Competing Influences of Emotion and Phonology During Picture-Word Interference

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Abstract

Speaking is susceptible to distraction, illustrated by slowed picture naming in the presence of taboo distractor words. However, other distractors such as phonologically-related words speed picture naming. Two experiments explored the simultaneous influences of these competing factors. Participants named target pictures superimposed with taboo, negative, positive, or neutral distractor words, and filler pictures were presented after every target to investigate emotional carryover effects. Distractors were phonologically related or unrelated to the target (Experiment 1) or filler (Experiment 2). Results showed that taboo, and to a lesser extent negative, distractors slowed picture naming relative to neutral and positive distractors, and slowing from taboo distractors persisted into the filler trial. In contrast, phonological overlap between targets and distractors sped target but not filler picture naming, especially when distractors were taboo. These findings suggest that strong emotional words engage attention to influence phonological encoding during speech production, and interfering effects from taboo words are particularly long-lasting. Results are interpreted within existing language production theories, using mechanisms that are sensitive to words' emotional properties and that regulate distractor interference during speech production.

Keywords: speech production, attention, picture-word interference, phonology, emotion, taboo

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Emotion affects our cognitive processing in many ways, influencing how we learn, attend to, and remember information (e.g., Bower, 1981; Compton, 2003). In some circumstances, emotion can enhance cognition, such as when an arousing or threatening stimulus is detected faster than a neutral one (Öhman, Flykt, & Esteves, 2001). However, emotional material or events can also hinder cognition by disrupting and slowing processing of an ongoing task (e.g., Algom, Chajut, & Lev, 2004). A particularly strong example of emotion's disruptive effects on cognition comes from taboo words, which slow response times in tasks such as Stroop color naming (e.g., Siegrist, 1995). Although less researched, taboo words also disrupt language production, evidenced by slowed picture naming when taboo distractor words are present (Dhooge & Hartsuiker, 2011a). Conversely, other factors such as distractor words' phonology can facilitate production and speed picture naming (e.g., Damian & Martin, 1999; Schriefers, Meyer, & Levelt, 1990). The present research explored the simultaneous influences of these competing factors by investigating whether emotional distractor words, independently or in conjunction with phonological overlap, influence the production of picture names.

Evidence suggests that speakers are particularly cautious when there is a possibility that they may erroneously speak a taboo word. For example, Dhooge and Hartsuiker (2011a) investigated the effects of distracting taboo words on speech production in order to determine the mechanisms by which speakers are able to avoid producing distracting information. They used a picture-word interference (PWI) task where participants named pictures superimposed with taboo or neutral distractor words. Participants made fewer errors (when focusing on speed) and were slower (when focusing on accuracy) when naming pictures accompanied by taboo than neutral distractors. They interpreted these results within a *verbal self-monitoring account* where speakers possess an internal monitor that checks their speech before articulation, monitoring potential utterances for accuracy and social appropriateness. Taboo distractors would be particularly inappropriate to utter in an experimental setting and are therefore carefully edited from the speech output buffer, slowing production of the target picture name.

An alternative account for why taboo distractors slow picture naming can be derived from research showing that strong emotional words disrupt performance in tasks such as Stroop color naming and word recognition by *capturing attention* and therefore drawing resources away from the primary task (e.g., Algom et al., 2004; Harris & Pashler, 2004; Pratto & John, 1991; Siegrist, 1995). Although not yet applied to interference from emotional words, the role of attention is specified in at least one model of language production (e.g., Roelofs, 2003; Roelofs & Piai, 2011). Specifically, Roelofs and colleagues' WEAVER++ model includes two attentional mechanisms that regulate distractor interference during picture naming, one of which is a *competition threshold*. The competition threshold is a mechanism of selective attention that assumes a distractor competes with a target when its level of activation levels exceeds a threshold. The competition threshold has been used to explain the nature of interference from semantic distractors, where semantically-related distractors (e.g., zebra) compete for selection with targets (e.g., horse) if the distractor exceeds the competition threshold (see also La Heij, Boelens, & Kuipers, 2010). Distractors that are closely related to the target exceed the threshold, but more distantly related ones (e.g., frog) do not (Piai, Roelofs, & Schriefers, 2012).

The concept of a threshold could be extended to emotional words, particularly taboo words, which are highly arousing (Janschewitz, 2008). Accumulating evidence shows enhanced lexical access for high-arousal (non-taboo) positive and negative words, suggesting that there are specialized brain networks responsible for processing the emotional meaning of words early in word recognition (e.g., Keuper et al., 2012; Ortigue et al. 2004). Coupled with the evidence that strong emotional words capture attention (e.g., Algom et al., 2004; Harris & Pashler, 2004; Pratto & John, 1991; Siegrist, 1995), emotional words could rapidly exceed a competition threshold for recognition, which functions as an attentional filter (Piai et al., 2012). Emotional words that exceed a competition threshold will quickly grab attention and draw attentional resources away from picture naming. Because of their highly-arousing properties, taboo distractors are particularly likely to exceed the competition threshold quickly and interfere with naming a target picture, consistent with slower naming times in the presence of taboo distractors (Dhooge & Hartsuiker, 2011a). However, unlike semantic distractors which compete at the lexical level, competition from emotional distractors likely results from their attention-grabbing nature, thus limiting the amount of attention that can be directed to naming the picture.

While both the self monitoring and competition threshold accounts can explain the occurrence of taboo interference in speech production, one goal of the present study was to determine whether these theories can explain the influence of other emotional characteristics of words, particularly arousal and valence (Bradley & Lang, 1999), on picture naming. No studies to date have investigated whether non-taboo emotional words interfere with or facilitate production. In word recognition studies using the emotional Stroop task (e.g., Algom et al., 2004), as well as in lexical decision and naming (e.g., Estes & Adelman, 2008), negative words often slow color naming times. Positive words have been used much less frequently than negative words, and there is mixed evidence as to their effect on word processing (e.g., Kuchinke, Jacobs, Grubich, Võ, Conrad, & Herrmann, 2005; McKenna & Sharma, 2004; Pratto & John, 1991; Wurm, Labouvie-Vief, Aycock, Rebucal, & Koch, 2004). Furthermore, prior studies often used words that ranged in arousal level or confounded arousal and valence, making it difficult to specify the unique contributions of arousal and valence to word processing. We aimed to investigate how emotional characteristics (tabooness, arousal, and valence) of distractor words influence interference in picture naming. Doing so not only contributes to our understanding of non-lexical sources of interference in picture naming, but also provides an opportunity to expand current theories of language production to include a role for emotional influences.

Currently, theories that assign distractor interference to delays in monitoring predict interference in speech production from emotional distractors if they need to be edited from speech due to social inappropriateness (e.g., taboo words) or if they have lexical characteristics (e.g., low frequency) that result in slowed processing and thus take longer to remove from an output buffer (Miozzo & Caramazza, 2003). However, we argue that any characteristics that speed or slow word processing should affect editing from the buffer, and there is evidence that a distractor's arousal and valence affects lexical access. Complementing evidence showing facilitated lexical access for highly-arousing words (Keuper et al., 2012), Keuper et al. (2013; see also Estes & Alderman, 2008) also used EEG/MEG to demonstrate enhanced lexical access for positive compared to negative words, suggesting that a word's valence might contribute to the amount of picture-word interference. Thus, we reasoned that emotional distractors should be detected more quickly by the monitor and discarded from the output buffer, resulting in faster picture naming times when distractors are (non-taboo) emotional compared to neutral. Furthermore, if positively-valenced distractors are detected and removed from the buffer faster than negatively-valenced ones, we would expect faster naming times for positive compared to negative distractors.

The WEAVER++ model could also be expanded to account for emotional influences in PWI. Specifically, a word's arousal level is predicted to influence whether it exceeds the competition threshold and enters into a competition with the picture name for attentional resources. Thus, compared to neutral words, both negative and positive distractors are expected to slow picture naming when they are high in arousal. However, a second attentional mechanism, *distractor blocking*, may also play a role in the degree of interference produced by emotional words. Blocking has been proposed as an early selective attention mechanism that is engaged upon encountering a distractor and thus minimizes interference from the distractor by reactively blocking, or attenuating, it (Roelofs, 2003; Roelofs, Piai, & Schriefers, 2011, 2013). Words that are recognized faster are blocked faster, as is the case with high-frequency words (Roelofs et al., 2011). Thus, although highly-arousing words are expected to exceed the competition threshold, the blocking mechanism would then be responsible for dampening their interference. Given positive words' advantage in lexical access (Keuper et al., 2013), we might expect faster blocking of positive words than negative words, i.e., less interference from positive words.

A secondary goal of the present study was to determine whether any interference that occurs from highly-arousing emotional words can be dampened by phonology. A well-established effect of phonological facilitation in PWI occurs when targets are named faster when accompanied by a shared-phonology distractor than when accompanied by an unrelated distractor (Damian & Martin, 1999; Schriefers et al., 1990). This effect is typically explained within theories of speech production as speeding the stage of phonological encoding due to activation of shared phonemes between a target and distractor (e.g., Dell, 1986; Levelt et al., 1999). There are also interactive effects of phonological facilitation and semantic interference, specifically that semantic interference is attenuated when distractors share both semantics and phonology (S+P) with a target (e.g., Damian & Martin, 1999; Starreveld & LaHeij, 1996). One explanation for this effect is that the flow of activation between a word's lexical representation (lemma) and phonological word form is bidirectional (e.g., Damian & Martin, 1999; Dell, 1986; Melinger & Abdel Rahman, 2013; but see Vigliocco & Hartsuiker, 2002, for an alternative explanation[1]), so that the shared phonology between the S+P distractor and the target allows activation to feed back from the distractor's phonology to the target's lemma, reducing the amount of semantic interference relative to a purely semantic distractor.

While the monitoring account has had trouble explaining S+P effects (see Mulatti & Coltheart, 2012), an attentional account can generate predictions for whether phonology would interact with emotion. We hypothesized that like semantically-related words, the interference induced by strong emotional words may be reduced when emotional distractors share phonological overlap with their targets. It is possible that heightened attention to strong emotional words makes feedback from phonology to the target's lemma more efficient. Thus, similar to semantic distractors, adding phonological overlap to emotional distractors might reduce the amount of interference experienced, relative to emotional distractors that do not share phonology with their target. If heightened attention facilitates phonological encoding, we would expect greater phonological facilitation for words that are particularly attention-grabbing, i.e., taboo words. The predicted influence of phonology for non-taboo emotional words is less clear and would depend on the degree to which high-arousing positive and negative words interfere with picture naming. We speculated that whatever factors allow emotional words to capture attention and interfere with picture naming could benefit from early phonological feedback, increasing phonological facilitation.

