What Makes a Tumor Worse: Taboo Context Affects How Emotional Distractors Influence Picture Naming

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Abstract

Strong emotional words tend to command attention and disrupt cognitive processing. Three experiments investigated whether taboo context, defined by the inclusion of taboo distractors in a picture-word interference task, influences how a distractor's emotional properties affect speech production. Participants named target pictures accompanied by written distractors varying in arousal and valence. Trials were presented in blocks with negative, positive, and neutral distractors that also included or omitted taboo distractors. Results showed that positive distractors had no significant effect on naming times, whereas negative distractors slowed picture naming only when they were higher in arousal and only in a taboo block. Naming times were slower overall in the taboo context compared to the non-taboo context. These findings suggest that the presence of taboo words changes the influence of non-taboo emotional words during speech production, which has implications for the role of attention in speech production theories and more broadly for cognition.

Keywords: taboo words, arousal, valence, attention, picture-word interference

What Makes a Tumor Worse: Taboo Context Affects How Negative and Positive Distractors Influence Picture Naming

It is well-established that emotionally-charged words engage attention, facilitate memory, and affect speech production (e.g., Kensinger & Corkin, 2003; Pratto & John, 1991; White et al, 2016). For example, compared to neutral words, taboo and negatively-valenced words tend to attract attention, be well-recalled, and distract a speaker from producing words. The impact of emotional words on cognition depends on the words' specific emotional properties (e.g., tabooness, arousal, and valence) and lexical characteristics (e.g., word frequency, age of acquisition, concreteness; Kanske & Kotz, 2007; Palazova et al., 2011; see Hinojosa et al., 2020, for a review), although our understanding of the influence of these properties derives primarily from studies on word recognition (e.g., Larsen et al., 2008). Furthermore, there is considerable variability across studies in the properties of emotional words that are controlled or manipulated, as well as the types of emotional words that are included as stimuli. For example, investigations focusing on whether negative words interfere with Stroop color naming have not always controlled for arousal (e.g., McKenna & Sharma, 2004; Pratto & John, 1991), and studies vary in whether negative words are mixed with only neutral words (e.g., Algom et al., 2004), neutral and positive words (e.g., Pratto & John, 1991), or even taboo words (e.g., Bertels & Kolinsky, 2016). To our knowledge, no research has investigated whether these different contexts alter the ways in which emotional words, or their arousal (i.e., intensity) and valence (i.e., pleasantness) properties, influence cognition. Therefore, the primary goal of the present study was to investigate whether the inclusion of taboo distractor words in an experimental block, i.e., a *taboo context,* influences the likelihood that non-taboo emotional distractors will interfere with speech production. We investigated the effect of a taboo context using a picture-word interference

paradigm, which also provided a method to explore the independent and interactive effects of a distractor word's valence and arousal in producing interference during picture naming.

Speaking is a fundamental human ability that appears relatively automatic in nature (speakers produce an average of 120-150 words per minute; Maclay & Osgood, 1959), thus seeming to require few attentional resources in the absence of distraction. However, real-world conversations often occur in the face of considerable distractions, both verbal such as other people talking and non-verbal such as surrounding noise. Recently, researchers have shown that strong emotional words, particularly taboo words, can be distracting by engaging attention and slowing speech production (Dhooge & Hartsuiker, 2011; Hansen et al., 2017; Mädebach et al., 2018; White et al., 2016, 2017). Specifically, when naming pictures accompanied by taboo distractor words in a picture-word interference task, a *taboo interference effect* emerges, where participants are slower to name pictures accompanied by taboo distractors (as well as negative distractors to a lesser degree) relative to other types of distractors, including positively-valenced distractors, neutral distractors, and semantically-related distractors (White et al., 2016, 2017). Furthermore, in a model that included the distractor word characteristics of tabooness, valence, and arousal, tabooness explained the largest amount of variance in picture naming time. Why are taboo words particularly distracting? They are a unique class of words (Jay, 2009) that are defined by their strong emotional properties: high arousal, offensiveness, and social inappropriateness (Janschewitz, 2008; Jay, 2009). Thus, taboo words engage attention in ways that non-taboo words do not (Hansen et al., 2017).

Although it has been established that taboo words disrupt speaking, the theoretical implications of this disruption are not well understood. One theoretical account suggests that a verbal self-monitor, which checks internal speech before articulation, is sensitive to tabooness

and subsequently more cautious in the presence of taboo distractors (Dhooge & Hartsuiker, 2011). In picture-word interference, planned speech is carefully checked in a response output buffer before articulation to ensure the taboo word is not spoken. An alternative attentional account of taboo interference in picture naming derives from the WEAVER++ model (Roelofs, 2003), which proposes that slowed picture naming in the presence of taboo distractor words reflects both the rapid and lasting interference they cause: Taboo words rapidly exceed a competition threshold, or attentional filter, drawing attentional resources away from picture naming (White et al., 2016). Further, disengaging from taboo distractors is difficult, increasing the time it takes to reactively block them prior to naming the picture (e.g., Mädebach et al., 2018; White et al., 2016, 2017).

