Long-Lasting Attentional Influence of Negative and Taboo Words in an Auditory Variant of the Emotional Stroop Task

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Using an auditory adaptation of the emotional and taboo Stroop tasks, the authors compared the effects of negative and taboo spoken words in mixed and blocked designs. Both types of words elicited carryover effects with mixed presentations and interference with blocked presentations, suggesting similar long-lasting attentional effects. Both were also relatively resilient to the long-lasting influence of the preceding emotional word. Hence, contrary to what has been assumed (Schmidt & Saari, 2007), negative and taboo words do not seem to differ in terms of the temporal dynamics of the interdimensional shifting, at least in the auditory modality.

Keywords: emotional Stroop, taboo Stroop, spoken words, carryover effects

The emotional Stroop task (EST) has often been used to investigate attentional biases linked to emotional information. In this task, a neutral or emotionally charged word is presented during each trial, and the participant has to name its physical color as fast as possible. The “Stroop” label may seem inappropriate (e.g., Algom, Chajut, & Lev, 2004) because there is no potential (in)congruence between the emotional valence of the carrier word and its color. However, the affective dimension of the word, although task irrelevant, interferes with color naming: Reaction times (RTs) are delayed on emotional relative to neutral trials. This is an instance of the interference effects considered to reflect fast attentional capture by the emotional content of the word, called attentional biases or, more commonly in this case, emotional Stroop effects.

Attentional biases toward negative, but not positive, words have been observed using the EST (e.g., Dalgleish, 1995; McKenna & Sharma, 1995; Pratto & John, 1991; Ruiz-Caballero & Bermández, 1997; but see, e.g., Borkenau & Mauer, 2006; Dresler, Mériaux, Heekeren, & van der Meer, 2009). Nevertheless, in healthy participants not selected on the basis of their anxiety level, these biases are usually not observed with emotional words (either from one specific emotional category or from several) mixed with neutral words within the same block of trials, but only with blocked presentation, namely with words of a single emotional (or neutral) category in each block (see Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007, and Phaf & Kan, 2007, for meta-analyses, but see, e.g., McKenna & Sharma, 1995).

According to McKenna and Sharma (2004), the frequent lack of attentional bias with the mixed design is probably due to the involvement, in the EST, of a slow or long-lasting attentional component in addition to the fast short-lived interference mechanism that intervenes during stimulus presentation. The slow component would indeed lead to an RT delay not only on the current (emotional) trial, but also—even exclusively—on the subsequent (e.g., neutral) trial, hence masking the within-trial fast interference effect. With blocked presentations, given that word valence is constant across trials, online within-trial interference is not masked by the occurrence of between-trials long-lasting effects; hence, the observed attentional bias would reflect the combined influence of fast and slow effects. The term carryover effect was first used by Waters and collaborators (Waters, Sayette, Franken, & Schwartz, 2005; Waters, Sayette, & Wertz, 2003) to refer to these slow effects and to contrast them with the fast influence on attention that emotional stimuli operate within a single trial.

However, there is an alternative, nonexclusive explanation for the fact that interference is usually observed with blocked but not mixed EST designs: The blocked presentation of emotional stimuli induces a congruent mood; specifically, negative words may cause prolonged rumination effects (e.g., Holle, Neely, & Heimberg, 1997; Richards, French, Johnson, Naparstek, & Williams, 1992), delaying RTs in the negative relative to the neutral blocks.

It is interesting that several studies have reported consistent interference linked to taboo relative to neutral words in healthy participants in both mixed and blocked designs of the taboo Stroop task (TST; Eilola, Havelka, & Sharma, 2007; MacKay & Ahmetzhanov, 2005; MacKay et al., 2004; Schmidt & Saari, 2007; Siegrist, 1995; Taylor, Kornblum, Lauber, Minoshima, & Koepppe, 1997). Given the divergent results between the EST and TST depending on presentation design, Schmidt and Saari (2007) proposed that what is usually referred to as the emotional Stroop effect would in fact only reflect the slow long-lasting influence of negative words on attention, whereas the taboo Stroop effect would result from a fast short-lasting effect of what these authors considered to be particularly threatening stimuli.
A crucial difference between the effects of negative and taboo words on attentional orienting would thus consist in their temporal course. However, this distinction rests on insufficient evidence: Whereas negative and taboo words have been compared in blocked presentations (Eilola et al., 2007; Schmidt & Saari, 2007) and in mixed presentations in which either taboo or negative words were presented with neutral words in separate blocks (Schmidt & Saari, 2007), to our knowledge, effects of these words have never been contrasted directly in a mixed, within-subject design with taboo, negative, and neutral words presented within the same block. Moreover, carryover effects of taboo words have never been directly assessed, so that suggesting that slow effects would be the privilege of negative words is taking a shortcut.