An additional way to test the attentional and monitoring explanations of emotional interference during PWI is to investigate whether emotional target trials influence a subsequent (neutral) trial, i.e., have a carryover effect. Carryover effects have been observed in studies of emotional Stroop (e.g., Bertels et al., 2011; McKenna & Sharma, 2004; Phaf & Kan, 2007) and word recognition (e.g., Zeelenberg, Bocanegro, & Pecher, 2011) when an emotional “target” trial affects speed of responding on a subsequent “filler” (neutral) trial. Finding carryover effects in PWI would extend findings from word recognition to word production. Theoretically, both the monitoring and attentional accounts would predict carryover effects following taboo target trials. Dhooge and Hartsuiker (2011a) suggested that the monitor might adjust at the micro-level (i.e., trial to trial), resulting in increased caution following a taboo target trial and thus slowed naming on filler pictures. The blocking mechanism of the attentional account only attenuates a distractor’s influence once it has exceed the competition threshold (Roelofs, 2003), suggesting that a taboo distractor could continue to engage attentional resources after its presentation. With respect to non-taboo emotional words, carryover effects would not be expected in a monitoring account because these words should not put the monitor on alert. However, carryover effects might be observed following highly arousing positive and negative words if attentional mechanisms are sensitive to the arousing properties of words.

In summary, we tested emotional PWI on target and filler trials as well as the extent to which phonological overlap between targets and distractors would reduce interference. With respect to targets, we attempted to replicate taboo interference and compare it to interference from other types of emotional distractors that might also demand attention, specifically highly-arousing negatively and positively-valenced distractor words. One problem with comparing results from previous studies using positive and negative words is that these words often differed in arousal as well as other lexical characteristics (Larsen, Mercer, & Balota, 2006), making cross-study conclusions difficult. In order to more directly compare potential interference from negative and positive words with taboo interference, we chose highly-arousing words and matched negative and positive words on arousal. In addition, we tested whether carryover effects from emotional target-distractor trials would be observed in speech production.

Experiment 1

Method

Participants

Participants included 48 undergraduates (33 females) who ranged in age from 18 to 22 years (*M* = 18.72, *SD* = 1.06), spoke English as their native language, and participated in exchange for partial course credit.

Materials

Target Pictures. A set of 64 target pictures was selected, with 16 pictures assigned to each of four distractor word conditions that varied in emotional valence (distractors were taboo[2], negative, positive, or neutral; see Appendix A). Within each distractor condition, no more than five targets came from one semantic category (e.g., animals, body parts, household items, food). Each target stimulus was assigned a picture of a black drawing on a white background chosen from Google images. Each individual picture was sized to 3.5” by 3.5” and presented on a 21” wide monitor.

The design of this experiment required that distractors vary in both valence and phonological overlap with the target, thus limiting our ability to counterbalance pictures across valence conditions. Thus, different target pictures were used for each of the four valence conditions, but target pictures were matched across valence conditions on word frequency and word length: Mean word frequency of targets in the taboo (*M* = 935, *SD* = 1124), negative (*M* = 483, *SD* = 534), positive (*M* = 912, *SD* = 8801), and neutral (*M* = 911, *SD* = 866) distractor valence conditions did not differ, $F < 1$ (Zeno, Ivans, Millard, & Duvvuri, 1995). Similarly, mean word length of targets in the taboo (*M* = 4.9, *SD* = 1.3), negative (*M* = 5.4, *SD* = 1.8), positive (*M* = 4.7, *SD* = 1.5), and neutral (*M* = 4.8, *SD* = 1.4) distractor valence conditions did not differ, $F < 1$.

To assess whether targets assigned to each valence condition varied on other dimensions known to affect picture naming that we did not control (e.g., visual complexity), we analyzed naming times for pictures presented during the "familiarization phase" of the experiment. That is, participants were asked to name each picture (without distractors) prior to the main experiment to ensure that the correct name was used for each picture (see Procedure). We examined mean naming times for pictures in the four valence conditions (M_{taboo} = 845 ms, *SD* = 130; $M_{negative}$ = 893, *SD* = 219; $M_{positive}$ = 866, *SD* = 158; $M_{neuttral}$ = 869, *SD* = 155) and found no significant differences in naming times between targets assigned to the four valence conditions, $F < 1$. These results suggest that our use of different pictures for each valence condition did not confound any subsequent distractor valence effects on picture naming.

Distractors. Targets within each distractor valence condition were assigned one phonological and one unrelated distractor (see Appendix A). Most phonological distractors (89%) shared at least the first two phonemes with their corresponding picture in each valence condition, but a small number of distractors (two taboo, two negative, two positive, and one neutral) were used that shared only the ending phonology, since distractors with similar final phonemes can also facilitate picture naming (Zhang & Damian, 2010). The number of phonemes shared between targets and distractors did not differ across valence conditions (M_{positive} = 2.31,

$M_{negative} = 2.31$, $M_{taboo} = 2.50$, $M_{neutral} = 2.56$), $F < 1$. Unrelated distractors did not share phonology with their corresponding target picture. Both phonological and unrelated distractors had noun as their primary part of speech.

Phonological and unrelated distractors in the positive, negative, and neutral valence conditions were matched on valence, arousal, word frequency (Zeno et al., 1995), and word length (see Table 1). Valence and arousal ratings for positive, negative, and neutral distractors were taken from the Affective Norms for English Words (ANEW) norms (Bradley & Lang, 1999) on a scale of 1 to 9, where lower ratings correspond to more negativity and lower arousal, respectively. Positive and negative distractors were similar in overall arousal ($t < 1$), although neutral distractors were inherently less arousing than both positive (t (62) = 6.05, $p < .001$) and negative distractors (t (62) = 6.14, $p < .001$). Because the majority of taboo distractors were not included in the ANEW norms, phonological and unrelated taboo distractors were instead matched for tabooness (Janschewitz, 2008), with higher numbers indicating more tabooness. Paired samples t-tests indicated that phonological and unrelated distractors in positive, negative, taboo, and neutral conditions did not differ in any of the above measures, *t*s < 1. However, the constraints of matching the phonological and unrelated distractors on the above dimensions resulted in overall word frequency differences between the distractor valence conditions. Specifically, positive distractors had higher frequency than taboo (t (56) = 3.66, $p < .001$), negative (t (62) = 3.48, $p < .001$), and neutral (t (62) = 2.19, $p = .03$) distractors. Neutral distractors were higher in frequency than negative distractors (t (62) = 3.02, $p = .004$), which in turn were higher in frequency than taboo distractors (t (56) = 4.41, $p < .001$).

Fillers. Sixty-four filler pictures were included in order to investigate potential carryover effects from emotional target trials. Including fillers also ensured that taboo and negative trials did not account for more than 25% of all trials. Filler pictures were randomly presented and were accompanied by an unrelated distractor word. Distractor words were chosen from the ANEW database (Bradley & Lang, 1999) to be neutral in valence (M = 6.36, SD = 1.37) and arousal (M = 4.95, SD = 1.19).

Procedure

Participants gave informed consent and were aware that some of the trials would present taboo words. Prior to beginning the experiment, participants were exposed to each target and filler picture in order to familiarize them with the appropriate name for each picture. Each target and filler picture was randomly presented (without any distractor) and participants were asked to provide a name for each picture. An experimenter indicated whether or not the participant used the correct picture name. Pictures that were named incorrectly were re-presented until all of the correct picture names were produced.

Upon beginning the experiment, participants were instructed to name each picture as quickly and accurately as possible while ignoring the distractor word. They first saw five practice trials using pictures and distractors that were not used elsewhere in the experiment. Participants named these practice pictures while the experimenter was in the room and were able to ask questions prior to beginning the main experiment. At the beginning of each trial, a question mark appeared and remained on the screen until the participant pressed the space bar. A fixation (+) then appeared for 500ms, disappeared and was immediately replaced with the target picture and superimposed distractor. The picture and word remained on the screen until the space bar was pressed or 3000 ms elapsed. Each target picture was followed by a filler picture trial with the identical sequence. Pictures were presented in counterbalanced blocks so that each picture was named with one distractor type (phonological or unrelated) in Block 1 and with the alternate distractor type in Block 2. Within each block, presentation of distractor valence type (positive, negative, neutral, taboo) was random except for the constraint that one distractor of each valence was presented before any valence type was repeated. Each target picture was followed by a filler picture. Similar to targets, each filler picture and accompanying distractor was presented twice, once within each of the two blocks. Thus, participants named a total of 128 target pictures and 128 fillers. The entire experiment (familiarization and PWI task) took approximately 45 minutes.

Results

Naming times (in ms) were extracted from wavefiles using a voice onset program (Jennings & Abrams, 2015). All wavefiles were checked manually for accuracy, and naming onset times were manually coded when the program could not easily determine the onset time (8.5% of trials). Trials were excluded from analyses when a wavefile failed to record or was undecipherable, and when participants made speech errors, failed to respond within 3000 ms, or produced the wrong picture name (4.1% of targets, 3.7% of fillers). Outliers were then calculated as naming times greater or less than 2 *SD* from each participant's/item's mean in the participant and item analyses, respectively. This removed 5.7% of targets and 5.2% of fillers in the participant analysis, and 5.6% of targets and 5.0% of fillers in the item analyses.

Target Picture Naming. A 2 (Distractor Phonological Overlap: Phonological, Unrelated) x 4 (Distractor Valence: Positive, Negative, Taboo, Neutral) repeated-measures analysis of variance (ANOVA) was performed on mean target picture naming times (in ms) by participants (F_1) and items (F_2). There was a main effect of distractor phonological overlap, F_1 (1, 47) = 49.57, MSE = 3467, $p < .001$, $\eta^2 = .18$, F_2 (1, 60) = 38.91, MSE = 1600, $p < .001$, $\eta^2 = .69$, with targets being named faster when accompanied by phonological distractors (M_1 = 822 ms) compared to unrelated distractors (M_1 = 965 ms), i.e., a phonological facilitation effect. To ensure that any emotional valence effects were not due to the use of different target pictures across distractor valence conditions, we conducted a more conservative analysis for the distractor valence main effect: We computed each target's naming time with each distractor type via a proportional measure that accounted for the target's baseline naming time, i.e., without a distractor, calculated as ($\frac{(M_{Distractor\,Valence} - M_{Baseline})}{M_{Baseline}}$). The main effect of distractor valence was significant[3], F (3, 58) = 6.49, MSE = .023, p < .001, η^2 = .25. Independent samples t-tests (see Table 2) revealed that targets accompanied by taboo distractors (M = .137) were named slower than targets accompanied by negative (M = -.043), positive (M = -.073), and neutral (M = -.047) distractors. Targets accompanied by negative distractors, positive, and neutral distractors did not differ.