It has not been established whether attention or monitoring mechanisms are also sensitive to non-taboo emotional properties of distractors, specifically arousal and valence (although see White et al., 2016). There is some evidence that both arousal and valence affect the speed of recognizing a word (Larsen et al., 2008), and research on emotion and language production indicates possible disruption in word form retrieval and/or monitoring when production involves negative words, images, or moods (e.g., Hinojosa et al., 2010, 2017; Rohr & Abdel-Rahman, 2018). However, it is unknown whether the *inhibition* of distracting emotional words varies as a function of those words' arousal and valence properties, which could affect the speed of producing a (non-emotional) word. While White et al. (2016, Experiment 2) found that distractors slowed picture naming when they were negatively-valenced but not positively-valenced, their experiment only included higher-arousal distractors presented in a taboo context. White et al. (2016) offered a theoretical account for making predictions about how non-taboo emotional distractors will affect picture naming, which is dependent on the degree of the

distractor's arousal. In this framework, the competition threshold is sensitive to arousal, where higher-arousing words rapidly exceed the competition threshold, capturing attention and potentially competing with the picture for attentional resources. This idea extends the competition threshold from one where a distractor's activation level determines whether it competes with the picture for selection (e.g., Piai et al., 2012) to one that is also sensitive to a distractor's emotional characteristics that draw attention from picture naming. It also extends research identifying the dimensions of emotion that capture exogenous (i.e., automatic, bottom-up) attention in visual tasks (see Carretié, 2014, for a review) to language tasks.

The present experiments were designed to investigate whether a taboo context influences the degree to which non-taboo emotional words are distracting during picture-word interference. The majority of studies investigating emotional interference during speech production (i.e., using picture-word interference) have included taboo distractors, thus creating a taboo context which potentially could have influenced whether or not other types of distractors impacted picture naming. Aquino and Arnell (2007) suggested that the context in which words are presented (e.g., mixed with words from other valences) might influence "which words capture attention and for how long" (p. 434). Independent of emotion, context defined as the proportion of congruent vs. incongruent trials influences the size of Stroop interference in color naming (Logan & Zbrodoff, 1979). Similarly, context defined by a mixture of words and nonwords in an experiment has been shown to influence speech production (Dhooge & Hartsuiker; 2012; Hartsuiker et al., 2005). For example, in an experiment where trials alternated between picture-word interference trials and trials where words had to be read out loud, picture naming was slower when distractors were words vs. nonwords (Dhooge & Hartsuiker, 2012). This experimental context made it more difficult for the monitor to exclude a word distractor, thus slowing naming times when

distractors were words relative to nonwords. This evidence favors a monitor that is adaptive to experimental context (i.e., the kinds of trials that are included, defined by Dhooge and Hartsuiker as word or nonword contexts), and uses context to determine what kinds of errors (or distractors in picture-word interference) are intercepted. Dhooge and Hartsuiker (2011) also demonstrated that context can be defined by the "social appropriateness" of distractors, as picture naming is slower and more careful on trials with taboo than neutral distractors. They assume a self-monitor that is adaptive to the kinds of items encountered; speakers who wish to refrain from using inappropriate language will be more cautious by monitoring their speech when taboo distractors are present.

Although the monitor is thought to help ensure that a taboo distractor is not spoken on any given trial, we predicted that the monitor also operates within a block of trials, adopting a high level of caution once the speaker sees taboo words presented as distractors. We therefore selected a context manipulation to investigate the emotional "contrast" that might be created in blocks that include non-taboo emotional words along with or without taboo words. Because tabooness and arousal are highly correlated (Roest et al., 2018), we propose that the inclusion of taboo trials will result in lowering the competition threshold for all distractors to ensure that speakers detect potentially aversive stimuli. The consequence of lowering the threshold is that higher-arousal non-taboo distractors will more easily exceed the threshold and interfere with picture naming, but this will only occur in a block containing taboo trials and not in a block without taboo trials. In contrast, lower-arousal distractors will not exceed the competition threshold and therefore will not compete with the picture for attention, resulting in lower-arousal distractors having no effect on picture naming. Furthermore, the interference from higher-arousal distractors in a taboo block is hypothesized to be dependent on a distractor's valence, which

influences blocking of distractors: Higher-arousing positive distractors more rapidly capture attention (Hinojosa et al., 2015) and are more rapidly recognized (Keuper et al., 2013) and subsequently blocked than higher-arousing negative distractors. Consequently, negative distractors are expected to interfere more than positive distractors. Lastly, because taboo monitoring would be required on every trial in a block that has taboo distractors (one would always need to be on alert in case a taboo distractor was presented), we predicted slower times for naming pictures with non-taboo distractors in that block relative to a block without taboo distractors.

Experiment 1

Because the taboo interference effect in picture-word interference is well established (Dhooge & Hartsuiker, 2011; Hansen et al., 2017; White et al., 2016, 2017), the goal of Experiment 1 was to identify the degree to which a *non-taboo* emotional distractor's valence and arousal predict variance in picture naming times in both taboo and non-taboo contexts, i.e., whether taboo words were present or absent in a block of picture-word interference trials. We therefore chose a large number of distractors that ranged from negative-to-positive in valence and from low-to-high in arousal, providing an opportunity to use a multiple regression approach.