In the present study, we used a hybrid version of the EST and TST in which we presented negative, positive, taboo, and neutral words. The aim was to contrast the attentional effects of emotional words of different valences in both mixed and blocked designs. More specifically, we investigated the occurrence of fast and slow effects of these words in a mixed design in which all types of emotional words (plus neutral words) were presented in the same block as a within-subject factor. This design provided the opportunity not only to directly compare fast and slow effects of words of different emotional valence, but also to investigate slow effects of emotional words on emotional words of either the same or different emotional valence.

Contrary to previous studies in which linguistic EST and TST have used written words, we presented spoken words. The auditory equivalent of the physical color was the identity of the speaker uttering the word: On each trial, participants had to identify the speaker as fast as possible from four potential speakers by pressing one of four buttons labeled with the speakers’ first names. In addition to increasing the social relevance of the task given that speaker identification is part of daily life activities, there is a clear ecological benefit resulting from the auditory presentation.

Indeed, audition is considered to be the main alerting system (Scharf, 1998): In many daily life situations, people hear a danger before seeing it. As such, it has been shown that auditory signals have a more important alerting power than visual signals (Harvey, 1980; Posner, Nissen, & Klein, 1976) and that the localization of an auditory event could influence the localization of a visual stimulus, whereas the reverse is not true (Spence & Driver, 1997). Moreover, regarding verbal stimuli, oral language is a more fundamental and widespread cognitive ability than written language (see, e.g., Morais & Kolinsky, 2001; Morais, Macedo, & Kolinsky, 2004) because it is acquired before reading and writing and is phylogenetically more ancient. According to Wurm, Vakoch, Strasser, Calin-Jageman, and Ross (2001), this is a strong argument for using spoken language in studies that investigate the impact of emotional stimuli. Still, although the impact of emotional prosody on cognitive processing has been investigated (e.g., Brosch, Grandjean, Sander, & Scherer, 2008; Sander et al., 2005; and using an auditory variant of the EST: Wurm et al., 2001; Wurm, Labouvie-Vief, Aycock, Rebucal, & Koch, 2004), to our knowledge, only one study has investigated the influence of the emotional content of spoken words. Bertels, Kolinsky, and Morais (2010) used an auditory adaptation of the dot-probe task (MacLeod, Mathews, & Tata, 1986) to explore the influence of emotional words on spatial attentional orienting. That study confirmed the interest of using spoken words to investigate attentional biases in participants not selected on the basis of their personality traits: These exhibited spatial attentional biases that are usually not observed with written words.

Coherently, here, we expected to observe attentional biases to negative and taboo words, namely delayed speaker identification latencies for these words relative to neutral words. No attentional bias was expected for positive words (McKenna & Sharma, 1995; Pratto & John, 1991). In the mixed design, carryover effects were estimated by taking into account word valence not only in a specific trial \( N \) (\( N \) words), but also in the preceding trial \( N - 1 \) (\( N - 1 \) words). We expected to observe carryover effects of negative words, as such slow effects previously have been observed using visual materials (Ashley & Swick, 2009; Frings, Englert, Wentura, & Bermeitinger, 2010; Kunde & Maurer, 2008; McKenna & Sharma, 2004; Waters et al., 2003, 2005). Predictions relative to taboo words were less clear given that the carryover effects of these words have never been investigated. Nevertheless, if Schmidt and Saari (2007) were right in postulating slow effects only for negative words, interference linked to taboo words would be observed with both mixed and blocked presentations, whereas interference linked to negative words would not be observed with mixed presentations, due to carryover effects, but only with blocked presentations.

