 96 participants. The design is a 3(stimulus status: go, no-go, new) by 2 (valence: negative, positive) mixed design with repeated measures on the first factor. Experiment 3 is identical to Experiment 1 except for the fact that we added a condition in which participants were presented with negative pictures in the go/no-go task and subsequent rating task. These negative pictures were selected from the IAPS (M = 3.32 on a 9-point scale; range 2.46 – 3.95).

Results and discussion

Three participants were excluded from the following analyses, because their error rates were greater than 2.5 SDs from the mean error rating, leaving 93 participants for analyses (46 in the positive pictures condition and 47 in the negative pictures condition). Error percentages in the go/no-go task were again low (1.3 % on go and 0.4 % on no-go trials).

To test whether repeated pairing of specific stimuli (i.e. pictures) with a no-go response would cause devaluation of these no-go stimuli only when these stimuli are positive we performed a 3(stimulus status: go, no-go, new) by 2(valence: negative, positive) mixed analysis of variance (ANOVA) with repeated measures on the first factor. First of all, this analysis showed a main effect of valence $F(1,91) = 405.73$, $p < .05$, partial $\eta^2 = .54$. This effect shows that the negative stimuli ($M = 3.53$, $SD = 1.35$) were evaluated lower than positive stimuli ($M = 5.95$, $SD = .87$). More importantly, an interaction between stimulus status and valence emerged, $F(2,182) = 5.23$, $p < .05$, partial $\eta^2 = .05$. For the negative stimuli, stimulus status had no reliable effect, $F < 1$, implying that there was no reliable difference between, negative go ($M = 3.60$, $SD = 1.38$), negative no-go ($M = 3.56$, $SD = 1.43$), and negative new stimuli ($M = 3.44$, $SD = 1.50$).

Replicating Experiments 1 and 2, the predicted pattern emerged again reliably for the positive stimuli, $F(2,90) = 5.53$, $p < .05$, partial $\eta^2 = .11$. Simple effect analyses revealed that positive no-go stimuli ($M = 5.62$, $SD = 1.23$) were devalued compared to both positive go ($M = 6.01$, $SD = 0.98$), and positive new stimuli ($M = 6.21$, $SD = 1.13$), respective comparisons $F(1,45) = 5.30$, $p < .05$, $\eta^2 = .11$ and $F(1,45) = 10.33$, $p < .05$, $\eta^2 = .19$. There was no reliable difference between positive go and positive new stimuli, $F(1,44) = 1.10$, $p = .30$, $\eta^2 = .02$.

In line with the BSI theory we found that behavioral inhibition directed at positive stimuli results in devaluation, whereas this effect is not present in the case of negative stimuli. So, just as in Experiment 2, we obtained an interaction between valence of stimuli and behavior in guiding evaluations. Furthermore, in addition to Experiment 2, Experiment 3 renders a mere conditioning account and demand characteristics as alternative explanations unlikely, as these explanations would predict devaluation for both negative and positive stimuli.

Furthermore, we found no enhanced evaluations of negative go stimuli. This could be for a number of reasons. First of all, it could be that, because negative stimuli can elicit such a diverse behavioral repertoire, a response alone is not sufficient to affect stimulus evaluations. Secondly, it could be that negative stimuli are resistant to positive affective tuning, and a limited number of simple go responses is not sufficient to alter evaluations of such stimuli (Cacioppo et al., 1997). It could be that evaluations of negative stimuli can change, but only after extensive training (Kawakami, Phills, Steele, & Dovidio, 2007). Finally, it could be that both these reasons apply. Although it is not immediately evident how to disentangle these possibilities, future research may give more insight in what happens in the case of negative stimuli. In any case, Experiment 3 shows that evaluations of positive stimuli are influenced by a no-go cue, whereas negative stimuli are not.