Method

Participants

Participants included 52 undergraduate students (32 female, 19 male, 1 transgender) who ranged in age from 18 to 22 years (M = 19.06, SD = 0.98), spoke English as their first language, reported corrected-to-normal vision, and participated in exchange for partial course credit. The majority (47) of participants were right-handed. Although multiple regression is not typical for picture-word interference studies, our number of participants exceeded the sample sizes used in

multiple regression studies of picture naming (e.g., Alario et al., 2004; Bonin et al., 2002; LaGrone & Spieler, 2006). Further, estimating a multiple regression with three predictors using G*power 3.0 (Faul et al., 2007) suggested a minimum sample size of 48 to ensure power of .80 to detect a minimum effect size of .25 (as in White et al., 2016).

Materials

Target Pictures. Sixty target pictures were selected, with no more than 10% from one semantic category (e.g., animals, vehicles). Target pictures were black drawings on a white background chosen from Google images, sized to 3.5" by 3.5", and presented on a 21" wide monitor.

Distractors. A total of 120 distractors that did not share semantic or phonological overlap with their assigned pictures and that had noun as their primary part of speech were selected. Distractors were also selected to range broadly in valence (how negative/positive words are) and arousal (how exciting/attention grabbing words are). Using Warriner et al.'s (2013) norms for valence and arousal, we selected 40 non-taboo positive distractors (6-9 on valence scale; e.g., joy), 40 non-taboo negative distractors (1-4 on valence scale; e.g., rabies), and 30 neutral distractors (4-6 on valence scale; e.g., string). Among the positive and negative distractors, half were higher in arousal (5-9 on arousal scale) and half were lower in arousal (1-4.9 on arousal scale). Finally, we selected 10 taboo distractors, defined by their social inappropriateness or offensiveness to people, from Janschewitz's (2008) taboo norms, half of which were positive (e.g., orgasm) in valence and half were negative (e.g., asshole). Taboo distractors had high tabooness ratings (M = 6.3 on a 9-point scale). A list of targets and distractors can be found at https://osf.io/4ejhf/.

Filler Pictures. Sixty filler pictures were included so that a filler appeared after each higher-arousing negative, positive, and taboo trial in order to reduce carryover effects between target trials (White et al., 2016). Similar to targets, filler pictures were paired with two distractors that did not share semantic or phonological overlap. Distractors for fillers were neutral in valence (M = 5.07) and lower in arousal (M = 3.61) (Warriner et al., 2013).

Blocks. The stimuli were divided into two blocks of 90 experimental trials (60 target and 30 filler) each, one block that included taboo distractors and one block that did not. Each block included 20 positive distractors and 20 negative distractors, and the remaining target trials were either 20 neutral distractors in the non-taboo block or 10 neutral and 10 taboo distractors in the taboo block. This ensured that the proportion of positive (22%) and negative (22%) trials was constant across the two blocks. The pictures shown in each block were identical but were paired with a different distractor that was roughly equivalent in valence and arousal to the other distractor. In the taboo block, neutral filler trials followed each of the 10 higher-arousing positive and negative trials, as well as the 10 taboo target trials. In the non-taboo block, neutral filler trials also followed the higher-arousing positive and negative trials, with the 10 extra neutral fillers following five low-arousing positive trials and five low-arousing negative trials.

Procedure

Participants first gave informed consent and knew that taboo words would be presented. Prior to beginning the picture-word interference task, participants were familiarized with the appropriate names of each picture by random presentation of target and filler pictures and asked to provide a name for each picture. An experimenter indicated whether or not the participant used the correct picture name, and any pictures that were named incorrectly were presented until the correct name was produced. The main experiment included five practice trials (using pictures

not used elsewhere in the experiment) followed by the two blocks whose order was counterbalanced across participants so that half of the participants saw the taboo block first and the other half saw the taboo block second. Upon beginning the picture-word interference task, participants were instructed to quickly and accurately name each picture. They were told that some pictures would be accompanied by distractor words and that they should ignore the distractor word on these trials.

Distractors were also counterbalanced across participants such that a given distractor (e.g., coffin) appeared equally often in either the taboo or non-taboo block and either the first or second block. In order to provide separation between blocks, a message appeared on the screen after the first block, informing participants that they had completed half of the trials and instructing them to notify the experimenter if they needed to take a break (no participants took the break). Each picture-distractor pairing was randomly presented within each block with the exception that one of each valence type (positive, negative, taboo) was presented before a valence type was repeated. Each trial had the following sequence: A fixation appeared for 1000 ms, followed by a picture with a superimposed 22 point distractor word in bold, black Arial font that slightly varied in placement to ensure that the distractor position did not become predictable. On each trial, the computer program randomly selected one of five possible positions: centered on the screen, 500 Twips to the left of and above center, 500 Twips to the right of and above center, 500 Twips to the left of and below center, and 500 Twips to the right of and below center. The picture and distractor remained on the screen for 2000 ms and were then replaced by a blank screen for 1500 ms before the fixation for the next trial appeared.

Results and Discussion

Naming times (in ms) were extracted from wavefiles using a voice onset program (Jennings & Abrams, 2020) and were then manually checked for accuracy. Any onset time that the program could not easily detect was manually coded (37.1% of trials). Errors made by participants were excluded (2.0%), including dysfluencies, not responding within 2000 ms, and producing the wrong picture name. Of the remaining correct trials, outliers greater or less than 2 *SD* from each item's mean across all trials (4.6%) were excluded from analyses.

