Emotion Learning: The Influence of Associating Sexual–Taboo Words With Nonwords in RSVP

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FSWP401: Master Thesis PSY
July 3, 2025

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Independent reviewer: prof. dr. Diane Pecher

Word count: 7518

Abstract

Associative repetition priming is a relatively under-investigated phenomenon, despite the fact that forming associations between items is a fundamental principle of real-world learning. Novel-word learning is a prime example of associative learning in which nonwords are paired with existing words and an associative bond is expected to be formed. This study investigated whether arousal and meaning of sexual–taboo words can be transferred to nonwords through associative learning by testing whether these novel sexual–taboo words were able to elicit an emotional-induced blindness effect similar to that of existing sexual–taboo words. To address this, I combined a novel-word learning task in which participants matched nonwords with neutral and sexual–taboo words and an RSVP task in which participants had to respond to colour target words while ignoring neutral and sexual–taboo critical distractor stimuli. Results showed that participants gradually got better at identifying matched word pairs in the novel-word learning task. Results in the RSVP task showed that existing sexual–taboo words had a detrimental effect on identification of neutral target words, while novel sexual–taboo words did not, suggesting that there was no carry-over effect of arousal and meaning when nonwords were paired with existing sexual–taboo words. Follow-up research could consider implementing other research paradigms, like the Stroop task, specifically designed for word-concept links and word meaning assessment, and focus on the importance of the difference in emotional intensity in native and non-native languages.

Our ability to process and remember stimuli is influenced by our previous encounters with them. A well-documented example of this is the repetition priming effect, in which prior exposure to a stimulus facilitates a faster and more accurate later identification compared to stimuli encountered for the first time (Gotts et al., 2012; Park & Donaldson, 2016; Zeelenberg et al., 2008). Repetition priming literature, demonstrating implicit memory phenomena, has mainly focussed on presenting stimuli in isolation. However, the interesting concept of associative repetition priming, where stimuli are presented in pairs and an associative bond is expected to be formed, has received noticeably less attention, even though the fundamental principle of real-world learning is the formation of associations between items (Elmer et al., 2022; Morís et al., 2014; Zeelenberg et al., 2008). A prime example of associative learning by means of associative repetition priming is novel-word learning through picture-word or word-word associations (Dittinger et al., 2016; Elmer et al., 2022; Geukes et al., 2015). The present study aimed to use this novel-word learning

paradigm to investigate whether there is a carry-over effect of arousal and meaning when nonwords were paired with emotionally salient words, specifically sexual–taboo words high in arousal.

Novel-word learning

Novel-word learning studies have made use of nonwords, which are entirely novel and made-up letter strings. In these studies, participants form associations between nonwords and meaningful stimuli. While nonwords may lack ecological validity, they offer experimental control over the learning process and stimuli being presented by eliminating confounding variables that may affect learning, such as prior semantic knowledge or language overlap (Geukes et al., 2015).

A study conducted by Geukes et al. (2015) used novel-word learning to investigate the Stroop effect, as they argued that the Stroop task is an excellent tool to assess whether the presentation of a novel word automatically activates the meaning of its previously learned association. In the learning phase of their study, they paired nonwords with German colour words. Participants had to decide whether the word pairs were a match or mismatch depending on their co-occurrence frequencies. Their results showed that participants eventually reached a percentage of correct responses of 95.1%, suggesting that participants were able to successfully associate the nonwords with the existing colour words over time. After the learning phase, they assessed whether a link was established between newly associated nonwords and colour words using the Stroop task. Their results showed that when novel words and their contextual German colour words appeared together in the Stroop task, a Stroop effect was found immediately after the learning phase. However, when the nonwords were presented without their contextual German colour words in the Stroop task, a Stroop effect was found only after 24 hours. This study by Geukes et al. suggested that the automatic activation of the meaning of nonwords depends on the supporting presentation of the contextual words. Memory consolidation, however, had an important role in the associative repetition priming process of nonwords with their to-be-associated German colour words. Specifically, the authors suggested that memory consolidation facilitates the reduction of newly learned nonwords' reliance on contextual cues from the context in which they were learned.