**Method**

**Participants**

Seventy-nine native French-speaking students of the Université Libre de Bruxelles took part in the experiment (51 women; six left-handed), ranging from 18 to 41 years of age (\( M = 23 \) years). The results of 15 participants (nine women), all right-handed, were discarded from the analyses: six because their average RTs were superior to 2 standard deviations above the overall average performance, eight because their error rates exceeded the same threshold, and one on the basis of both criteria. They were paid for their participation.

Previous studies investigating attentional biases in the visual modality have pointed to the robustness of this phenomenon only in selected groups of participants such as anxious (e.g., Mogg & Marden, 1990), repressives (e.g., Dawkins & Furnham, 1989), and depressed people (e.g., Bradley, Mogg, Millar, & White, 1995). Therefore, we used personality questionnaires (filled in after the task) assessing anxiety and depression levels (the Spielberger Trait-State Anxiety Inventory [Spielberger, 1983] and the Beck Depression Inventory [Beck, Steer, & Brown, 1996], respectively), as well as willingness to be socially desirable (the Marlowe-Crowne Scale of Social Desirability [Crowne & Marlowe, 1960]) to check for any correlation between these scores and the emotional effects. Table 1 displays the average scores obtained from these questionnaires.

**Material and Apparatus**

Stimuli consisted of 20 negative, 20 positive, and 20 emotionally neutral words (for similar proportions in mixed designs, see, e.g., McKenna & Sharma, 1995, and Mauer & Borkenau, 2007), as well as 20 taboo words. These mono- or bisyllabic words came from the database created by Bertels, Kolinsky, and Morais (2009).
The four types of words were matched according to oral frequency, number of phonological neighbors, and phonological uniqueness point (cf. database Lexique 3.01; New, Pallier, Ferrand, & Matos, 2001; see the Appendix).

Four French-speaking actors (two women, two men) pronounced the words with a neutral tone. Words were digitally recorded on a Sony MiniDisc and then transferred on a Macintosh Powerbook G3 via the interface Digidesign DIGI 002 Rack; they were cleaned, normalized, and synchronized with Protools/ Digidesign 6.2.2 software. Mean word length was 627 ms ($SD = 112$ ms).

Participants were tested individually wearing headphones in front of a computer screen. Stimulus presentation and data collection were controlled using the E-Prime button box and 1.1.4.1 software (Schneider, Eschman, & Zuccolotto, 2002) running on an Asus laptop.

**Procedure**

Each trial started with a 1,000-ms fixation cross displayed in the middle of the screen. An auditory word was then presented, uttered by one of the four speakers. Participants were required to identify the speaker by pressing one of the four keys of the button box as quickly and accurately as possible. The first name of each speaker was written on the top of the corresponding button (Marcha, Claire, Tim, and Alex). Participants had 5,000 ms to answer. The interval between the response and the next trial was 500 ms, leading to a 1,500-ms response–stimulus interval.

The experiment started with three 20-trial practice blocks, during which participants learned to identify the four speakers (i.e., to match a voice with a first name). They received feedback and correction in case of error. Next, they were presented with four 80-trial experimental blocks, receiving feedback—a beep—when the answer was wrong. Practice words were not used in the experimental blocks.

Participants were randomly assigned to the blocked and mixed conditions (32 participants by condition; 22 and 20 women in the blocked vs. mixed condition, respectively).

In the blocked condition, all words of a block had the same emotional valence (neutral, negative, positive, or taboo). Hence, the same words were repeated 4 times in each block, each time uttered by a different speaker. At least 10 other words separated two repetitions of the same word.

In the mixed condition, all words were presented once in each block in a pseudorandom order: A word of the same emotional type or said by the same speaker was never presented more than 3 times in a row. One fourth of the words of a specific emotional type were pronounced by a specific speaker. Doing this, the emotional valence and the identity of the speaker were not correlated, and each block included the same number of stimuli pronounced by a specific speaker. Blocks differed by the assigned pseudorandom order and by the speaker pronouncing a specific word (each word was pronounced by a different speaker in each block).

In both conditions, block order and response key assignment were counterbalanced across participants using a Latin square design.

After the experiment, participants completed the three personality questionnaires listed above.