A hierarchical regression was conducted on target naming time (see Table 1). Because the question of interest was how a taboo vs. non-taboo *context* influences naming times for non-taboo distractors that vary in valence and arousal, taboo trials were excluded from analysis. This ensured that the valence and arousal of the distractors included in the analysis were identical in the two blocks so that any effects of these variables were not inflated by slower naming times of targets with taboo distractors.

All continuous predictors were centered in order to control for multicollinearity between predictor variables. The categorical variables Block Type (taboo, non-taboo) and Block Order (taboo block presented first or second) were dummy coded and entered in Step 1. Previous research has shown that distractor frequency influences picture naming, with low-frequency distractors slowing picture naming relative to high-frequency words (Miozzo & Caramazza, 2003), and therefore distractor frequency (using SUBTLEX frequency; Brysbaert & New, 2009), was also entered in Step 1 along with distractor emotional characteristics of valence and arousal. Step 1 was significant, F (5, 394) = 13.65, MSE = 7633, $p < .001$. Block Type and Block Order were significant predictors, showing that naming times were slower in the taboo block and when the taboo block was presented first, respectively.[1] Distractor frequency was a significant predictor of naming times, replicating the distractor frequency effect. Distractor arousal did not

emerge as a significant predictor, although distractor valence was significant, showing that naming times increased as distractors became more negative in valence. Step 2 added the two-way interaction between arousal and valence. This model was significant, F (6, 393) = 15.27, MSE = 7281, $p < .001$ (adjusted $R^2 = .18$), and Figure 1 illustrates the significant Arousal x Valence interaction using +/- 1 *SD* from each predictor's mean. The nature of this interaction was determined by estimating simple slopes models examining the effect of valence at lower and higher arousal levels. The first model indicated no effect of valence for lower-arousal distractors, $t = 1.17$, $p = .24$, $\beta = -.03$. The second model indicated a significant effect of valence for higher-arousal distractors, $t = -6.31$, $p < .001$, $\beta = -.37$, with more negatively valenced distractors slowing picture naming times relative to more positively valenced distractors.

Two of our hypotheses were supported by these regressions. One is that taboo context slowed naming times overall for that block relative to a non-taboo context, consistent with the idea that taboo distractors evoke monitoring at the block level. The second is that an Arousal x Valence interaction emerged where negative distractors slowed picture naming relative to positive distractors but only when distractors had higher levels of arousal, consistent with the idea that the competition threshold is sensitive to a distractor's level of arousal. Contrary to our hypothesis, this effect of distractor valence occurred in both the taboo and non-taboo blocks, which is incompatible with the idea that the competition threshold is lowered when taboo distractors are present. However, it is also possible that inclusion of words on a continuum of arousal unintentionally lowered the competition threshold in the non-taboo context. By having distractors that varied across a large range of arousal, higher-arousing distractors may have become more distinctive from the other, lower-arousal distractors (similar to how taboo

distractors distinguish themselves) and caused speakers to also lower their competition threshold in the non-taboo block.

We eliminated this possibility in the subsequent experiments by controlling for arousal, i.e., only selecting positive and negative distractors that were higher in arousal and including taboo distractors in one experiment (Experiment 2) but excluding them in another (Experiment 3). If having a taboo context lowers the competition threshold for non-taboo distractors, we would expect more interference from higher-arousal negative distractors than higher-arousal positive distractors in a taboo context (Experiment 2) but not in a non-taboo context (Experiment 3). The difference between negative and positive distractors in a taboo context is expected because positive distractors can be blocked more quickly after they pass the competition threshold due to their rapid recognition (e.g., Keuper et al., 2013).

Experiment 2

Experiment 2 investigated the influence of negative and positive distractors on picture naming times, representing the context where taboo distractors were included.

Method

Participants

To ensure sufficient power to detect interference, we first reviewed previous picture-word interference studies and their effect sizes (e.g., Damian & Martin, 1999; Dhooge & Hartsuiker, 2011; White et al., 2016). We then estimated our sample size based on a repeated measures design using G*power (Faul et al., 2007), which suggested a minimum sample size of 24 to ensure power of .80 to detect an effect size of .25. Forty-nine undergraduate students (43 females, 44 right-handed) participated in this experiment in exchange for partial course credit, but the requirement of English as the first language resulted in removal of one bilingual

participant from analyses. All participants ranged in age from 18 to 22 years (M = 18.92, SD = 1.05).

Materials

Target Pictures. Sixteen target pictures were selected for each of the four distractor valence conditions (taboo, negative, positive, or neutral), for a total of 64 target pictures. Targets in each distractor valence condition did not differ in mean word length, $F < 1$, or mean word frequency using SUBTLEX norms (Brysbaert & New, 2009), $F < 1$. A maximum of five target pictures within a distractor valence condition came from the same semantic category (e.g., food, animals).

Distractors. Each target picture was paired with one unrelated and one phonological distractor with noun as their primary part of speech. Phonological distractors were relevant to a separate issue and were chosen in a manner similar to that done by White et al. (2016, Experiment 1). Results relevant to phonologically-related distractors are included in Supplemental Materials. Thus, the analyses in Experiments 2 and 3 were subsequently conducted only on trials containing unrelated distractors.