A Distractor Phonological Overlap x Distractor Valence interaction also emerged, F_1 (3, 141) = 11.67, MSE = 2482, p < .001, F_2 (3, 60) = 7.56, MSE = 1600, p < .001 (see Figure 1). Further inspection of this interaction revealed that phonological facilitation occurred for all four valence types (see Table 2). To compare the size of the phonological facilitation effects in each of the four valence conditions, 2 (Distractor Phonological Overlap) x 2 (Distractor Valence) ANOVAs were conducted with each pair of distractor valence types. Significant interactions emerged when the pair of distractor valence types included taboo, suggesting that the degree of phonological facilitation was greater on taboo trials than negative trials, F_1 (1, 47) = 19.32, MSE = 3026, p < .001, F_2 (1, 30) = 10.67, MSE = 2493, p = .003, positive trials, F_1 (1, 47) = 14.70, MSE = 3202, p < .001, F_2 (1, 30) = 9.96, MSE = 1991, p = .003, and neutral trials, F_1 (1, 47) = 24.02, MSE = 2738, p < .001, F_2 (1, 30) = 12.35, MSE = 2053, p < .001. In contrast to comparisons of pairs that included taboo valence types, there were no significant interactions for the other valence types, F_1s < 1, F_2s < 1, suggesting that the magnitude of phonological facilitation was equivalent on positive, negative, and neutral trials.

Filler Picture Naming. Analyses were conducted on time (in ms) to name filler pictures that followed target pictures. In these analyses, both distractor phonological overlap and distractor valence refer to the *preceding* target-distractor trial. A repeated measures ANOVA on mean filler picture naming times revealed only a main effect of distractor emotional valence, F_1 (3, 141) = 8.29, MSE = 1709, p < .001, η^2 = .78, F_2 (3, 189) = 5.00, MSE = 17824, p = .002, η^2 = .78 (see Table 3). Further inspection of this effect revealed that fillers following taboo target-distractor trials (M_1 = 835 ms) were named slower than fillers following positive (M_1 = 808 ms), negative (M_1 = 811 ms), or neutral (M_1 = 819 ms) target-distractor trials (see Table 2). In contrast, fillers following positive target-distractor trials were named faster than fillers following neutral target-distractor trials, but only in the participant analysis. Fillers following negative target-distractor trials did not differ from fillers following positive target-distractor trials or neutral target-distractor trials. There was no significant main effect of phonological overlap, F_1 (1, 47) = 3.07, MSE = 1538, p = .086, η^2 = .09, F_2 (1, 63) = 1.80, MSE = 9033, p = .185, η^2 = .13, nor a Phonological Overlap x Emotional Valence interaction, F_1 < 1.24, F_2 < 1.

Discussion

Experiment 1’s results replicate the taboo interference found in PWI when naming pictures presented with unrelated taboo words (Dhooge & Hartsuiker, 2011a), and extend those findings by demonstrating that taboo words interfere in a unique way that emotionally positive and negative words do not. Furthermore, while all four valence conditions showed facilitation from phonological relative to unrelated distractors, the largest phonological facilitation effect occurred when the distractor's valence was taboo. These data provide a challenge for monitoring accounts of interference to accommodate phonological facilitation from taboo distractors (the T+P effect; see also Dhooge & Hartsuiker, 2012, and Mulatti & Coltheart, 2012, for discussions of additional challenges for self monitoring accounts), where taboo words should slow target processing regardless of their phonological overlap because phonological facilitation would be completed before the monitor is invoked to detect the taboo nature of a word. Alternatively, an attentional explanation of emotional interference can accommodate the interaction. Taboo distractors invoke heightened attention, which impacts phonological encoding by facilitating feedback from the phonology shared among the distractor and the target to the target's lemma. This heightened attention may serve to help taboo words quickly exceed the threshold but be blocked more slowly, which in turn allows more time for shared phonology to enhance picture naming. Nonetheless, it is worth noting that phonological feedback did not eliminate taboo interference, i.e., T+P distractors still slowed picture naming relative to neutral distractors, differentiating them from S+P distractors, which can actually speed picture naming under some circumstances (e.g., Damian & Martin, 1999; Starreveld & La Heij, 1996).

A particularly noteworthy and novel finding of this experiment was the demonstration that a target's distractor influenced naming on a subsequent filler trial, i.e., a carryover effect of emotion, even though filler trials occurred 3-4 seconds following a target trial. The strongest carryover effect occurred on filler pictures following taboo target trials, which were named slower than fillers following any other valence condition. To our knowledge, this is the first study to demonstrate carryover effects of any kind in picture naming, extending the taboo slowing carryover effects previously found in Stroop color naming and word recognition studies (e.g., Bertels et al., 2011; McKenna & Sharma, 2004; Phaf & Kan, 2007; Zeelenberg et al., 2011) to speech production and suggesting that the effects of taboo words on speech are longer-lasting than previously documented.

A potential shortcoming of Experiment 1’s design was that it was virtually impossible to match distractors across all eight valence x phonological relatedness conditions on psycholinguistic variables known to affect speech. One of those variables is word frequency, as research has shown that low-frequency distractors slow picture naming more than high-frequency distractors (Miozzo & Caramazza, 2003). However, because we matched phonological and unrelated distractors within each valence condition, distractor frequency cannot explain the interaction between emotion and phonology. Previous research has shown that distractor frequency interacts with distractor phonological overlap such that phonological distractors facilitate picture naming more when distractor frequency is low (Miozzo & Caramazza, 2003). However, we found similar levels of phonological facilitation in positive, negative, and neutral trials despite negative distractors being lower in frequency than neutral distractors, which were lower in frequency than positive distractors.

With respect to the greater slowing from taboo distractors (independent of phonology) compared to the other three valences, it is also unlikely that distractor frequency can completely explain this result, as Dhooge and Hartsuiker (2011a) also found greater taboo slowing when comparing frequency-matched taboo and neutral distractors. Nonetheless, it is possible that distractor frequency influenced carryover effects, specifically the finding that fillers following positive target-distractor trials were named faster than fillers following neutral trials, because positive distractors were higher in frequency than neutral distractors. If high-frequency distractors can be blocked faster or removed from the output buffer faster than low-frequency distractors, and the speed at which distractors are blocked/removed from the buffer affects available resources to devote to naming the subsequent picture, fillers following the high-frequency positive distractors in Experiment 1 may have had an advantage. In order to eliminate distractor frequency as a potential cause of differences in how naming was influenced by distractor valence, Experiment 2 matched taboo, negative, positive, and neutral distractors on frequency as well as other important lexical characteristics, a change made possible by removing the phonological relatedness variable between targets and distractors.

Experiment 2

The first goal of this experiment was to replicate the effects of emotional distractors on target production while controlling for the lexical characteristics of distractors from different valence conditions. By removing the phonological overlap variable, the distractor valence conditions could be better matched on lexical characteristics like word frequency, and four emotional distractors could be assigned to one picture. This change in stimuli also allowed us to use a hierarchical regression analysis to investigate how much variance in PWI is accounted for by emotional characteristics when lexical characteristics, namely word frequency, are controlled. Because the theories do not detail the degree to which these factors might explain variance in speech production, this analysis was exploratory in nature. The second goal of this experiment was to further investigate the taboo carryover effects by testing whether phonological overlap between a distractor and a subsequent picture name could moderate those carryover effects. Filler pictures were phonologically related (e.g., slide) or unrelated (e.g., bridge) to the previous target's distractor word (e.g., slut).

Method

Participants

Participants were 48 undergraduate students (34 females) who were recruited and compensated as in Experiment 1. They ranged from 18 to 21 years old (*M* = 19.04, *SD* = 0.85) and reported English as their native language.

Materials

Target Pictures. Sixteen target pictures were selected (38% from Experiment 1), and each target picture was assigned one distractor from each of the distractor valence conditions (see Appendix B). Targets had a mean word frequency of 599 (*SD* = 1014; Zeno et al., 1995) and a mean word length of 5.63 letters (*SD* = 1.93). No more than two target pictures came from the same semantic category (e.g., animals).

Distractors. Different from Experiment 1, this experiment only included unrelated distractors (65% of distractors used in this experiment were also used in Experiment 1). Lexical characteristics for the four valence conditions are reported in Table 4. Distractors did not share phonology or a semantic relationship with their associated target picture. Further, using the English Lexical Project database (Balota, Yap, Cortese, Hutchison, Kessler, et al., 2007), we determined that distractors from the four valence types shared the same number of syllables, did not statistically differ in number of letters, phonological neighborhood, mean bigram frequency, or word frequency using SUBTLEX norms (Fs < 1.1; Brysbaert & New, 2009).

We collected our own normative data by having 28 students from the same participant population rate distractors on several characteristics. Although emotional words have previously been normed on college students, the norms were collected with different samples at different periods of time and not all taboo words are included in both databases, making comparisons between taboo, positive, and negative words on arousal difficult (Bradley & Lang, 1999; Janschewitz, 2008). Collecting our own normative estimates provided ratings on emotional dimensions (valence, arousal, tabooness) and lexical characteristics (personal use, familiarity, and imageability) from one sample. Participants rated 225 words on all six scales, using the same 1 – 9 scale as Bradley and Lang (1999) and Janschewitz (2008), and mean ratings from our norms were highly correlated with existing norms on both lexical characteristics (*r*s >= .56, *p*s < .001) and emotional dimensions (*r*s >= .76, *p*s < .001). We used these norms to match distractors in each valenced condition on the three lexical characteristics, *F*s < 1.1. With respect to the emotional dimensions, distractors differed in valence, with negative distractors being more negative than taboo distractors (t (30) = 3.44, p = .002), which were more negative than neutral distractors (t (30) = 3.16, p = .005), which were more negative than positive distractors (t (30) = 13.92, p < .001). For arousal, taboo distractors were more arousing than both positive (t (30) = 6.00, p < .001) and negative (t (30) = 4.58, p < .001) distractors, which were matched for arousal (t < 1). Both positive (t (30) = 13.92, p < .001) and negative distractors (t (30) = 13.79, p < .001) were more arousing than neutral distractors, as is common. For tabooness, taboo distractors were higher in tabooness than negative (t (30) = 12.14, p < .001), positive (t (30) = 24.93, p < .001), and neutral distractors (t (30) = 24.19, p < .001). Although negative distractors were rated as more taboo than positive (t (30) = 7.95, p < .001) and neutral distractors (t (30) = 7.71, p < .001), the latter two did not differ (t < 1).