**Results**

**Emotional and Taboo Stroop Effects With Mixed and Blocked Presentations**

A 2 (presentation: blocked design, mixed design) × 2 (participant’s gender) × 4 (word valence: neutral, negative, positive, taboo) repeated measures analysis of variance (ANOVA) was run on the RTs. The participant’s gender was considered given previous studies revealing divergences in emotional Stroop effects between men and women (e.g., Egloff & Schmukle, 2004; Sass et al., 2010; Smith & Waterman, 2005). Design and gender were between-subjects factors, and word valence was a within-subject factor. Average RTs per word valence are presented in Figure 1 separately for the blocked and mixed designs.

Gender was the only significant main effect, $F(1, 60) = 4.066$, $p < .05$, with women responding faster than men ($735$ vs. $790$ ms).

The word valence by presentation interaction was also significant, $F(3, 180) = 8.24$, $p < .001$. As expected, word valence was significant in both the blocked and mixed designs, $F(3, 90) = 3.963$, $p = .01$, and $F(3, 90) = 6.063$, $p = .001$, respectively, but affected RTs quite differently (see Figure 1).

Planned comparisons revealed that, with blocked presentations, both taboo and negative words led to longer RTs than neutral words, $F(1, 30) = 4.699$, $p < .04$, and $F(1, 30) = 9.566$, $p < .005$, with no bias occurring for positive words, $F < 1$. The positive attentional biases associated with negative (24 ms) and taboo words (34 ms) were not correlated with any of the personality scores ($-.18 < r_s < .19$, $ps > .10$). Similarly, the nonsignificant attentional bias for positive words (7 ms) was not correlated with any of these scores ($-.05 < r_s < .19$, $ps > .10$).

With mixed presentations, planned comparisons showed that taboo words led to shorter RTs compared with neutral words, $F(1,$

### Table 1

<table>
<thead>
<tr>
<th>Questionnaire</th>
<th>Mixed design ($n = 32$)</th>
<th>Blocked design ($n = 32$)</th>
<th>Average ($n = 64$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>STAI–Y</td>
<td>46.41 (7.27)</td>
<td>49.38 (10.78)</td>
<td>47.89 (9.24)</td>
</tr>
<tr>
<td>Trait anxiety</td>
<td>44.13 (9.10)</td>
<td>49.56 (12.65)</td>
<td>46.84 (11.27)</td>
</tr>
<tr>
<td>SDS</td>
<td>48.13 (5.00)</td>
<td>43.91 (7.85)</td>
<td>45.98 (6.89)</td>
</tr>
<tr>
<td>BDI–II</td>
<td>7.81 (6.58)</td>
<td>8.03 (7.72)</td>
<td>7.92 (7.13)</td>
</tr>
</tbody>
</table>

Note. STAI–Y = Spielberger Trait-State Anxiety Inventory (Form Y); SDS = Marlowe–Crowne Scale of Social Desirability; BDI–II = Beck Depression Inventory (2nd ed.). The displayed scores are standard scores for STAI and SDS, while they are raw scores for the BDI.
30) = 4.755, p < .04, with positive words only tending to elicit longer latencies, F(1, 30) = 3.492, p = .07. No difference was found between negative and neutral words, F < 1. The negative attentional bias for taboo words (i.e., the difference between RTs on taboo and neutral words, −15 ms) was not correlated with any of the personality scores (−.13 < rs < .00, ps > .10). Similarly, the nonsignificant attentional biases for positive and negative words (−15 and 0 ms, respectively) were not correlated with any of these scores (−.17 < rs < .06, ps > .10).

No correlation was found between the mean attentional bias for each individual emotional word (calculated by subtracting the mean RT on neutral words from the mean RT on each individual emotional word, separately for blocked and mixed presentations) and word oral frequency (blocked: r = −.202, mixed: r = −.071, ps > .10), number of phonological neighbors (blocked: r = −.125, mixed: r = −.193, ps > .10), or phonological uniqueness point (blocked: r = .039, mixed: r = .112, ps > .10).

The mean error rate was 3.04% (range: 0.00–7.18%). Repeated measures ANOVAs on the error rates corrected by the arcsine function did not show any significant effect or interaction (ps > .10).

### Carryover Effects With Mixed Presentations

To track carryover effects with mixed presentations, we looked for the occurrence of attentional biases, taking into account word valence not only on trials N but also on trials N−1. Although this analysis is not orthogonal to the preceding one, its relevance is supported by various studies suggesting a major involvement of slow effects in emotional Stroop situations (e.g., Waters et al., 2003, 2005). Moreover, it provides the opportunity to further explore the unexpected results observed with our mixed design. We thus ran a 4 (word valence at trial N) × 4 (word valence at trial N−1) repeated measures ANOVA on RTs at trial N.² Both were within-subject factors. If carryover effects did occur, we would expect to observe a significant interaction between word valence on trial N and word valence on trial N−1.