Distractors were categorized as negative, positive, and neutral using the Affective Norms for English Words (ANEW) norms (Bradley & Lang, 1999) and Warriner et al. (2013) norms, whereas taboo distractors were selected from Janschewitz (2008). Negative, positive, and neutral distractors were controlled on several emotional and lexical characteristics (see Table 2 for means) using a criteria of $p < .05$ for significant differences. For valence, positive distractors were more positively valenced than neutral distractors, which were more positively valenced than negative distractors. For arousal, positive and negative distractors were similar, with neutral distractors being less arousing, as is typical. There were no differences in overall SUBTLEX log

frequency or orthographic neighborhood between the four types of distractors. However, neutral distractors were shorter than positive and negative distractors, with no differences in length between the other distractor valences.

Filler Pictures. Sixty-four filler pictures without distractors were included to reduce carryover effects from taboo target trials.

Procedure

The procedure was identical to White et al. (2016, Experiment 1), except that filler pictures were presented without distractors. As in Experiment 1, participants were first familiarized with the picture names and were told to quickly and accurately name each picture while ignoring distractor words. Five practice trials were provided to familiarize participants with the task. Each trial had the following sequence: a question mark appeared to focus participants' attention on the center of the screen and remained until the participant pressed the space bar, followed by a 500 ms fixation (+) that was replaced with the target picture (and superimposed distractor in varied positions on target trials). Participants had 3000 ms to name the picture, after which a blank screen appeared for 1000 ms, followed by the next trial's fixation. They also were instructed to press the space bar after naming as a signal for the computer program to stop recording the speaker on that trial. A target picture was always followed by its associated filler picture, and across the course of the experiment, each target and filler picture were presented twice and only repeated after all had been shown the first time. Pictures were presented with both distractor types in counterbalanced order so that each picture was named with either its phonological or unrelated distractor on the first half of trials, and the alternate distractor was shown on the second half of trials. Distractors within each valence type

(positive, negative, neutral, and taboo) were randomly presented except for the constraint that one distractor of each valence was presented before any valence type was repeated.

Results and Discussion

Naming times (in ms) were treated the same way as in Experiment 1, and 8.9% of trials were manually coded. Missing and undecipherable wavefiles (1.1%), as well as errors made by participants (5%) were excluded from analyses. Of the remaining correct trials, outliers greater or less than 2 *SD* from each participant's mean (5.1%) were excluded from analyses.

A repeated measures analysis of variance (ANOVA)[2] was performed on mean target picture naming times (in ms) (see Table 3). There was a main effect of distractor valence, F (3, 141) = 59.36, MSE = 2318, $p < .001$, $\eta_p^2 = .56$. Planned comparisons with Bonferroni correction revealed slower naming times for pictures accompanied by taboo distractors ($p < .001$, $\eta_p^2 = .73$) and negative distractors ($p = .005$, $\eta_p^2 = .21$) compared to neutral distractors (with taboo slowing more than negative, $p < .001$, $\eta_p^2 = .57$). Naming times for pictures with positive and neutral distractors did not differ ($p = .22$, $\eta_p^2 = .09$).

The findings of Experiment 2 extend the results from Experiment 1 using solely higher-arousing positive and negative distractors, and also replicate the key findings from White et al. (2016, Experiment 2) using different stimuli. When non-taboo distractors were included in a taboo context, target naming was slowed when distractors were taboo or negative relative to neutral distractors. Further, positive distractors had no effect on target naming relative to neutral distractors. Given that negative and positive distractors were matched on arousal, differing results for negative and positive distractors suggest a role of distractor valence in affecting target naming when taboo distractors are present in the block. This role will be explored more fully by comparison with Experiment 3, which removes the presence of taboo distractors.

Experiment 3

This experiment investigated the influence of negative and positive distractors on picture-word interference in the absence of a taboo distractor condition. If inclusion of taboo distractors in a block of trials lowers the competition threshold that is applied to all distractors in that block, then removing taboo distractors from the experimental context in Experiment 3 should create a higher competition threshold relative to Experiment 2, making it more difficult for non-taboo emotional distractors to exceed the threshold and affect picture naming. Alternatively, if taboo and non-taboo contexts set similar competition thresholds, then the results should mimic Experiment 2.

Method

Participants

Participants were recruited in the same manner as Experiments 1 and 2 and included 47 students (32 females, 44 right-handed) who ranged in age from 18 to 21 years (M = 18.65, SD = 0.87) and spoke English as their first language. One female participant was unable to finish the picture-word interference task, resulting in 46 participants for analyses. Similar to Experiment 2, the sample size exceeded the G*power (Faul et al., 2007) estimate of a minimum sample size of 28.

Materials

Target Pictures. Fifty-four target pictures were selected so that 18 pictures were shown in each of the three distractor valence conditions (negative, positive, or neutral). As in Experiment 2, targets in each distractor valence condition did not differ in mean SUBTLEX word frequency or mean word length, Fs < 1.

Distractors. Distractors were assigned to targets in the same manner as Experiment 2. Also similar to Experiment 2, positive distractors were more positive than neutral distractors, which were more positive than negative distractors (see Table 2). Additionally, positive and negative distractors did not differ in arousal and were more arousing than neutral distractors. Finally, the distractors in the three valence conditions did not differ in SUBTLEX log frequency, orthographic neighborhood, or word length.

Filler Pictures. Fifty-four filler pictures were chosen and assigned to a target picture, as in Experiment 2.