General Discussion

In three experiments we showed that consistently not responding to positive stimuli leads to devaluation of these stimuli compared to stimuli to which a response was required, and compared to new stimuli. In addition, Experiments 2 and 3 demonstrated that valence of stimuli moderates the devaluation effect: Only withholding a response towards positive stimuli, but not towards neutral and negative stimuli, leads to lower evaluations. Therefore, the present research shows that behavior towards stimuli and the valence of these stimuli interact, so that consistently not responding to positive stimuli results in the devaluation of these stimuli. These findings suggest automatic behavior regulation in terms of the devaluation of positive stimuli in situations where environmental cues potentially triggering approach (because of their positive valence) run counter to situational demands (a cue that elicits behavioral inhibition). As such, they are consistent with BSI theory outlined in the introduction.

The present research is based on two assumptions that we did not test directly. The first one is that an approach tendency is activated by positive stimuli. However, the fact that this process has already been shown in earlier research (e.g. Chen & Bargh, 1999; Custers & Aarts, 2005; Winkielman, Berridge, & Wilbarger, 2005) indicates that this is a reasonable assumption. The second assumption is that the no-go cues in the go/no-go task triggered behavioral inhibition upon presentation of a positive stimulus. Although we did not measure behavioral inhibition directly in the current experiments, research employing go/no-go tasks using a variety of procedures and stimuli has established that not responding to a no-go cue can activate neurological areas related to response inhibition (e.g. Anderson et al., 2004; de Zubicaray, Andrew, Zelaya, Williams & Dumanoir, 2000; MacDonald, Cohen, Stenger, & Carter, 2000). It would be worthwhile for future research to measure behavioral inhibition directly, and relate it to stimulus devaluation to test whether these processes are indeed directly linked.

Related findings

Recently there has been an increasing interest in the relation between inhibition or interference and evaluative processes (e.g. Brendl, Markman, & Messner, 2003; Fenske & Raymond, 2006). Most related to the current research is research in the domain of (selective) visual attention that has examined the affective consequences of *attentional* inhibition (e.g. Fenske, Raymond, Kessler, Westoby, & Tipper 2005; Raymond, Fenske, & Tavassoli, 2003; Raymond, Fenske & Westoby, 2005; Veling, Holland, & van Knippenberg, 2007). For instance, in an experiment by Fenske et al. (2005) participants were presented with two faces and asked to select a face when, after 1 second, a go cue was superimposed over one of the faces, and they were asked to refrain from responding at all when a no-go cue was superimposed over one of the faces. After each trial participants were asked to indicate which of the two faces was more (or less) trustworthy. Participants judged faces that were associated with a no-go cue on the previous trial as less trustworthy than un-cued faces, whereas a go cue did not affect perceived trustworthiness.

Although this effect may appear similar to the present findings, it is not. Specifically, note that in the paradigm by Fenske et al. (2005) an attentional process is manipulated. That is, participants are first presented with two faces, and after 1 second attention is directed towards the face with the go (no-go) cue and, dependent on the nature of the cue, a (non) response follows. Most importantly, on no-go trials a non response is given with both the cued (no-go) and the uncued face present. Therefore, the devaluation of the cued (no-go) face is unlikely the sole result of behavioral inhibition. In addition, it is noteworthy that in the domain of visual attention, devaluation is found on neutral stimuli whereas we do not predict any devaluation of neutral stimuli in the present research. In order to test whether behavioral inhibition (and not attentional inhibition) can lead to devaluation we presented participants with one stimulus at a time together with either a go or a no-go cue. Depending on the valence of the stimulus, we expected that withholding a response would lead to devaluation. Note that attention was not manipulated in the present research. Thus, our findings are new and of a different nature than those obtained in the domain of (visual) attention, and provide compelling evidence.

In addition, the present research converges with research on goal-directed behavior. That is, whereas research on goal priming has shown that negative affect can ensure that goal pursuit of an initially desired goal is stopped (Aarts et al., 2007), the present research shows that a stop signal can lead to devaluation of an initially positive stimulus. An interesting question is whether the effects in the Aarts et al. study are driven by negative affect, or by behavioral inhibition elicited by the negative affect (cf. Wilkowski & Robinson, 2006). This is an important question as inhibition of approach is, in many everyday-life situations, instigated by negative affect. For instance, when approaching a cookie the thought of becoming fat might be activated. Devaluation of the cookie could in these instances arise from behavioral inhibition, or via evaluative conditioning (i.e. linking the negative thought to the cookie; De Houwer, Thomas, & Baeyens, 2001). In the present research we tried to get around this problem by using no-go cues that are of neutral valence (i.e. letters). As such, the present data render a behavioral inhibition account of the Aarts et al. results possible.