This evidence suggests that newly learned nonwords can acquire semantic properties from the word they were previously paired with. Building on this, the present study investigated whether arousal and meaning, specifically high arousal associated with sexual–taboo words, can be transferred to nonwords through associative learning. Thus, the first question that was addressed

in the present study is whether participants can gradually improve in matching the correct nonword-word pairs. Participants were instructed that it was initially impossible to know which words matched but that co-occurrence frequencies indicated matched and mismatched pairs. In most previous research, novel-word learning tasks were conducted by pairing nonwords with semantically elaborate concepts, definitions, textual contexts, or pictures (Borovsky; et al., 2012; Tamminen & Gaskell, 2013). This study, however, used lexical associations by providing only a sexual–taboo or neutral word without providing a definition or textual context. The present study used the same novel-word learning paradigm as Geukes et al. (2015), but instead of pairing nonwords with colour words, the present study used a paradigm in which nonwords were paired with either neutral or highly arousing sexual–taboo words in the learning phase. As Geukes et al. found, I expected that participants gradually improved at identifying matching and mismatching nonword-word pairs. More critically, I investigated whether these novel sexual–taboo words and their newly learned associations would influence visual attention using the Rapid Serial Visual Presentation (RSVP) paradigm.

Emotional-induced blindness

Emotional stimuli are prioritised in visual processing and are able to capture attention better than emotionally neutral stimuli (Anderson & Phelps, 2001; Most et al., 2007; Schupp et al., 2007; Zeelenberg et al., 2006). There is even considerable evidence that emotional stimuli have a detrimental effect on the perception of neutral stimuli presented within the same context as the emotional stimuli due to their attentional benefit (Arnell et al., 2007; Most et al., 2005; Most et al., 2007). This is also referred to as emotional-induced blindness, or emotional attentional blink (McHugo et al., 2013). In addition to other emotionally salient stimuli, research has focused on the use of taboo words as stimuli. That is because taboo words are higher in arousal compared to other emotionally salient and emotionally neutral words. They are associated with enhanced attention and are also processed differently compared to emotionally non-taboo words. That is, they are processed more automatically than emotionally non-taboo words (Anderson, 2005; Janschewitz, 2008). The studies by Janschewitz (2008) and Roest et al. (2018) suggested that the emotional salience of taboo words come from their arousal level rather than their valence, making arousal an important factor when conducting emotion research. In the present study, I examine

whether existing and novel sexual–taboo words will involuntarily capture attention in an RSVP paradigm.

In the RSVP paradigm, stimuli, such as words or images, are presented briefly one at a time in a stream of stimuli (usually each stimulus is presented for 75-120 ms). Embedded in this stream of stimuli is a critical distractor (T1) and a target stimulus (T2) which is presented in various lags after the critical distractor stimulus (Edwards et al., 2024). Normally, the target stimulus is masked in an RSVP paradigm, as there are multiple distractors that were presented before and after the target stimulus (Zeelenberg et al., 2011). The RSVP paradigm is able to demonstrate the emotional-induced blindness effect, which is the impairment of correctly identifying the target stimulus at T2 when the critical distractor stimulus at T1 was presented approximately 200-500 ms before the target stimulus. Thus, the RSVP shows how task-irrelevant emotional stimuli influence the perception of neutral stimuli presented in the same context (Goodhew & Edwards, 2022). This occurs because the critical distractor stimulus takes away the limited attentional resources available, leaving fewer to none resources for the processing of the neutral target stimulus (Keefe et al., 2019; Zeelenberg et al., 2011). This suggests the occurrence of stage 2 processing of emotional stimuli within the two-stage models of the attentional blink, or the two-stage models of temporal attention. These models propose two stages of stimulus identification and are described by Chun and Potter (1995) and Bocanegra and Zeelenberg (2009) as follows: stage 1 involves fast and automatic high-capacity sensory processing in order to extract stimulus features prior to conscious identification, whereas stage 2 is a much slower limited-capacity attentional processing stage where detected stimuli are processed and consolidated for conscious reporting. Stage 2 processing enhances the processing of emotional stimuli. The emotional stimuli thus attract more attentional resources relative to neutral stimuli, resulting in an emotional-induced blindness effect in the RSVP paradigm.