Procedure

The procedure was identical to Experiment 2, but with three emotional valence conditions (negative, positive, neutral) instead of four.

Results

Naming times (in ms) were treated the same way as in previous experiments, and 18.7% of trials were manually coded. Missing and undecipherable wavefiles (0.5%), errors made by participants (7.0%), and outliers greater or less than 2 *SD* from each participant's mean (4.5%) were excluded from analyses.

Similar to Experiment 2, a repeated measures ANOVA was performed on mean target picture naming times (in ms) (see Table 3). Unlike Experiment 2, there was no main effect of distractor valence, $F < 1$, $\eta_p^2 = .00$, demonstrating that the absence of taboo distractors changed target naming following negative distractors relative to Experiment 2 by eliminating the slowing from negative distractors.

We also compared the size of the distractor effects on target naming between Experiments 2 and 3. In order to account for group differences and variability in naming time,

each naming time was first converted to a z-score (Faust et al., 1999). Z-scores from Experiment 2 were computed after excluding taboo distractors, which would skew the naming times. Negative z-scores indicate speeding, whereas positive z-scores indicate slowing. We then tested a 2 (Experiment) x 3 (Distractor Valence) repeated measures ANOVA on target naming time, and results relevant to the new variable (Experiment) are reported below. While there was no main effect of Experiment, $F < 1$, the Experiment x Distractor Valence interaction was significant, F (2, 184) = 8.02, MSE = .04, $p < .001$ (see Figure 2). In Experiment 2, planned comparisons with Bonferroni correction revealed that targets with negative distractors were named slower than neutral ($p = .003$, $\eta_p^2 = .21$) and positive distractors ($p < .001$, $\eta_p^2 = .35$), and targets with positive and neutral distractors did not differ ($p = .11$, $\eta_p^2 = .02$). In Experiment 3, there were no differences in naming times among the distractors (ps > .99, η_p^2s = .00). The above patterns of results were also observed in analyses of the raw naming times, with the exception of the main effect of Experiment, which was significant in the raw naming times, F (1, 92) = 13.87, MSE = 498313, $p < .001$, with slower overall responses in Experiment 2 (M = 907) than in Experiment 3 (M = 823), replicating Experiment 1's context effect and suggesting that a taboo context slows naming times overall relative to a non-taboo context. A similar finding was reported by Bertels and Kolinsky (2016), who showed that Stroop responding was slower when taboo words were in the list versus when they were not.

General Discussion

As with many cognitive processes, speaking is inherently context-dependent, with each utterance having some dependence on what was said previously, what will be said next, and how well the speaker can attend to their message in the face of environmental distractions. Strong emotional words, particularly taboo words, can be one of those distractions and disrupt a speech

task by increasing monitoring of targets in the response output buffer (Dhooge & Hartsuiker, 2011), but also all trials within that block. The present study provides evidence that the influence of taboo words is also linked with attention, showing that their mere presence in a speech production task can increase the attentional demands of other non-taboo emotional distractors, specifically negative distractors.

Finding that a taboo context changes the impact that distractor arousal and valence have on picture naming has implications for theories of speech production and broadens our understanding of contextual influences on speech production to include aspects of emotion. One theoretical implication of these findings is for attentional mechanisms involved in the production of speech. Specifically, our findings demonstrate that arousal not only affects the rate at which distractors exceed the competition threshold (e.g., White et al., 2016), but also the threshold itself which is not fixed. The threshold adjusts to a level based on the context in which distractors are presented, with lower thresholds in contexts with potential for strong interference (e.g., taboo vs. not taboo) or where there is a strong contrast between stimuli (e.g., low vs. high arousal). A lower threshold would ensure that we detect potentially aversive stimuli. In contexts without such variability in arousal, i.e., when taboo words are absent and the majority of words are higher in arousal, as in Experiments 2 and 3, the threshold is higher and the likelihood that emotional distractors will engage attention and interfere with picture naming is reduced. Finding that context influences the threshold for emotional interference in language production also extends research on factors that influence the capture of exogenous attention to visual stimuli (Carretié, 2014). For example, visual attentional capture by emotional stimuli is greater when tasks have high attentional demands, which are associated with negative affect (e.g., Eysenck et

al., 2007). A taboo context may operate in a similar manner, facilitating exogenous attention to emotional distractors.

A second theoretical implication is that the time it takes to reactively block, or disengage from, an emotional distractor depends on whether a distractor exceeds the competition threshold. In contexts where the variability in distractor arousal lowers the competition threshold, lower-arousing distractors, regardless of valence, do not exceed the threshold and can be blocked more quickly so that they do not interfere with picture naming. For higher-arousing distractors that do exceed the threshold, reactive blocking is dependent on the speed with which words are recognized, as previous research has shown that positive words are recognized more quickly than negative words (e.g., Keuper et al., 2013; Schacht & Sommer, 2009), a processing advantage that occurs regardless of frequency (Scott et al., 2012). Results from Experiments 1 and 2, where negative distractors slowed picture naming more than positive distractors, support this suggestion. Distractors in Experiment 3 did not require the same level of reactive blocking because they did not exceed the competition threshold and interfere with picture naming.