Filler Pictures. Due to the complexity of having filler pictures share phonology with their preceding distractors, the unrelated distractor word was removed from the filler picture. A phonological filler picture (four (6.3%) were used in Experiment 1) was assigned to each of the 64 distractors so that the distractor and phonological filler picture shared at least two letters and often two phonemes (e.g., filler picture *train* shared the first two phonemes with the positive distractor *trophy* that was assigned to the target picture *camera*). As summarized in Table 5, the four phonological filler pictures that were assigned to a target picture's four valence distractors were matched for number of syllables, number of letters, number of shared phonemes with the distractor, SUBTLEX word frequency, phonological neighborhood, and mean bigram frequency, *F*s < 1. The unrelated fillers were created by re-assigning phonological filler pictures to a different target so that identical pictures were used for the phonological and unrelated conditions. Each participant saw a given filler picture in either the phonological or the unrelated condition, but not both, with presentation of the two filler types counterbalanced across participants. Neither type of filler shared semantic category with the target.

Procedure

The procedure was similar to Experiment 1, with two exceptions: (1) each target picture was presented four times, once with each of the four distractor valences, and (2) target pictures were followed twice by phonological fillers and twice by unrelated fillers. Thus, participants named a total of 64 target pictures and 64 fillers. The entire experiment took approximately 30 minutes.

Results

Naming times (in ms) were treated the same way as in Experiment 1, and 9.2% of trials were manually coded. Analyses excluded trials when a wavefile failed to record or was undecipherable, and when participants made speech errors, failed to respond within 3000 ms, or produced the wrong picture name (4.1% of targets, 3.4% of fillers). Of the remaining correct trials, outliers greater or less than 2 *SD* from each participant's mean (8.7% of targets and 8.3% of fillers) or item's mean (8.7% of targets and 8.1% of fillers) were excluded from analyses.

Target Picture Naming. A repeated-measures ANOVA on mean target naming times was significant, F_1 (3, 141) = 44.73, *MSE* = 3569, $p < .001$, $\eta^2 = .49$, F_2 (3, 60) = 18.71, *MSE* = 2739, *p* < .001, η^2 = .48 (see left half of Figure 2). Replicating Experiment 1, targets with taboo distractors were named slower than targets with neutral, positive, and negative distractors (see Table 6 for statistical results). Contrary to Experiment 1, targets with negative distractors were named slower than targets with neutral and positive distractors, which did not differ.

To explore which emotional characteristics of distractor words account for the most variance in target picture naming, we conducted a hierarchical regression with target naming time as the dependent variable (see Table 7). In order to control for multicollinearity between predictor variables, we first centered all the predictors. Because distractor frequency has been shown to influence PWI (e.g., Miozza & Caramazza, 2003), we controlled for it by entering it in the first step[4]. Although this model was not statistically significant, *F* (1, 62) = 1.04, *MSE* = 5047, *p* = .31, it is not surprising given that we controlled for frequency across the four valence conditions. Next, we investigated how much variance in PWI could be explained by the distractor emotional characteristic of tabooness, and whether valence and arousal accounted for additional variance beyond tabooness. Adding tabooness in Step 2 resulted in a significant model, *F* (2, 61) = 26.69, *MSE* = 2782, *p* < .001, and a significant increase in adjusted R^2 (*p* < .001). Adding the emotional characteristics of distractor arousal and valence in Step 3 did not change the model (*p* = .90), suggesting that arousal and valence do not explain additional variance when tabooness is controlled[5]. Finally, drawing on research showing that arousal and valence interact to influence word recognition (i.e., lexical decision responses are slowest to low-arousal negative words; Larsen, Mercer, Balota, & Strube, 2008), we tested for a similar interaction in word production. Adding an interaction between arousal and valence in Step 4 resulted in a significant model, *F* (5, 58) = 13.27, *MSE* = 2558, *p* < .001, and this final model accounted for a relatively large portion of variance in naming time (adjusted R_2 = .49). Word frequency and tabooness remained significant predictors, with unique prediction in naming time emerging from the Valence x Arousal interaction after tabooness was controlled. Figure 3 illustrates this interaction using +/- 1 *SD* from each predictor's mean. As illustrated, valence had a larger effect on target naming when distractors were lower in arousal, with greater slowing for negative than positive distractors. When distractors were higher in arousal, the effect of valence was smaller and in the opposite direction, trending toward greater slowing for positive than negative distractors.

Filler Picture Naming. A 4 (Target Distractor Valence) x 2 (Filler Phonological Overlap) repeated measures ANOVA was performed on mean filler naming times (see Table 8). Filler phonological overlap was defined by whether the filler shared or did not share phonology with the preceding distractor. There was a main effect of target distractor valence in the participant analysis, F_1 (3, 141) = 5.26, *MSE* = 3814, p = .002, η^2 = .93, F_2 (3, 60) = 1.37, *MSE* = 3895, p = .26, η^2 = .06 (see right half of Figure 2). Similar to Experiment 1, fillers following taboo target-distractor trials (M_1 = 759 ms) were named more slowly than fillers following neutral (M_1 = 724 ms), negative (M_1 = 739 ms), and positive target-distractor trials (M_1 = 742 ms). Also consistent with Experiment 1, fillers following negative target-distractor trials did not differ from fillers following positive target-distractor trials or neutral target-distractor trials. Unlike Experiment 1, fillers following positive target-distractor trials were slower than fillers following neutral target trials. There was no main effect of filler phonological overlap, $F_1 < 1$, $F_2 < 1$, and no Target Distractor Valence x Filler Phonological Overlap interaction, $F_1 < 1$, $F_2 < 1$.

A hierarchical regression similar to that reported above was conducted with filler naming time as the dependent variable[6]. Step 1 was not significant, F (1, 62) = 1.86, *MSE* = 1898, p = .18, and had an adjusted R^2 of .01. Step 2 resulted in a significant model, F (2, 61) = 3.41, *MSE* =

1787, $p = .04$ (adjusted $R^2 = .07$). The only *beta* to reach significance was tabooness ($\beta = .27$, $t = 2.20$, $p = .03$), although there was a marginally significant effect of distractor frequency ($\beta = -.21$, $t = 1.69$, $p = .10$). The addition of arousal and valence in Step 3 and their interaction in Step 4 did not significantly change the predictive quality of the model, *F*s < 1.2.

Discussion

Experiment 2 replicated the slowing effect caused by taboo distractors found in Experiment 1's target trials and extended it to negatively-valenced distractors: Picture naming was slowed on taboo and (to a lesser extent) negative target trials, even when distractors were matched on critical lexical variables such as word frequency and imageability. The interpretation of these results is aided by the regression analysis, which showed effects of distractor frequency and tabooness on target naming. The importance of distractor frequency in predicting naming time supports previous research demonstrating slower picture naming when distractors are low vs. high frequency (e.g., Dhooge & Hartsuiker, 2010, 2011b; Miozzo & Caramazza, 2003). However, the effect of tabooness was even stronger, suggesting that taboo words possess other characteristics that make them particularly susceptible to distraction, such as their offensiveness or social inappropriateness, and provide further evidence of the special properties of taboo words (see Jay, 2009). Additional support for the distinctiveness of taboo words is that they produced greater interference than negative distractors even though negative distractors were rated more negatively than taboo. This finding also suggests that a distractor's valence is not the most important predictor of interference in speech production, although the differences between taboo, negative, and positive distractors that emerged in our ANOVA suggest that valence does play some role.

Finding an interaction between distractor valence and arousal (when tabooness was controlled) helps to clarify that role, suggesting a small but unique contribution of these two emotional characteristics to target naming. Specifically, the effect of valence on target naming was pronounced among lower- compared to higher-arousal distractors, such that negative distractors were more distracting than positive distractors when the distractors' arousal is relatively low. These results parallel Larsen, Mercer, Balota, and Strube's (2008) findings that negative, low-arousing words produced the greatest slowing in lexical decision and demonstrate that slowing of naming times during production does not occur uniformly for negative words or for all arousal levels. These researchers speculated that the differential slowing for negative, low arousal words could be due to their threatening nature, as many threatening words (e.g., coffin) tend to be negative and low in arousal. It is also possible that positive, highly-arousing distractors (e.g., riches) have a characteristic such as their reward value that continues to engage attention during PWI. This idea would be consistent with the notion that threat and reward are relevant properties by which we evaluate incoming stimuli in preparation for action (Schrerer, 1994; Brosch, Sander, Pourtois, & Scherer, 2008). However, the arousal x valence interaction should be interpreted with caution given that our emotional distractors were relatively highly arousing (i.e., greater than 5 on the standard valence scale of 1 – 9; Bradley & Lang, 1999), and that the regression controlled for tabooness, which essentially removes a large amount of variance associated with arousal (because arousal and tabooness are highly correlated). Thus, future research should attempt to tease apart valence and arousal effects when distractors are truly low in arousal.

With respect to filler pictures, carryover effects from taboo target-distractor trials into filler trials were again observed (in the more powerful participant analysis), where the naming of filler pictures was slowed when the previous target was accompanied by a taboo distractor. Furthermore, the regression analysis elucidated that tabooness was the only emotional characteristic that influences these carryover effects into filler naming. Although carryover effects were found following positive distractors (and a trend in that direction for negative distractors), this effect was not significant in the item analysis or confirmed in the regression, suggesting carryover effects from non-taboo emotional trials are less robust than those from taboo trials. One possibility is that potential carryover effects from non-taboo emotional trials could be affected by the presence of taboo words, which may have diminished the impact of highly-arousing non-taboo words. 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). Additionally, finding any carryover effects in these studies is quite remarkable given that trials were separated by approximately three seconds. It is therefore unsurprising that the phonological relationship between the distractor and the filler picture did not modify the carryover effects, as filler naming times were equivalent for phonologically-related and unrelated distractors.

General Discussion

The main purpose of this research was to investigate how interference from emotional distractor words affects speech production and whether this interference is moderated by phonological relatedness. Although strong emotional words have been shown to slow processing in several cognitive tasks (e.g., Algom et al., 2004; Dhooge & Hartsuiker, 2011a; Estes & Adelman, 2008), there is considerably less research on the ways in which emotion influences language processing. We argue that current theories of language production should be adapted to accommodate the influence of emotion and its interaction with phonology when naming target and subsequent filler pictures.