There have been several studies that have suggested the prioritised attentional processing of taboo words compared to other emotionally salient and neutral words. A study conducted by Mathewson et al. (2008) found that the presentation of emotionally salient words impaired the correct identification of the neutral target word. More importantly, however, they found that the attentional blink effect was larger when taboo words were presented at T1 compared to when other emotionally positive, negative or neutral words were presented at T1. Another study conducted by Most et al. (2007) showed an attentional blink for positively arousing stimuli, in which they

showed erotic pictures as critical distractors. The authors argued that positive emotional stimuli elicit an attentional blink less susceptible to attentional set modulation compared to that elicited by negative emotional stimuli. Furthermore, they argued that adopting a specific attentional set, as opposed to a nonspecific one, significantly reduced distraction from task-irrelevant negative stimuli. This effect, however, was not observed in the positively arousing erotica condition, suggesting that the impact of positively arousing pictures proved to be even more robust than that of negative images. Zeelenberg et al. (2011) also showed that sexual–taboo distractors impaired task performance by inducing a slower reaction time to target stimuli compared to neutral distractors. What is interesting is that this emotional-induced blindness effect was still found despite the fact that the stimuli were not masked in all four experiments of this study, which ensured the possibility of conscious processing of the target stimulus. Another interesting study was conducted by Arnell et al. (2007) which showed that sexual–taboo critical distractors capture attention at the expense of correctly identifying the target colour word at T2, more so than neutral, threat, anxiety, positive, or negative critical distractor words. Additionally, they found that arousal, but not valence, negatively influenced target accuracy and that a higher arousal level had a positive effect on remembering the critical distractor words, suggesting that words high in arousal are more likely to be attended to than words lower in arousal.

Before testing whether there is a carry-over effect of arousal and meaning when nonwords were paired with existing emotionally salient words, I first wanted to confirm the previous findings that existing sexual–taboo words have an attentional advantage over neutral words. Thus, the second question that was addressed in the present study is whether participants are worse at identifying neutral T2 target words when the T1 stimulus was an existing sexual–taboo word compared to an existing neutral word in an RSVP paradigm. To assess this, the same test phase was used as in the study by Arnell et al. (2007). While they used a variety of critical distractor stimuli, the present study only used emotionally neutral and sexual–taboo words, because sexual–taboo words are found to be more arousing than other emotionally neutral, positive, and negative words. As Arnell et al. found, I expected that the sexual–taboo words have a detrimental effect on the identification of the neutral target word compared to the neutral critical distractors.

The present study

Previous findings raise an intriguing possibility: If a nonword is associated with a sexual–taboo word, can it inherit its arousing properties and impair attention in the same way as the existing sexual–taboo word? Prior research has not addressed whether the emotional and attentional impact of sexual–taboo words can be transferred to nonwords via associative learning. The current study aims to fill this gap by combining a novel-word learning paradigm with an RSVP paradigm. The main focus of the present study is thus to investigate whether there is a carry-over effect of arousal and meaning when nonwords are paired with sexual–taboo words and neutral words. The question of interest in the present study is whether performance in the test phase is similar for the sexual–taboo words and the novel sexual–taboo words. If the participants are worse at identifying the neutral T2 target words after the presentation of a T1 novel sexual–taboo word, it can be concluded that there is a carry-over effect of arousal that caused this detrimental attentional effect. While research has used existing taboo words in repetition priming studies, to my knowledge, this will be the first study investigating the effect of novel sexual–taboo words in an RSVP paradigm. The present study examined this by conducting an experiment consisting of a learning phase in which nonwords were paired with either neutral or sexual–taboo words in a novel-word learning paradigm and a test phase in which the critical distractors in an RSVP paradigm were either existing or novel neutral and sexual–taboo words.