This was indeed the case. In addition to the main effect of word valence on trial N, F(3, 93) = 5.133, p = .002, already observed in the previous analysis, there was a main effect of word valence on trial N−1, F(3, 93) = 11.586, p < .001. It is important to note that these effects were qualified by an interaction between these two factors, F(9, 279) = 6.108, p < .001.

This interaction was decomposed using Bonferroni-adjusted paired samples t tests.³

First, we compared the size of the fast within-trial effects of emotional words. Indeed, when the N−1 word was neutral, any difference observed on the subsequent trial N between RTs on emotional words (separately for the three types of emotional words) and RTs on neutral words may be attributed to the fast within-trial component. These comparisons showed that after an N−1 neutral word, RTs on negative, positive, or taboo N words did not differ significantly from RTs on neutral N words (ps > .10; see white bars in Figure 2). These nonsignificant attentional biases (+23, +21, and +13 ms, respectively) were not correlated with any of the personality scores (−.107 < rs < .177, ps > .10).

Second, we assessed the size of the slow between-trials carryover effects of emotional words presented on trial N−1 on RTs on trial N. The size of these effects was estimated as the difference between RTs on neutral N words following emotional words (separately for negative, positive, or taboo trials) and RTs on neutral N words following neutral words. The presentation of N−1 negative or taboo words relative to N−1 neutral words delayed RTs

² Given that neither the main effect of participant’s gender nor any interaction involving this factor was significant (ps > .10), we did not consider it in this second analysis.

³ The p values were multiplied by 15 given that 15 t tests were made. We compared the case in which a neutral word was followed by an emotional word with the case in which it was followed by a neutral word (three comparisons). Also, for each word valence at trial N, we compared the case in which it was preceded by an emotional word with the case in which it was preceded by a neutral word (4 × 3 comparisons).
Discussion

We created an auditory hybrid version of the EST and TST to investigate the influence of the task-irrelevant emotional dimension of spoken words on the processing of an unrelated task-relevant dimension of the same stimulus, here the speaker’s identity. We used both blocked and mixed presentations and examined, in the mixed design, the temporal course of this emotional influence by investigating the effects of the presentation of an emotional word on the response to the subsequent word. The influences of negative, positive, and taboo emotional valences were considered in this study. To our knowledge, this is the first study that has systematically investigated long-lasting, carryover effects of taboo words in a mixed design, and that allowed a direct comparison with the effects of negative and positive words presented in the same block. This creates a quite ecologically valid emotional context given that everyday conversations mostly consist of a mixture of words of various emotional contents (e.g., negative, neutral, and taboo; negative, positive, and neutral, etc.). Moreover, the fact that different types of emotional words were presented in the same block gave us the opportunity to assess interemotional carryover effects, whereas previous studies exclusively have assessed carryover effects of emotional stimuli on subsequent neutral stimuli. Another major interest of our study consisted of the presentation of spoken rather than written words. In addition to the fact that oral language is a more fundamental and widespread cognitive ability than written language (see, e.g., Morais & Kolinsky, 2001; Morais et al., 2004) and that auditory signals have a more important alerting power than visual signals (Harvey, 1980; Posner et al., 1976), the use of spoken words allowed using an ecologically valid speaker identification task through which attentional effects of taboo words were assessed in their most frequent (oral) vehicle.

As predicted, interference of negative and taboo words, but not of positive words, was observed with blocked presentations. Thus, the first contribution of the present study is to show that emotional and taboo Stroop effects are not only visual effects, but can also be observed with auditory stimuli. Although further studies should aim at comparing more directly and precisely the effects of visual and auditory stimuli, this finding suggests that the occurrence of such effects depends on the activation of semantic, probably modality-independent, representations.