To summarize our results, we found that taboo words are a source of unique distractibility in picture naming, evidenced by (1) taboo properties of distractors explaining the most variance in target and filler naming times, (2) greater phonological facilitation effects on target naming relative to the other distractors, and (3) interference from taboo distractors that persisted into the next trial, slowing naming of a neutral filler picture. As explained below, (1) and (3) can be explained by both an attentional and a monitoring of taboo interference during language production, although as noted earlier (2) is best accommodated within an attentional account. With respect to non-taboo emotional words, slowed target naming occurred when distractors were negative but not positive, whereas the effect of distractor valence on filler naming was less reliable. These findings require some modification of both theoretical accounts.

Attention has long been implicated in processing of strong emotional stimuli (e.g., Fisk, 1980; Pratto & John, 1991), and it is generally accepted that highly-arousing words capture attention and thus interfere with an ongoing task. Our results extend these ideas to picture naming by showing that taboo distractor words, and to a lesser degree negative distractor words, slowed target naming. Theoretically, these findings of emotional interference can be accommodated by attentional mechanisms that regulate the interference from distractors during picture naming, the competition threshold and distractor blocking mechanisms (Roelofs, 2003; Roelofs & Piai, 2011; Roelofs et al., 2011, 2013). Highly-arousing words are more quickly recognized than less arousing words, allowing them to rapidly engage attention and exceed the competition threshold. The threshold is particularly low for taboo words, which tend to be not only highly arousing but also socially inappropriate and offensive, and it is well-established that tabooness and arousal are highly correlated (Janschewitz, 2008). It is important to note that previous conceptualizations of the competition threshold have specified a threshold where distractors enter a competition for lexical selection. The present results suggest that the threshold is not solely lexically-driven but is also sensitive to characteristics of words that draw attentional resources from picture naming.

The second attentional mechanism, distractor blocking, minimizes interference from the distractor by attenuating it and provides another mechanism by which taboo words interfere with speech production more than other highly-arousing words: Sustained attention to taboo words makes them more difficult to block than non-taboo, highly-arousing words. These mechanisms synthesize nicely with proposed mechanisms for attention to emotional words in the Stroop literature, where emotional words are thought to engage both a rapid, automatic allocation of attention as well as a slower, more controlled threat-detection mechanism (Frings et al., 2010). The competition threshold would explain interference from the former, whereas the blocking mechanism can explain the latter. Accommodating emotional interference within these two attentional mechanisms also implicates a dual role for regulating interference from emotional words, unlike the proposed mechanisms to handle other types of interference, such as semantic distractors (thought to arise with the competition threshold) or low-frequency distractors (thought to arise during blocking) (Roelofs et al., 2011).

However, the finding that positive distractors did not affect naming times when distractor frequency was controlled is problematic for the idea that high arousal is sufficient to exceed the competition threshold. Differential findings for taboo, negative, and positive distractors suggest that emotional properties of words other than arousal, such as valence, influence the rate at which the distractor exceeds the competition threshold. Alternatively, another possible explanation is that arousal influences how quickly distractors exceed the competition threshold, but other factors such as a word's threat level or reward value influence the speed with which distractors are blocked. Indeed, the valence x arousal interaction that was found in the regression on target naming times suggests that valence has a smaller impact on higher-arousing distractors than on lower-arousing distractors. Specifically, in a similar way that high-frequency distractors are read and blocked faster than low-frequency distractors, lexical access for high-arousal (non-taboo) distractors may be faster than access for low-arousal distractors (e.g., Keuper et al., 2012, 2013), leading to faster blocking, regardless of valence. In contrast, when distractors are less arousing, valence exerts a larger impact, and negative distractors take longer to block than positive distractors. It is plausible that the blocking mechanism, a form of reactive cognitive control (see Braver, 2012), is sensitive to the threat-level of words (Pessoa, 2009). This idea would be consistent with research suggesting that attentional priority is given to threatening emotional stimuli which require more resources than non-threatening stimuli (e.g., Pessoa, 2009).

An alternative theoretical explanation for taboo interference assumes the self-monitor screens potential output for socially unacceptable words so that they are not articulated in place of the target (Dhooge & Hartsuiker, 2011a). However, the monitoring account needs to be broadened in order to account for slowing from negative words. It is possible that the monitor is more cautious with negative words because they tend to be higher in tabooness than positive or neutral words, which might also explain why tabooness so strongly predicted target naming times in the regression. Alternatively, the monitor could screen negative words (e.g., pervert, cancer) that are unpleasant to produce. This might also explain the additional slowing of negative, lower arousal words that was found when tabooness was controlled. Regardless, the monitoring approach would benefit from specifying which aspects of negative words are expected to be detected by the monitor, such as threat, unpleasantness, etc. Although some negative words that might be unpleasant to produce (e.g., tumor) are high in arousal, others (e.g., corpse) are lower in arousal. Also, given all negative words are defined by their low ratings on a pleasantness dimension, it is unclear why some negative words would be more or less unpleasant to produce than others.

Our results also revealed carryover effects from taboo distractors, where filler naming times were slowed following taboo target trials. An attentional explanation for carryover effects assumes that an inability to disengage from the taboo distractors slows filler picture naming, consistent with a blocking mechanism that attenuates, but does not fully suppress, a distractor on a target trial. After a taboo distractor grabs attention on a PWI trial and interferes with target picture naming by drawing resources from this primary task, disengagement from this attentional bias is difficult and slows naming on the next trial (e.g., Fox et al., 2001; McKenna & Sharma, 2004; Phaf & Kan 2007; Zeelenberg et al., 2011). The inability to disengage attention is likely to have occurred only for taboo words and not other types of emotional distractors because of the long-lasting nature of their arousing properties and/or a failure of the distractor blocking mechanism to fully block taboo words.

In order to accommodate the carryover effects within a monitoring account, we have to assume the monitor adjusts on a trial-by-trial basis and is on heightened alert following a taboo target trial (Dhooge & Hartsuiker, 2011a). That is, encountering a taboo distractor on a target trial could make the self monitor more careful on the subsequent trial, thus employing a more stringent criterion following taboo target trials compared to trials with less arousing distractors. However, it is not entirely clear when the monitor would adjust at the micro (trial-by-trial) level vs. the macro (entire list) level. That is, because there is no predictability in when a taboo trial will appear, we would assume that the monitor stays on heightened alert for the duration of the experiment. Future research should manipulate the predictability of taboo trials and the proportion of taboo trials in a PWI block to try to tease apart micro- vs. macro-level adjustments by the monitor. Additionally, the monitoring account should specify how long the monitor stays on alert and whether we would expect the micro-level adjustment to occur for only one filler or several subsequent trials.

These carryover effects suggest that processing during one trial may extend to a subsequent trial, even during single-word production tasks. The carryover effects demonstrated here add to literature by Hartsuiker and colleagues (Dhooge & Hartsuiker, 2012; Hartsuiker, Corley, & Martensen, 2005), showing that the larger experimental context can influence individual trials. For example, speech errors are more likely to result in real words than nonwords, i.e., the lexical bias effect (e.g., Levelt et al., 1999; see also Hartsuiker et al., 2005), but only when the experimental list (context) includes both words and nonwords and not all nonwords. Here, we showed that “context” can also be defined as a trial-to-trial influence, where the stimulus properties of a single trial influence production on that and subsequent trials. Just as attention influences how taboo words affect naming of the current trial, attentional influences could be playing a role in these context effects (e.g., see Norazi & Dell, 2012). For example, differences in carryover effects could be due to different types of attentional control, one for handling the current picture’s task demands, and one that handles the larger experimental demands or task switching (see Bugg, 2012). In sum, given that speech is incremental in nature, with production of one word building on what was previously said, theories that have been focused primarily on explaining the time course of retrieving and articulating a single word need to be sensitive to these context effects.

In conclusion, these experiments demonstrate that interference in picture naming extends beyond semantic associates to include emotional characteristics of words such as tabooness, arousal, and valence. We explored how well two existing models of speech production can accommodate emotional sources of interference and found that they offer a solid foundation by accommodating most, but not all, of our findings. Additionally, the finding that emotion can have lasting influences on speech production has implications for models of single word production and reminds us that speech is incremental in nature, with the production of one word building on what was previously said. This research provides a starting point for understanding how characteristics of emotion interface with non-lexical cognitive processes such as attention and self-monitoring to influence speech production.

References

Algom, D., Chajut, E., & Lev, S. (2004). A rational look at the emotional Stroop phenomenon: A generic slowdown, not a Stroop effect. *Journal of Experimental Psychology: General, 133*, 323-338. DOI: 10.1037/0096-3445.133.3.323

Aquino, J. M., & Arnell, K. M. (2007). Attention and the processing of emotional words: Dissociating effects of arousal. *Psychonomic Bulletin & Review, 14,* 430-435.

Balota, D. L., Yap, M. J., Cortese, M. J., Hutchison, K. A., Kessler, B., Loftis, B., Neely, J. H., Nelson, D., Simpson, G.., & Treiman, R. (2007). The English Lexicon Project. *Behavior Research Methods, 39,* 445-459.

Bertels, J., Kolinsky, R., Pietrons, E., & Morais, J. (2011). Long-lasting attentional influence of negative and taboo words in an auditory variant of the emotional Stroop task. *Emotion, 11,* 29-37. DOI: 10.1037/a0022017

Bower, G. (1981). Mood and memory. *American Psychologist, 36*, 129–148.

Bradley, M.M., & Lang, P.J. (1999). *Affective norms for English words (ANEW): Stimuli, instruction manual and affective ratings*. Technical report C-1, Gainesville, FL. The Center for Research in Psychophysiology, University of Florida.

Braver, T. S. (2012). The variable nature of cognitive control: A dual-mechanisms framework. *Trends in Cognitive Science, 16,* 106-113. doi: 0.1016/j.tics.2011.12.010

Brosch, T., Sander, D., Pourtois, G., & Scherer, K. R. (2008). Beyond fear: Rapid spatial orienting toward positive emotional stimuli. *Psychological Science, 19*, 362–70.

Brysbaert, M., & New, B. (2009). Moving beyond Kucera and Francis: A critical evaluation of current word frequency norms and the introduction of a new and improved word frequency measure for American English. *Behavior Research Methods, 41,* 977-990.