A final theoretical implication is that the verbal self-monitor proposed to regulate internal speech and be sensitive to tabooness (Dhooge & Hartsuiker, 2011) is adaptive to taboo context: The presence of taboo distractors in the experimental context puts the monitor on “alert”, slowing responses to all trials as was observed in Experiment 1 and in the raw naming times of Experiment 2 relative to Experiment 3. Further, finding that negative distractors did not slow picture naming in Experiment 3 suggests that a higher-arousal context without tabooness is insufficient for putting the monitor on alert. Although having a monitor that adapts to emotional context provides further evidence of the monitor’s flexibility (e.g., Dhooge & Hartsuiker; 2012; Hartsuiker et al., 2005), the complexity of emotional properties and their interactions observed in

the present findings cannot solely be explained by a monitor as currently defined, and therefore require reliance on theoretical mechanisms such as those described above.

In addition to the implications for theories of speech production, these results have broader implications for the interactions between emotion, memory, and cognition. For example, demonstrating the contextual effects of taboo words extends research on memory (MacKay et al., 2004). According to MacKay et al.'s binding hypothesis, emotional reactions to taboo words help bind those words with their context, resulting in superior recall of font colors for taboo words compared to neutral words following a Stroop color naming task. An interesting question for future research is whether the presence of taboo words would enhance binding of contextual color information for negative words as well. Additionally, our results supplement research on context and perception of faces and scenes (e.g., Aviezer et al., 2008; Barrett et al., 2011; Czekóová et al., 2015). Research on the perception of faces' emotional expression has suggested that emotion words can function as a type of "internal context" that shapes how faces are processed (Barrett et al., 2007). For example, emotional descriptions (e.g., of danger) influence perception of faces (e.g., as more fearful) (Carroll & Russell, 1996), and emotional labels (e.g., angry) increase the likelihood of remembering that emotion in faces morphed to blend multiple emotions, e.g., happiness and anger (Halberstadt & Niedenthal, 2001). By specifying taboo distractors as a type of context, our findings demonstrate that the impact of emotion words is much broader than previously thought: The presence of taboo words determines which properties of other emotional distractors impact attention.

In conclusion, these experiments extend our understanding of emotional context to speech production, specifically the ways in which the presence of tabooness influences surrounding stimuli. Our results suggest that the influence of non-taboo emotional stimuli on

speech production is not fixed, and the impact of a word's emotional characteristics like valence and arousal is dependent on types of emotional words included in the experiment. These results may also help explain the variability in emotional interference effects in other tasks, such as the emotional Stroop task, where interference effects from negative words are only sometimes observed (e.g., Algom et al., 2004; Ashley & Swick, 2009; Pratto & John, 1991). Future research should investigate emotional context effects in other tasks (e.g., Stroop, lexical decision) to determine whether the influence of context on attentional engagement to emotional stimuli varies as a function of cognitive processes engaged during the task (e.g., word production vs. recognition). Similarly, emotional context may have differential effects when attention is required to process an emotional stimulus that is the target vs. when attention is required to inhibit a distracting emotional stimulus.

Open Practices Statement

The data and materials for all three experiments and supplemental materials are available at https://osf.io/4ejhf/. None of the experiments were preregistered.

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Footnotes

1. A 2 (Block Type) x 2 (Block Order) repeated measures analysis of variance (ANOVA) on naming times replicated the main effects of Block Type and Block Order, but did not reveal a significant interaction, $F < 1$. Furthermore, we conducted a separate regression to test for interactions among Block Type, Arousal, and Valence, and among Block Order, Arousal, and Valence. These interactions were not significant, ts < 1.3. Thus, the simplified model with Block Order and Block Type as main effects is presented here.
2. Because items were manipulated between Distractor Valence conditions (with 16 pictures per condition), analyses by participants had more cases, were more powerful, and are thus reported below along with effect size coefficients.

Table 1.

Hierarchical Regression in Predicting Target Picture Naming Time in Experiment 1.

	R^2	*Adjusted* R^2	ΔR^2	β	*t*
Step 1	.15	.14			
Block Type				.10	2.06*
Block Order				.18	3.77**
Distractor Frequency				-.29	-4.47*
Valence				-.21	-4.40**
Arousal				-.02	-0.37
Step 2	.19	.18	.04**		
Block Type				.10	2.11*
Block Order				.18	3.89**
Distractor Frequency				-.26	-5.50**
Valence				-.14	-2.79**
Arousal				-.03	-0.69
Valence x Arousal				-.22	-4.48**

Note: *$p < .05$; **$p < .01$

Table 2.

Means for Emotional and Lexical Characteristics for Distractors in Experiments 2 and 3.

Distractor Characteristic	Experiment 2				Experiment 3		
	Positive Distractors	Negative Distractors [a]	Neutral Distractors	Taboo Distractors [b]	Positive Distractors	Negative Distractors	Neutral Distractors
Valence (ANEW)	7.7	2.5	5.2	--	7.7	2.4	5.1
Valence (Warriner)	7.1	2.6	5.1	2.1	7.0	2.5	5.4
Arousal (ANEW)	5.7	6.0	4.1	--	5.7	5.8	4.1
Arousal (Warriner)	5.1	5.4	3.7	4.3	4.9	5.3	3.7
Tabooness	--	--	--	5.5			
Log Frequency	3.1	2.8	2.8	2.8	2.6	2.8	2.7
OrthoN	4.7	4.3	7.0	6.9	3.9	2.5	3.8
Word Length	5.6	5.8	4.9	5.1	6.1	6.1	5.6

Note: Taboo distractors were taken from Janschewitz (2008). Because the majority (91%) were not included in the ANEW database, their means for ANEW arousal and valence are not reported here. Significant differences (ps < .05) among distractor types are described in the text.