With mixed presentation, results were more complex, given that RTs depended both on the emotional valence of the word at a specific trial and on the emotional valence of the word presented at the previous trial. In summary, no fast effect of emotional words on neutral words presented at trial \(N\) (+50 and + 46 ms, respectively, see (a) and (b) in Figure 2), \(t(31) = 4.142\) and 5.419, \(p < .01\). No effect of the presentation of \(N-1\) positive words was observed \((p > .10)\). These attentional biases were not correlated with any of the personality scores \((-\.194 < rs < .177, p > .10)\). Similarly, the nonsignificant attentional bias for positive words \((+ 8\) ms) was not correlated with any of these scores \((-\.049 < rs < .068, p > .10)\).

Given that words of different emotional valences were mixed in the same block of trials, we had the opportunity to assess, in addition to carryover effects of emotional words on neutral words, the influence of an emotional \(N-1\) word on the responses to emotional \(N\) words. To our knowledge, this never has been investigated before. For each type of emotional \(N\) word, we compared the case in which it was preceded by an emotional word with the case in which it was preceded by a neutral word. Negative \(N-1\) words delayed responses to positive \(N\) words (+68 ms), \(t(31) = 4.466, p < .003\) (see (c) in Figure 2). All the other comparisons were not significant \((p > .10)\). In particular, RTs on negative and taboo \(N\) words were not affected by the previous presentation of an emotional (relative to a neutral) \(N-1\) word \((p > .10)\). The significant attentional bias was not correlated with any of the personality scores \((-\.183 < rs < .103, p > .10)\). Similarly, the nonsignificant attentional biases were not correlated with any of these scores \((-\.213 < rs < .271, p > .10)\).

![Figure 2. Mean (±SE) reaction times (RTs) with mixed presentations (n = 32), separately for each word valence in trial N-1 as a function of word valence in trial N. Horizontal lines denote the significant comparisons.](image-url)
was observed. Instead, negative and taboo words slowed RTs in ensuing trials containing neutral words.

We first discuss the absence of any fast effect of negative and taboo words with the mixed presentation. Then, we consider their carryover effects, and finally, taking the data of both the blocked and mixed presentations into account, comment on potential effects of the emotional context.

No Fast Effect of Negative and Taboo Words

As noted above, data from the mixed condition of our study do not support the existence of any fast within-trial effect of the emotional valence of the words on the processing of the task-relevant dimension of the stimuli. Indeed, following the presentation of a neutral word, participants were not slower to identify the speaker uttering an emotional rather than a neutral word.

The absence of any fast effect of negative words is coherent with previous findings from studies investigating this effect of negative stimuli in the visual modality, either with written words (McKenna & Sharma, 2004; but see Ashley & Swick, 2009) or with pictures (Kunde & Mauer, 2008). We have thus extended these findings to the auditory modality. However, Frings et al. (2010) recently showed that pseudorandom designs consisting of controlling the succession of neutral and emotional words actually create a contingency between the occurrence of neutral and emotional words that masks fast effects of the emotional words. Although in our mixed presentation we indeed prevented the succession of more than three words of the same emotional type, the fact that we used four emotional categories (instead of two as in Frings et al.) allowed not inducing a robust pattern of contingencies. Nevertheless, further studies should take this possibility into consideration by presenting emotional and neutral trials completely randomly.

Contrary to negative words, the temporal course of the effects linked to taboo words has never been investigated. Nevertheless, it is widely recognized that taboo words do lead to fast effects (Eilola et al., 2007; MacKay & Ahmetzanov, 2005; MacKay et al., 2004; Schmidt & Saari, 2007; Siegrist, 1995; Taylor et al., 1997). As a matter of fact, interference effects consistently have been observed with taboo words in blocked and mixed designs, a situation revealing the influence of fast effects in theory. Based on this observation, Schmidt and Saari (2007) proposed that the taboo Stroop effect would be distinct from the emotional Stroop effect in that it would result from a short-rather than long-lasting influence of these words. However, given that no effect of taboo words was observed here after the presentation of a neutral word, namely in a situation in which only within-trial fast effects can occur, our auditory results are inconsistent with this idea. Further studies in the visual modality should aim to explore systematically the existence of fast effects of taboo words. Whatever the conclusion of these studies, it is worth noting that our results are more liable to reflect everyday functioning given that taboo words are more frequent in speech than in written language.