Bugg, J. M. (2012). Dissociating levels of cognitive control: The case of Stroop interference. *Current Directions in Psychological Science, 21*, 302-309. doi: 10.1177/0963721412453586

Compton, R.J. (2003). The interface between emotion and attention: A review of evidence from psychology and neuroscience. *Behavioral and Cognitive Neuroscience Reviews, 2*, 115–129. doi: 10.1177/153458230325527

Damian, M. F., & Martin, R. C. (1999). Semantic and phonological codes interact in single word production. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 25,* 345–361. doi: 10.1037/0278-7393.25.2.345

Dell, G. S. (1986). A spreading-activation theory of retrieval in sentence production. *Psychological Review, 93,* 403–438.

Dhooge, E., & Hartsuiker, R. J. (2010). The distractor frequency effect in picture–word interference: Evidence for response exclusion. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 36*, 878–891. doi:10.1037/a0019128

Dhooge, E., & Hartsuiker, R. J. (2011a). How do speakers resist distraction? Evidence from a taboo picture-word interference task. *Psychological Science, 22,* 855-859. doi:10.1177/0956797611410984

Dhooge, E., & Hartsuiker, R. J. (2011b). The distractor frequency effect in a delayed picture–word interference task: Further evidence for a late locus of distractor exclusion. *Psychonomic Bulletin & Review, 18*, 116–122. doi:10.3758/s13423-010-0026-0

Dhooge, E.. & Hartsuiker, R. J. (2012). Lexical selection and verb self-monitoring: Effects of lexicality, context, and time pressure in picture-word interference. *Journal of Memory and Language, 66,* 163-176. doi:10.1016/j.jml.2011.08.004

Estes, Z., & Adelman, J. S. (2008). Automatic vigilance for negative words in lexical decision and naming: Comment on Larsen, Mercer, and Balota (2006). *Emotion, 8*, 441–444. doi: 10.1037/1528-3542.8.4.441

Fox, E., Russo, R., Bowles, R., & Dutton, K. (2001). Do threatening stimuli draw or hold visual attention in subclinical anxiety? *Journal of Experimental Psychology: General, 130,* 681–700. doi: 10.1037/0096-3445.130.4.681

Frings, C., Englert, J., Wentura, D., & Bermeitinger, C. (2010). Decomposing the emotional Stroop effect. *The Quarterly Journal of Experimental Psychology, 63,* 42-49. DOI:10.1080/17470210903156594

Harris, C. R., & Pashler, H. (2004). Attention and the processing of emotional words and names. *Psychological Science, 15,* 171-178.

Hartsuiker, R. J. (2006). Are speech error patterns affected by a monitoring bias? *Language and Cognitive Processes, 21,* 856-891. doi: 10.1080/10690960600824138

Hartsuiker, R. J., Corley, M., & Martensen, H. (2005). The lexical bias effect is modulated by context, but the standard monitoring account doesn't fly: Reply to Baars, Motley, and MacKay (1975). *Journal of Memory and Language, 52,* 58–70. doi: 10.1016/j.jml.2004.07.006

Janschewitz, K. (2008). Taboo, emotionally valenced, and emotionally neutral word norms. *Behavior Research Methods, 4,* 1065-1074. doi: 10.3758/BRM.40.4.1065

Jay, T. (2009). The utility and ubiquity of taboo words. *Perspectives on Psychological Science, 4,* 153-161. doi: 10.1111/j.1745-6924.2009.01115.x

Jennings, D. T., & Abrams, L. (2015). *Automatic detection of voice onset times from waveform data using Microsoft Excel*. Manuscript in preparation.

Keuper, K., Zwanzger, P., Nordt, M., Eden, A., Laeger, I., Zwitserlood, P., Kissler, J., Junghöfer, M., Dobel, C. (2012). How ‘love’ and ‘hate’ differ from ‘sleep’: Using combined electro/magnetoencephalographic data to reveal the sources of early cortical responses to emotional words. *Human Brain Mapping, 35*, 875-888. doi: 10.1002/hbm.22220

Keuper, K., Zwitserlood, P., Rehbein, M. A., Eden, A. S., Laeger, I., Junghöfer, M., Zwanzger, P., Dobel, C. (2013). Early prefrontal brain responses to the hedonic quality of emotional words – A simultaneous EEG and MEG study. *PLoS One, 8,* e70788. doi: 10.1371/journal.pone.0070788

Kuchinke, L., Jacobs, A. M., Grubich, C., Võ, M. L.H., Conrad, M., & Herrmann, M. (2005). Incidental effects of emotional valence in single word processing: An fMRI study. NeuroImage, *28*, 1022-1032.

La Heij, W., Boelens, H., & Kuipers, J. R. (2010). Object interference in children’s color and position naming: Lexical interference or task-set competition? *Language and Cognitive Processes, 25*, 568–588

Larsen, R. J., Mercer, K. A., & Balota, D. A. (2006) Lexical characteristics of words used in emotional Stroop experiments. *Emotion, 6*, 62-72. doi: 10.1037/1528-3542.6.1.62

Larsen, R. J.., Mercer, K. A., Balota, D. A., & Strube, M. J. (2008). Not all negative words slow down lexical decision and naming speed: Importance of word arousal. *Emotion, 8*, 445-452. doi: 10.1037/1528-3542.8.4.445

Levelt, W. J. M., Roelofs, A., & Meyer, A. (1999). A theory of lexical access in speech production. *Behavioral and Brain Sciences, 22,* 1–75. doi:10.1017/S0140525X99001776

McKenna, F. P., & Sharma, D. (2004). Reversing the emotional Stroop effect reveals that it is not what it seems: The role of fast and slow components. *Journal of Experimental*

Psychology: Learning, Memory, and Cognition, 30, 382-392. doi: 10.1037/0278-7393.30.2.382

Melinger, A., & Abdel Rahman, R. (2013). Lexical selection is competitive: Evidence from indirectly activated semantic associates during picture naming. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 39*, 348-364. doi: 10.1037/a0028941

Miozzo, M., & Caramazza, A. (2003). When more is less: A counterintuitive effect of distractor frequency in picture-word interference paradigm. *Journal of Experimental Psychology: General, 132,* 228-252. doi: 10.1037/0096-3445.132.2.228

Mullati, C., & Coltheart, M. (2012). Picture-word interference and the response-exclusion hypothesis. *Cortex, 48,* 363-372. doi: 10.1016/j.cortex.2011.04.025

Norazi, N.. & Dell, G. S. (2012). Feature migration in time: reflection of selective attention on speech errors. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 38,* 1084-1090. doi: 10.1037/a0026933

Öhman, A., Flykt, A., & Esteves, F. (2001). Emotion drives attention: Detecting the snake in the grass. *Journal of Experimental Psychology: General, 130,* 466–478. doi: 10.1037/0096-3445.130.3.466

Ortigue S., Michel, C. M., Murray, M. M., Mohr, C., Carbonnel, S., Landis, T. (2004). Electrical neuroimaging reveals early generator modulation to emotional words. *Neuroimage, 21,* 1242–1251. doi:10.1016/j.neuroimage.2003.11.007

Pessoa, L., (2009). How do emotion and motivation direct executive control? *Trends in Cognitive Science, 13,* 160 – 166. doi:10.1016/j.tics.2009.01.006

Phaf, R. H., & Kan, K. J. (2007). The automaticity of emotional Stroop: A meta-analysis. *Journal of Behavior Therapy and Experimental Psychiatry, 38,* 184-199. doi:10.1016/j.jbtep.2006.10.008

Piai, V., Roelofs, A., & Shriefers, H. (2012). Distractor strength and selective attention in picture-naming performance. *Memory and Cognition, 40,* 614-627. doi: 10.3758/s13421-011-0171-3

Pratto, F., & John, O. P. (1991). Automatic vigilance: The attention grabbing power of negative social information. *Journal of Personality and Social Psychology, 61,* 380–391.

Roelofs, A. (2003). Goal-referenced selection of verbal action: Modeling attentional control in the Stroop task. *Psychological Review, 110,* 88-125. doi: 10.1037/0033-295X.110.1.88

Roelofs, A., & Piai, V. (2011). Attention demands of spoken word planning: A review. *Frontiers in Psychology, 2,* 1-14. doi: 10.3389/fpsyg.2011.00307

Roelofs, A., Piai, V., & Schriefers, H. (2011). Selective attention and distractor frequency in naming performance: Comment on Dhooge and Hartsuiker (2010). *Journal of Experimental Psychology: Learning, Memory, and Cognition, 37,* 1032-1038. doi: 10.1037/a0023328

Roelofs, A., Piai, V., & Schriefers, H. (2013). Context effects and selective attention in picture naming and word reading: Competition versus response exclusion. *Language and Cognitive Processes, 28,* 655-671. doi: 10.1080/01690965.2011.615663

Schriefers, H., Meyer, A. S., & Levelt, J. M. (1990). Exploring the time course of lexical access in language production: Picture-word interference studies. *Journal of Memory and Language, 29,* 86-102.

Scherer, K. R. (1994). Emotion serves to decouple stimulus and response. In P. Ekman & R. J. Davidson (Eds).*The Nature of Emotion: Fundamental Questions* (p.127–30). NY/Oxford: Oxford University Press.

Siegrist, M. (1995). Effects of taboo words on color-naming performance on a Stroop test. *Perceptual and Motor Skills, 81*, 1119-1122.

Starreveld, P. A., & La Heij, W. (1996). Time-course analysis of semantic and orthographic context effects in picture naming. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *22*, 869-918.

Vigliocco, G., & Hartsuiker, R. J. (2002). The interplay of meaning, sound, and syntax in sentence production. *Psychological Bulletin, 128,* 442-482. doi: 0.1037//0033-2909.128.3.442

Wurm, L. H., Labouvie-Vief, G., Aycock, J., Rebucal, K. A., & Koch, H. E (2004). Performance in auditory and visual emotional Stroop tasks: A comparison of older and younger adults. *Psychology and Aging*, *19,*523-535. doi: 10.1037/0882-7974.19.3.523

Zeelenberg, R., Bocanegra, B.R., & Pecher, D. (2011). Emotion-induced impairments in speeded word recognition tasks. *Experimental Psychology, 58*,400–411. doi: 10.1027/1618-3169/a000109

Zeno, S. M., Ivens, S. H., Millard, R. T., & Duvvuri, R. (1995). The educator's word frequency guide. Brewster, NY: Touchstone Applied Science.