[a]The Warriner norms for negative distractors exclude one negative distractor that was not included in that database.

[b]The means for taboo distractors exclude four distractors that were not included in the SUBTLEX or Warriner databases.

Table 3.

Mean Naming Times (and Standard Deviations, in ms) for Target Pictures in Experiments 2 and 3.

	Experiment 2	Experiment 3
Taboo Distractor	1005.3	n/a
	(125.2)	
Negative Distractor	934.9	824.0
	(123.7)	(121.5)
Positive Distractor	883.0	821.6
	(94.5)	(122.3)
Neutral Distractor	903.3	823.4
	(108.9)	(116.4)

/

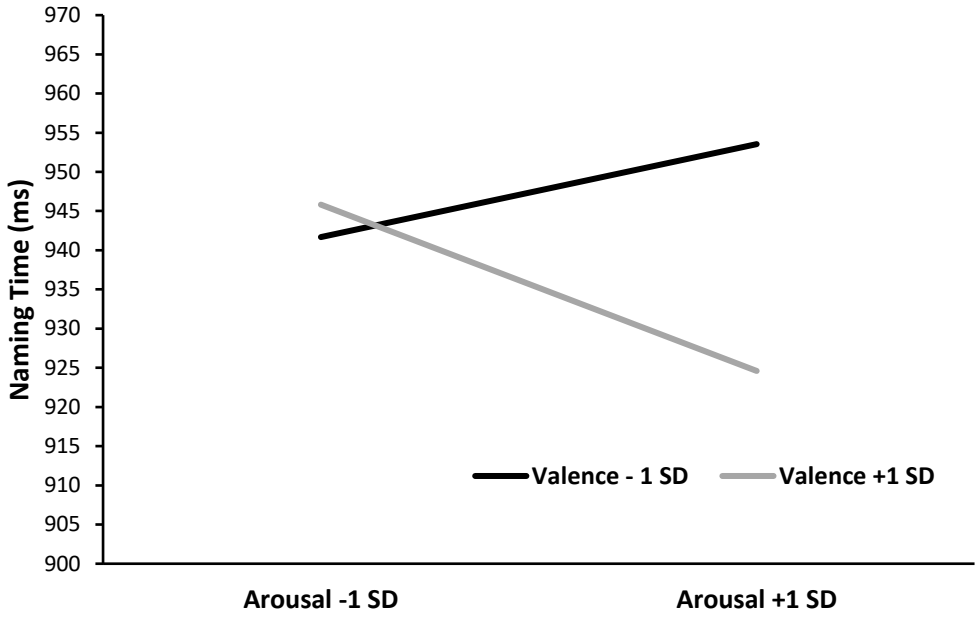

Figure 1. An illustration of the relationship between distractor valence, arousal, and naming time (ms) in Experiment 1. This figure represents the Valence x Arousal interaction using +/- 1 *SD* from each predictor's mean.

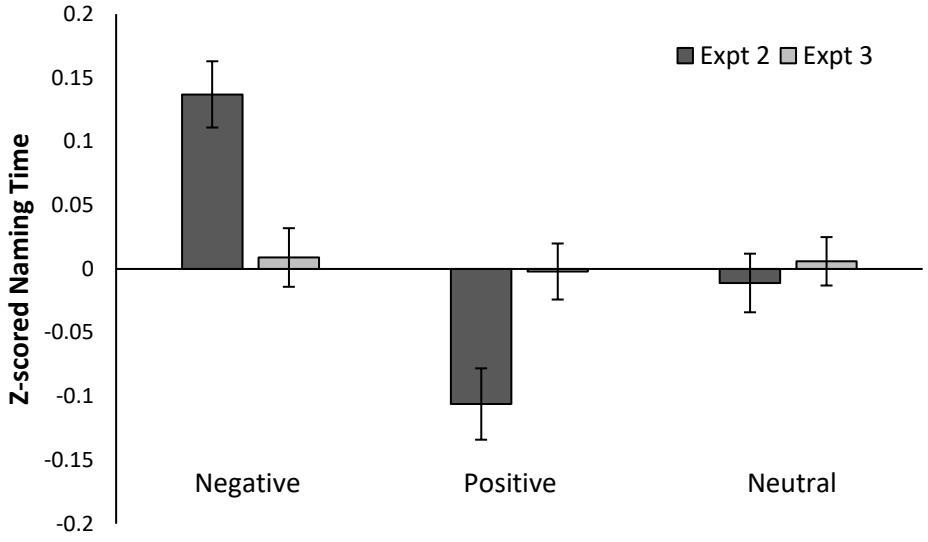

Figure 2. Mean z-scored picture naming time for target pictures as a function of Experiment (Expt 2, Expt 3) and distractor emotional valence (negative, positive, neutral). Z-scores were computed per participant according to mean picture naming time excluding taboo distractors. Z-scores above 0 indicate slowing. Note that the positive speeding effect observed here was eliminated after applying a Bonferroni correction.