Carryover Effects of Negative and Taboo Words

Although negative and taboo words did not induce fast within-trial effects, they did affect processing speed on the next trial, hence demonstrating that they generate slow long-lasting effects. As a matter of fact, carryover effects of both types of words were observed in the mixed condition. Both negative and taboo words delayed RTs on subsequently presented neutral words. Negative (but not taboo) words also delayed RTs on subsequently presented positive words. Remarkably, these carryover effects lasted for more than 1 s, given that the mean word length (627 ms) and the response–stimulus interval (1,500 ms) led to a long intertrial interval. Usually, for long intertrial intervals, slow effects tend to fade, at least in the visual modality (McKenna & Sharma, 2004).

What do these slow long-lasting effects reflect? Although there is no general agreement about the underlying psychological mechanisms, various authors assume that attentional disengagement can be identified as the main locus of the effect (McKenna & Sharma, 2004; Phaf & Kan, 2007; Strauss, Allen, Duke, Ross, & Schwartz, 2008; Waters et al., 2003, 2005; see also White, 1996). The idea that attentional biases are due to difficulties in disengaging attention from the emotional content of stimuli was first formulated in the context of spatial attentional orienting. Although facilitation of responses to a probe presented at the same spatial location where an emotional stimulus had been presented right before has been interpreted in terms of attentional vigilance (i.e., an effect at the level of the engagement of attention; for a meta-analysis, see Bar-Haim et al., 2007), various authors suggest that this effect would actually reflect difficulties in disengaging attention from that location (e.g., Fox, Russo, Bowles, & Dutton, 2001; Fox, Russo, & Dutton, 2002; Koster, Crombez, Verschueren, & De Houwer, 2004). Even if no spatial attentional shift is involved in the emotional Stroop situation, this idea has been transferred to the dimensional orienting of attention, namely to attentional orienting toward a specific dimension of the stimulus (e.g., Garner, 1962, 1974). Once attention has been initially captured by a stimulus, participants should disengage from it to process the next stimulus. In particular, in the case of a stimulus containing an emotional, task-irrelevant dimension, attentional disengagement from this dimension would be difficult, hampering the processing of the task-relevant dimension of the next stimulus. Our results suggest that (at least when stimuli are spoken words) such attentional disengagement problems arise with threatening stimuli (negative or taboo), but not with positive ones.

It is interesting that the present results also suggest that these threatening stimuli are themselves relatively immune to such carryover effects. Indeed, responses to negative and taboo words were not at all affected by the emotional valence of the preceding word. Yet, as pointed out by Frings et al. (2010), the impact of priming processes should moderate these conclusions: The successive presentation of two words of the same emotional valence would create a kind of “spreading inhibition,” making the target less accessible than when it is preceded by a neutral word, causing less interference. Nevertheless, this idea is difficult to reconcile with the pattern of data observed in the present study given that only slow effects and no fast interference of negative or taboo words were found.

Thus, although there is no fast within-trial effect of threatening stimuli, their emotional valence seems both to induce long-lasting attentional disengagement effects (observed on the next trial) and to modulate the impact of the previous trial on the current trial.

Potential Effects of the Emotional Context

Interference effects were observed for both negative and taboo words in the blocked design. In this condition both fast
and slow effects can occur, but the interference effects reported in the literature are usually interpreted as reflecting mostly the occurrence of slow effects (see, e.g., McKenna & Sharma, 2004). However, the pattern of carryover effects observed in the present study with mixed presentation is not consistent with this idea. Indeed, as already commented, with mixed presentations, negative and taboo words only delayed RTs on subsequent neutral trials, not on subsequent negative or taboo trials. Hence, carryover effects similar to the ones observed with mixed presentation cannot account for the interference effects observed with blocked presentations. Although further research should aim at better understanding the origin of these effects, it may be the case that the successive presentation of many negative words induced a congruent, negative mood, responsible for RT slowing in the emotionally homogeneous blocks (Holle et al., 1997; Richards et al., 1992). This may have occurred in the taboo blocks as well, insofar as both negative and taboo words are negatively loaded (see the Appendix and Bertels et al., 2009).