Zhang, Q., & Damian, M. F. (2010). Impact of phonology on the generation of handwritten responses: Evidence from picture-word interference tasks. *Memory & Cognition*, *38,* 1162-1162. doi: 10.3758/MC.38.4.519

Author Notes

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Footnotes

1. Vigliocco and Hartsuiker (2002) proposed an alternative explanation for the S+P effect: The enhanced activation of semantically distractors (from the picture and its lemma) allows it to cascade more activation to the target's phonology compared to phonological distractors. However, whether feedback or cascading activation is used to explain S+P effects does not alter predictions for either the attentional or monitoring account. Therefore, for simplicity we reference the feedback explanation throughout the paper.
2. Evidence suggests that tabooness cannot solely be defined by a valence dimension or as a semantic category (Janschewitz, 2008). However, in order to compare taboo distractors with distractors of other valences, taboo words were considered as a level of emotional valence in these experiments.
3. Although the proportional analysis was conducted by items, we confirmed the distractor emotional valence main effect in a Distractor Phonological Overlap x Distractor Valence ANOVA by participants and items using the raw mean target naming times, F_1 (3, 141) = 53.45, MSE = 4330, $p < .001$, $\eta^2 = .73$, F_2 (3, 60) = 15.44, MSE = 11073, $p < .001$, $\eta^2 = .44$. The nature of this effect confirmed that naming times were slowest for targets accompanied by taboo distractors (M_1 = 914 ms), followed by negative distractors (M_1 = 838 ms), then neutral distractors (M_1 = 820 ms), and finally positive distractors (M_1 = 802 ms), p_1s < .033, p_2s < .001.
4. Although distractors also vary in other lexical characteristics (bigram frequency, phonological neighborhood, word length, imageability), none of these were significant predictors when entered together in Step 1. Thus, only word frequency entered into Step 1 for

the final model because it has been shown to influence PWI (e.g., Miozzo & Caramazza, 2003).

5. In testing a model where arousal and valence were added in Step 2 and tabooness was added in Step 3, tabooness remained a significant predictor of target naming time. Thus, even when arousal and valence were first controlled, tabooness explained additional variance in target naming time.
6. The addition of a dummy coded variable for filler type (phonological or unrelated) was not significant and therefore not included in the final model.

Appendix A

Experiment 1 Target Pictures and Distractors

Target Picture Name	**Phonological Distractor**	**Unrelated Distractor**	**Distractor Valence**
astronaut	asshole	pussy	Taboo
basket	bastard	shithead	Taboo
blocks	blowjob	dildo	Taboo
bone	boner	anus	Taboo
boot	boobs	ass	Taboo
crab	crap	damn	Taboo
duck	dick	tits	Taboo
hook	hooker	scrotum	Taboo
horse	whore	clit	Taboo
organ	orgasm	vibrator	Taboo
rock	cock	slut	Taboo
seal	semen	nipples	Taboo
ship	shit	piss	Taboo
skate	skank	cum	Taboo
truck	fuck	bitch	Taboo
turkey	turd	prick	Taboo
anchor	anger	divorce	Negative
bird	burn	scum	Negative
bottle	bomb	rage	Negative
camera	cancer	victim	Negative
gum	gun	snake	Negative
knight	knife	sin	Negative
lime	grime	wasp	Negative
mask	maggot	coffin	Negative
lightbulb	lice	corpse	Negative
mummy	mosquito	criminal	Negative
mustache	malaria	cemetery	Negative
perfume	pervert	torture	Negative
printer	prison	illness	Negative
rat	fat	pain	Negative
rope	roach	thief	Negative
track	trash	mold	Negative
bat	bath	silk	Positive
beetle	beach	joy	Positive
bench	earth	bed	Positive

leaf	leader	honor	Positive
cat	cash	joke	Positive
doll	dollar	glory	Positive
flower	power	woman	Positive
foot	food	truth	Positive
goal	gold	king	Positive
steak	star	kids	Positive
kitchen	kitten	infant	Positive
milk	millionaire	valentine	Positive
mug	mother	party	Positive
peach	peace	friend	Positive
safe	savior	riches	Positive
scorpion	champion	miracle	Positive
ant	plant	key	Neutral
arm	army	paper	Neutral
bees	beast	swamp	Neutral
bucket	butter	statue	Neutral
cake	cane	lump	Neutral
collar	column	machine	Neutral
corn	cord	trunk	Neutral
couch	cow	lawn	Neutral
fly	flag	coin	Neutral
rain	razor	shadow	Neutral
radio	radiator	elevator	Neutral
stove	storm	cliff	Neutral
swing	swamp	tank	Neutral
shoe	shadow	contents	Neutral
windmill	window	market	Neutral
quarter	quart	chair	Neutral

Appendix B

Experiment 2 Target Pictures and Distractors

Target Picture	**Taboo Distractor**	**Negative Distractor**	**Positive Distractor**	**Neutral Distractor**
arrow	pussy	tumor	bunny	elbow
boot	semen	prison	sunset	patent
camera	boner	pervert	trophy	golfer
doll	breasts	rage	pie	vase
duck	bastard	hostage	perfume	poster
hammer	cunt	trash	thrill	quart
leaf	whore	corpse	bride	vest
rattle	dick	wasp	champ	stool
shoe	blowjob	killer	bouquet	ketchup
snowman	orgasm	funeral	miracle	privacy
table	slut	crutch	wit	beast
telescope	penis	maggot	savior	banner
umbrella	scrotum	headache	penthouse	bathroom
violin	clit	bomb	charm	swamp
web	nipples	demon	blossom	locker
whistle	cock	lice	grin	mop

Table 1

Means (and Standard Deviations) of Variables on Which Phonological and Unrelated Distractors Were Matched in Experiment 1.

	Distractor Valence (ANEW)	Distractor Arousal (ANEW)	Distractor Tabooness (Janschewitz)	Distractor Word Frequency	Distractor Word Length
Taboo Distractors					
Phonological	N/A	N/A	5.5 (1.0)	[a]46.7 (104.5)	5.1 (1.2)
Unrelated	N/A	N/A	5.4 (0.9)	[a]26.2 (36.7)	5.1 (1.6)
Negative Distractors					
Phonological	2.6 (0.6)	5.6 (1.1)	N/A	400.6 (415.1)	5.2 (1.4)
Unrelated	2.6 (0.5)	5.7 (1.1)	N/A	305.8 (299.4)	5.5 (1.6)
Positive Distractors					
Phonological	7.7 (0.5)	5.6 (1.1)	N/A	2779.8 (3821.3)	5.4 (1.9)
Unrelated	7.6 (0.6)	5.8 (1.0)	N/A	1904.1 (2507.3)	5.3 (1.5)
Neutral Distractors					
Phonological	5.1 (0.6)	4.3 (0.8)	N/A	986.1 (1175.4)	5.1 (1.2)
Unrelated	5.1 (0.5)	4.2 (0.8)	N/A	1051.8 (1251.8)	5.3 (1.5)

[a]This mean is based on only 13 of the 16 taboo distractors that had frequencies listed in the Zeno et al. (1995) database.

Table 2

Pairwise Comparisons to Explore the Significant Effects in Experiment 1.

Comparison	*Participant Effects*				*Item Effects*			
	df	*t*	*p*	η^2	*df*	*t*	*p*	η^2
Targets: Distractor Valence Main Effect (Proportional)								
Taboo vs. Negative					28	3.02	.01*	.25
Taboo vs. Positive					30	4.29	.001*	.38
Taboo vs. Neutral					30	3.40	.002*	.28
Negative vs. Positive					28	.55	.59	.01
Negative vs. Neutral					28	.07	.95	.02
Positive vs. Neutral					30	.52	.61	.01
Targets: Phonological facilitation (phonological – unrelated) for each distractor condition								
Taboo (phon vs. unrel)	47	7.31	.001*	.53	15	5.00	.001*	.63
Negative (phon vs. unrel)	47	2.08	.04*	.08	15	1.43	.18	.12
Positive (phon vs. unrel)	47	3.72	.001*	.23	15	3.51	.003*	.45
Neutral (phon vs. unrel)	47	2.17	.04*	.09	15	2.28	.04*	.26
Fillers: Distractor Valence Main Effect								
Taboo vs. Negative	47	3.34	.002*	.19	63	3.84	.001*	.19
Taboo vs. Positive	47	5.15	.001*	.36	63	3.28	.002*	.15
Taboo vs. Neutral	47	2.50	.02*	.11	63	1.92	.06[a]	.06
Negative vs. Positive	47	.65	.52	.01	63	.14	.89	.00
Negative vs. Neutral	47	1.36	.18	.04	63	1.30	.20	.03
Positive vs. Neutral	47	2.09	.03*	.08	63	1.23	.22	.02

Note: "phon" refers to the phonological condition and "unrel" refers to the "unrelated" condition of the distractor phonological overlap variable. Significant effects ($p \leq .05$) are indicated by an asterisk, and marginally significant effects ($p < .10$) are indicated by [a].

Table 3.

Mean Naming Times (and Standard Deviations, in ms) for Filler Pictures in Experiment 1.

Emotional Valence of Distractor in Preceding Target Trial	Preceding Target Trial's Distractor Phonological Overlap	
	Unrelated Distractor	Phonological Distractor
Taboo Distractor	825 (111)	845 (110)
Negative Distractor	809 (108)	813 (99)
Positive Distractor	809 (106)	806 (97)
Neutral Distractor	815 (109)	823 (115)

Table 4.

Means (and Standard Deviations) of Variables on Which Valenced Distractors Were Matched in Experiment 2.

	Valence (ANEW)	Arousal (ANEW)	Tabooness (Janschewitz)	Word Freq	Word Length	PhonoN	Bigram Freq	Imageability (Rhodes)	Familiarity (Rhodes)	Personal Use (Rhodes)	Valence (Rhodes)	Arousal (Rhodes)	Tabooness (Rhodes)
Taboo	N/A	N/A	5.68 (1.19)	14.94 (18.94)	5.38 (1.26)	14.79 (18.94)[a]	3381.04 (1435.71)[a]	5.21 (1.29)	5.07 (0.92)	3.93 (0.82)	3.76 (1.36)	5.53 (0.56)	6.87 (0.82)
Negative	2.19 (0.52)	5.96 (1.29)	N/A	21.12 (22.21)	5.63 (1.26)	9.50 (10.88)	3289.59 (1573.95)	5.52 (1.25)	4.50 (1.00)	3.62 (1.07)	2.50 (0.52)	4.31 (0.92)	3.24 (0.86)
Positive	7.31 (0.70)	5.44 (1.21)	N/A	11.94 (8.80)	5.75 (1.65)	10.94 (14.60)	3117.12 (1346.12)	5.60 (1.83)	4.65 (0.65)	4.65 (0.65)	6.96 (0.38)	4.23 (0.68)	1.43 (0.29)
Neutral	5.22 (0.51)	3.79 (1.03)	N/A	10.85 (14.97)	5.50 (1.27)	9.50 (9.00)	3163.90 (1769.43)	6.00 (1.64)	4.58 (1.19)	4.58 (1.19)	4.89 (0.46)	2.57 (0.57)	1.44 (0.36)

Note. PhonoN refers to phonological neighborhood and BigramFreq refers to average bigram frequency. Emotional characteristics are identified by the study in which they were collected (ANEW, Janschewitz, or Rhodes).