There are a number of limitations of the present research that are worth mentioning. Firstly, we used the same positive stimuli throughout our experiments. As a result, it is an empirical question whether the devaluation effect generalizes to other stimuli. Secondly, we manipulated valence by using pre-rated pictures depicting different objects. It would be worthwhile for future research to keep the stimuli constant and manipulate the valence of the stimuli (e.g. use pictures of drinks as stimuli and manipulate the drive states of participants (thirsty versus non-thirsty)). Another limitation of the present research is that the neutral pictures in Experiment 2 were rated rather negatively, probably as the result of a within subjects design. Although we think that these low ratings did not mask an unpredicted devaluation effect (as explained above), using a between subjects design in the future can help to overcome this limitation.

Furthermore, the fact that a go response did not affect the evaluations of positive, neutral, and negative stimuli should be treated cautiously. It could be that the go response in our task was perceived as the default response, and thus conveyed less information than the no-go response. When go cues are less common it might be that they may result in more positive evaluations of go stimuli. This issue, however, is beyond the scope of BSI theory. Finally, we like to point out that the selective devaluation of positive no-go stimuli is based on null findings for the neutral and negative stimuli. Although it is currently not immediately evident how to circumvent this problem, future research may tackle this issue.

Alternative explanations and related theories

Because the idea that behavior constitutes a source of information about a stimulus can also be found in Bem's (1972) self-perception theory, we like to stress that self-perception theory cannot explain the current results for three reasons. First of all, participants have to know the meaning of their behavior (i.e. that behavioral inhibition is a sign that the stimulus is unwanted) in order to have an influence. This is unlikely in the case of the link between motor behavior and evaluation (Förster & Strack, 1996). More importantly, however, self-perception theory (Bem, 1972) assumes that participants use their behavior as a source of information to infer their own attitudes with the constraint that the behavior should be at least "…free from the control of explicit reinforcement contingencies" (p. 6). Because in the present experiments behavior was explicitly determined by an external cue, the current behavior would be non-diagnostic as a basis for evaluation even with awareness of the meaning of the behavior. Therefore, self-perception would not predict the current results (for a similar argument see Strack et al., 1988). Finally, self-perception theory predominantly deals with behavioral influences on attitudes that are neutral, weak, or ambiguous (e.g. Bem, 1972; Holland, Verplanken & van Knippenberg, 2002), whereas BSI theory predicts stronger devaluation as stimuli become more positive.

Another theory that can be related to the present research is cognitive dissonance theory (Brehm, 1956; Festinger, 1957). Especially research with the *spreading of alternatives* paradigm (Brehm, 1956) seems relevant to the present work. In this paradigm participants are asked to choose between two (equally attractive) alternatives, and it has been repeatedly shown that after this decision the chosen alternative is evaluated higher than the rejected alternative (e.g. Brehm, 1956; Harmon-Jones & Harmon-Jones, 2002; Lieberman, Ochsner, Gilbert, & Schacter, 2001). A common explanation for this effect is that people experience an aversive feeling of post-decisional dissonance when they recognize that both alternatives have positive and negative features, and they try to resolve this by focusing on the positive features of the chosen alternative, and the negative features of the rejected alternative (see Harmon-Jones & Harmon-Jones for an alternative explanation). Research by Shultz, Leveille and Lepper (1999) further indicates that this dissonance reduction is, in the case of a choice between two attractive alternatives, mainly driven by devaluation of the rejected alternative.

Importantly, a critical condition that has to be met in order to elicit dissonance is that the choice should be experienced as a free choice (e.g. Brehm, 1956; Stone & Cooper, 2001). Consistent with this interpretation, recent research in monkeys and children, employing a modified version of the spreading of alternatives paradigm, suggests that dissonance in this paradigm is absent after forced choice (Egan, Bloom & Santos, in press). So, it can be argued that cognitive dissonance theory cannot account for the present results, as according to cognitive dissonance, behavior should be viewed as freely chosen to elicit attitude change, and in the present experiments participants were not presented with decisional freedom.