Similarly, one may argue that congruent mood explains the results observed with mixed presentations. Indeed, in the mixed design, all types of emotional (and neutral) words were presented. This gave us the opportunity to assess carryover effects of emotional words on subsequent emotional words, and allowed us to compare the effects of different types of emotional words in a within-subject design without repeating the same neutral words across successive blocks of trials (which may induce habituation effects) or using a different set of neutral words for each type of emotional words. But, in the mixed design, the proportion of words of negative valence (either negative or taboo words) was higher than the proportion of neutral words or positive words, probably creating a negative emotional context that could have induced a negative mood. Note that most other studies mixing only negative (or only taboo) words with neutral words in the same block of trials used the same proportion of negative words (i.e., half of the trials) as our study. Hence, the fact that our data are quite coherent with the results observed in these studies (e.g., McKenna & Sharma, 2004) does not eliminate the possibility that negative mood induced the effects in all cases.

However, at least one piece of evidence supports the idea that the specific emotional context used here was not mainly responsible for the pattern of results observed with mixed presentations. If one assumes that the high proportion of negative words would have induced a negative mood bias that slowed RTs (Holle et al., 1997; Richards et al., 1992), this should have been the case not only in the negative and taboo homogeneous blocks of the blocked presentation but also overall in the mixed presentation. Contrary to this idea, overall RTs did not differ between presentations in the repeated measures ANOVA, $F < 1$, and the RT difference between mixed versus blocked designs did not reach significance for either neutral or positive words, $t(62) = 1.208$ and $1.488$, respectively, $p_s > .10$.

Thus, although further studies will have to assess more precisely the impact of the specific emotional contexts created by mixing words of various emotional valences, we think that the advantages of the specific mixed design used in the present study prevailed over this potential limitation.

Conclusion

Contrary to the idea that the effects of negative and taboo words differ primarily according to their temporal course, with taboo Stroop effects resulting from fast attentional effects and emotional Stroop effects reflecting slow effects of negative stimuli (Schmidt & Saari, 2007), the present results show that the effects of both types of words largely overlap, at least when their vehicle is spoken. As a matter of fact, neither negative nor taboo words elicited fast effects. Rather, both had long-lasting influences on the processing of nonthreatening stimuli, and both were themselves relatively resilient to carryover effects of preceding emotional words. Finally, both types of words produced interference effects when presented in blocks.

In conclusion, the present results suggest that at least with respect to auditory presentations, negative and taboo words do not differ in terms of the temporal dynamics of the interdimensional shifting. Future studies should aim at establishing whether the same holds true for visual presentations, for which the taboo Stroop effect seems more reliable than the emotional Stroop effect.

References


### Appendix

**Values of Emotional Dimensions and Lexical Factors for Each Emotional Category of Words**

<table>
<thead>
<tr>
<th>Emotional category</th>
<th>n</th>
<th>Mean valence (1–7)</th>
<th>SD</th>
<th>Mean Arousal (1–7)</th>
<th>SD</th>
<th>Mean Threatening valence (1–5)</th>
<th>SD</th>
<th>Mean Shocking valence (1–5)</th>
<th>SD</th>
<th>Mean Mean oral frequency</th>
<th>SD</th>
<th>Mean phonological neighbors</th>
<th>Mean SD</th>
<th>Mean phonological uniqueness points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutral</td>
<td>20</td>
<td>4.444</td>
<td>1.181</td>
<td>3.820</td>
<td>1.011</td>
<td>1.400</td>
<td>0.741</td>
<td>1.083</td>
<td>0.268</td>
<td>67.964</td>
<td>75.070</td>
<td>10.100</td>
<td>8.372</td>
<td>1.356</td>
</tr>
<tr>
<td>Negative</td>
<td>20</td>
<td>1.821</td>
<td>1.553</td>
<td>5.923</td>
<td>1.144</td>
<td>4.253</td>
<td>0.970</td>
<td>2.665</td>
<td>1.309</td>
<td>73.395</td>
<td>126.61</td>
<td>6.400</td>
<td>6.524</td>
<td>1.095</td>
</tr>
<tr>
<td>Positive</td>
<td>20</td>
<td>6.225</td>
<td>1.191</td>
<td>2.245</td>
<td>1.466</td>
<td>1.675</td>
<td>0.661</td>
<td>1.175</td>
<td>0.448</td>
<td>71.904</td>
<td>107.11</td>
<td>7.600</td>
<td>6.193</td>
<td>0.889</td>
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</table>

Received December 19, 2008
Revision received May 18, 2010
Accepted September 10, 2010