[a] These means are based on only 14 of the 16 taboo distractors that had phonological neighborhood and bigram frequency listed in the English Lexicon Project (Balota et al., 2007) database.

Table 5.

Means (and Standard Deviations) of Variables on Which Filler Pictures Were Matched in Experiment 2.

	Filler # Syllables	Filler # Letters	Filler # Shared Phonemes	Filler Word Frequency	Filler PhonoN	Filler Bigram Freq
Taboo	1.38 (0.50)	5.50 (1.46)	2.19 (0.54)	20.87 (23.82)	10.94 (12.40)	1700.31 (760.53)
Negative	1.56 (0.63)	5.56 (1.41)	2.06 (0.44)	23.35 (24.18)	11.19 (12.26)	1701.90 (861.16)
Positive	1.44 (0.63)	5.69 (1.25)	2.00 (0.63)	24.18 (24.84)	12.19 (9.66)	1743.27 (832.69)
Neutral	1.50 (0.63)	5.06 (1.65)	2.00 (0.37)	21.70 (28.14)	11.75 (9.63)	1758.96 (937.22)

Note. PhonoN refers to phonological neighborhood and BigramFreq refers to average bigram frequency.

Table 6.

Pairwise Comparisons to Explore the Significant Effects in Experiment 2.

Comparison	*Participant Effects*				*Item Effects*			
	df	*t*	*p*	η^2	*df*	*t*	*p*	η^2
Targets: Distractor Valence Main Effect								
Taboo vs. Negative	47	6.69	.001*	.49	30	3.27	.003*	.27
Taboo vs. Positive	47	8.44	.001*	.60	30	6.54	.001*	.58
Taboo vs. Neutral	47	8.21	.001*	.59	30	6.75	.001*	.60
Negative vs. Positive	47	4.53	.001*	.30	30	2.41	.02*	.16
Negative vs. Neutral	47	4.99	.001*	.35	30	2.30	.03*	.15
Positive vs. Neutral	47	.09	.93	.00	30	.44	.67	.01
Fillers: Distractor Valence Main Effect								
Taboo vs. Negative	47	1.98	.05*	.08				
Taboo vs. Positive	47	1.79	.08[a]	.06				
Taboo vs. Neutral	47	3.78	.001*	.13				
Negative vs. Positive	47	.34	.73	.00				
Negative vs. Neutral	47	1.62	.11	.05				
Positive vs. Neutral	47	2.67	.01*	.13				

Note. Item effects are not reported for fillers because the Distractor Valence main effect was not significant by items. Significant effects ($p \leq .05$) are indicated by an asterisk, and marginally significant effects ($p < .10$) are indicated by [a].

Table 7.

Hierarchical Regression in Predicting Target Naming Time in Experiment 2.

	R^2	*Adjusted* R^2	ΔR^2	β	t
Step 1	.02	.001			
SUBTLEX				-.13	-1.02
Step 2	.47	.45***	.45***		
SUBTLEX				-.22	-2.35*
Tabooness				.68	7.18***
Step 3	.47	.43	.002		
SUBTLEX				-.23	-2.17*
Tabooness				.64	3.55***
Valence				.02	.12
Arousal				.06	.37
Step 4	.53	.49***	.06**		
SUBTLEX				-.20	-2.01*
Tabooness				.72	4.17***
Valence				-.09	0.73
Arousal				-.02	0.11
Valence x Arousal				.30	2.85**

Note: $*p < .05$; $**p < .01$; $***p < .001$

Table 8.

Mean Naming Times (and Standard Deviations, in ms) for Filler Pictures in Experiment 2.

Emotional Valence of Distractor in Preceding Target Trial	Filler Phonological Overlap with Previous Distractor	
	Unrelated Filler	Phonological Filler
Taboo Distractor	755 (121)	762 (120)
Negative Distractor	742 (115)	737 (100)
Positive Distractor	738 (104)	746 (105)
Neutral Distractor	720 (101)	727 (98)

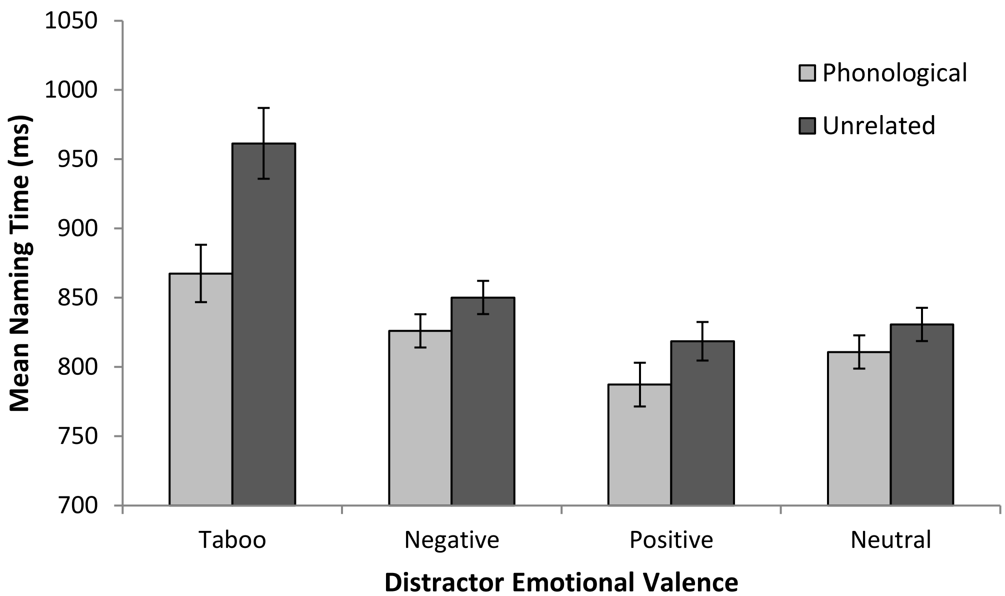

Figure 1. Mean picture naming time (ms) in Experiment 1, as a function of distractor emotional valence (taboo, negative, positive, neutral) and distractor phonological overlap (phonological, unrelated). Error bars represent one standard error from the mean.

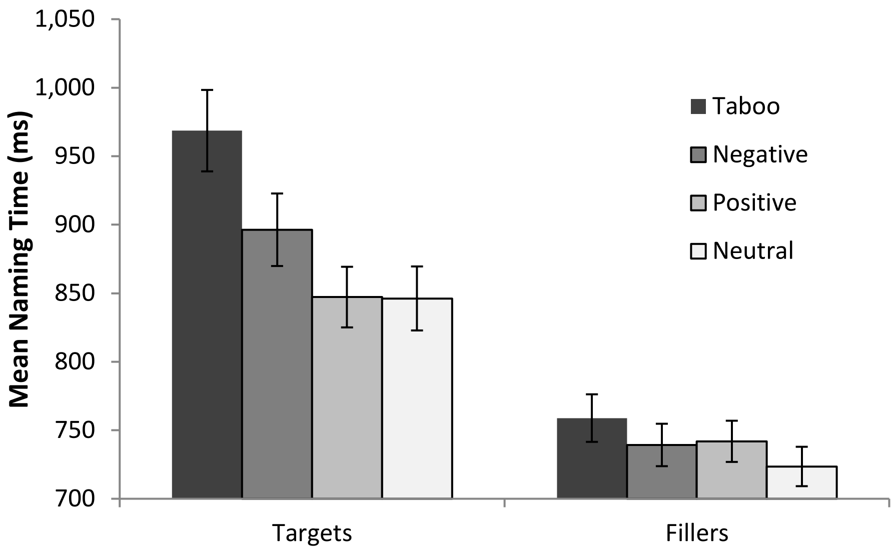

Figure 2. Mean picture naming time (ms) for targets and fillers in Experiment 2, as a function of distractor emotional valence (taboo, negative, positive, neutral). Error bars represent one standard error from the mean.

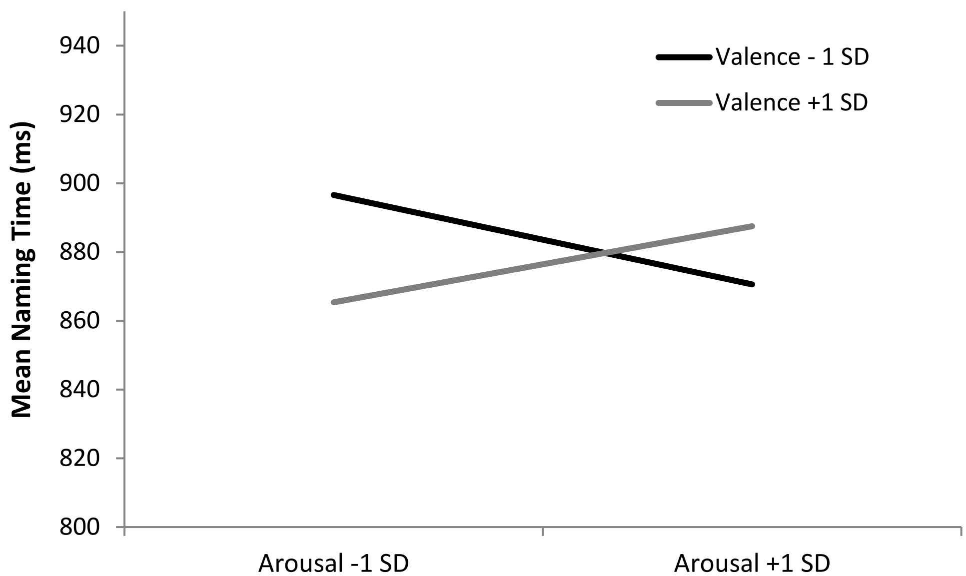

Figure 3. An illustration of the relationship between distractor valence, arousal, and naming time (ms) in Experiment 2. This figure represents the Valence x Arousal interaction (controlling for tabooness) using +/- 1 *SD* from each predictor's mean.