Finally, a theory that can be related to the present findings, despite the fact that it does not offer an alternative explanation, is that of psychological reactance (Brehm, 1966). According to this theory, people react against pressures that threaten their behavioral freedoms. It could be argued that presenting participants with a positive stimulus to which they should not react creates a possible ground for reactance (cf. Brehm & Weintraub, 1977). One way to react to such a threat, in line with reactance theory, is to perceive the threatened freedom as more attractive (Brehm & Weintraub, 1977). This theory could predict, then, that positive no-go stimuli would show enhanced evaluations compared to the other stimuli. However, in the present experiments, acting upon a simple instruction in a psychological laboratory is probably seen as appropriate, and consequently not experienced as a violation to behavioral freedoms. Therefore, reactance is not present in the current research Accordingly, whenever we perceive a glass of beer only to find out that it belongs to someone else, devaluation of that specific beer may be more likely than perceived increased attractiveness.

To summarize this section, we think that BSI theory has opened up a new line of research and generated some initial results that cannot so readily be accounted for by previous theories. More research is needed, however, to determine the full scope and implications of BSI theory.

Directions for future research

As outlined in the introduction, we have not intended to test the whole BSI theory and all its implications, but we focussed on one specific hypothesis, i.e. devaluation of positive stimuli as a result of behavioral inhibition. Apart from avenues for future research mentioned above, there are a number of unanswered questions that are interesting to pursue in future research. Firstly, we think it would be important to look at the duration of the devaluation effect. We think that devaluation could well be a long-lasting effect for a specific positive stimulus within a situation, as long as situational constraints are present that render approach undesirable. However, as devaluation serves to cancel a response conflict between approach and inhibition concerning a specific stimulus in a specific situation, it may well be that the devaluation effect does not easily generalize across situations because that may be dysfunctional. That is, at a different time and different circumstances the previously devalued stimulus may become available again, and taking the opportunity to act on this stimulus very desirable.

Another direction for future research would be to examine whether the devaluation effect can be found on implicit measures of evaluations. If the devaluation effect indeed serves to guide future behavior as we suggest, devaluation should also be obtained on implicit assessment of evaluations as well (Strack & Deutsch, 2004). Finally, a fascinating possibility for future scientific inquiry would be to examine whether devaluation of positive stimuli to which one should not respond is functional in the sense that then other stimuli can take over to guide behavior.

Conclusion

In the present research we show that withholding a response to a positive stimulus leads to devaluation of this stimulus. We have interpreted this result in terms of BSI theory. Although future research is needed to provide more evidence for this theory, the present research provides an encouraging first insight into the process of automatic behavior-regulation in conditions of conflicting stimulus-situation demands.

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Footnotes

1. The IAPS picture identification numbers of the positive stimuli used in Experiments 1, 2, and 3 are 1440, 1460, 1750, 5000, 5010, 5200, 5780, 5700, 5982, 5830, 5760, and 8190. The IAPS picture identification numbers for the neutral stimuli used in Experiment 2 are 7000, 7002, 7004, 7009, 7010, 7035, 7090, 7160, 7170, 7185, 7207, and 7233. The IAPS picture identification numbers for the negative stimuli used in Experiment 3 are 1050, 1052, 1120, 1200, 1201, 1220, 1270, 7360, 7380, 9600, 9620, and 9621.

2. The absolute mean ratings of the pictures differ from the original IAPS ratings probably because the absolute ratings depend on range of the selected set (i.e. stimulus context effect).

3. In addition, we like to point out that we found no overall reliable devaluation effect in an initial (unreported) experiment where we used (neutral) letters instead of pictures as stimuli, even though these letters were rated higher than the neutral stimuli in Experiment 2 (respective means for the go, no-go, and new letters were 4.06, 3.81, 3.83 on a 7-point scale). Thus, it seems that neutral stimuli are not devalued as a result of our manipulation.