Method

Participants

Thirty-eight native Dutch speakers ranging in age from 18 to 28 years (M = 22.6 years) participated in this experiment, of whom 22 identified as female, 15 as male, and 1 as cis male. Two participants had to be excluded due to problems with conducting the test phase of the experiment, resulting in a final sample of 36 participants. According to G*Power (Faul et al., 2009), a sample size of 54 is needed for a statistical power of .95, assuming an effect size of d = 0.50 (using two-sided paired samples t-tests with α = .05). A sample size of 36 resulted in a statistical power of .83, assuming an effect size of d = 0.50.

Amongst the participants were Psychology students from the Erasmus University Rotterdam who could sign up through the university's study participation portal for credits. The other participants were recruited through the researcher's own network. The participants were

informed that sexual–taboo words would be presented in this experiment and were instructed to not sign up if they were not comfortable with this. In the instructions prior to the experiment, another reminder was given to ensure participants did not miss this information. Participants gave their informed consent before starting the experiment.

Apparatus and stimuli

The experiment was conducted using E-Prime software (Schneider et al., 2002) on a Windows desktop computer in the Erasmus Behavioural Lab of the Erasmus University Rotterdam. The stimuli appeared on a grey background in black capitalised letters. The responses were recorded using a keyboard.

The sexual–taboo word list was adapted from stimuli by Roest et al. (2018). Ten Dutch sexual-taboo words were selected, as well as ten Dutch neutral words representing clothing items (see Table A1). The 20 nonwords used in this experiment in the learning and test phase were easily pronounceable for native Dutch speakers and were 3-7 letters long (e.g., *margen*, *zui*, *wilf*, *sia*). The learning phase consisted of two different versions, in which the word pairs that were considered matches, depending on their co-occurrence frequencies, were switched. These versions were counterbalanced between participants (see Tables A2 and A3). In addition to the 20 nonwords that were to be associated with a neutral or sexual–taboo word, there were 30 nonwords that served as mismatch fillers in the learning phase (see Table A4).

In the test phase, 18 items were presented in each RSVP stream. The streams consisted of 16 filler distractor words, one critical distractor word (neutral, novel neutral, sexual–taboo, or novel sexual–taboo), and one colour target word. In addition to the words and nonwords used in the learning phase, there were 40 neutral words and 40 nonwords that served as fillers during the test phase, depending on which block the participants were in (see Appendix B). Ten Dutch colour words represented the target words in the RSVP paradigm (*zwart*, *bruin*, *blauw*, *paars*, *geel*, *groen*, *oranje*, *roze*, *grijs*, and *wit*) (= black, brown, blue, purple, yellow, green, orange, pink, grey, and white respectively). The identity of the target colour word was randomly selected with replacement. The identity of the critical distractor word was randomly selected without replacement with the constraints that each critical distractor word be used once in every 40 trials. The critical distractor appeared either in position 5 or 8, with the target colour word always three positions after the critical distractor either in position 8 or 11. This corresponded to a 300 ms

separation between the critical distractor and the target colour word and was controlled in this way to ensure that a large attentional blink effect could be found.

Procedure

The experiment consisted of two phases: 1) the novel-word learning phase, and 2) the RSVP test phase.

Learning phase

The learning phase used in this experiment was adapted from the novel-word learning paradigm described by Geukes et al. (2015). During the learning phase, word pairs were presented. The learning phase consisted of two blocks; in one block, the nonwords were paired with neutral words, and in the other block, the nonwords were paired with sexual–taboo words. Which block was presented first was counterbalanced between participants. Sexual–taboo words and neutral words were divided into two blocks to eliminate a possible carry-over effect of arousal from the sexual–taboo words to the nonwords paired with neutral words. Both blocks were divided into four blocks of 120 trials each to be able to assess learning progression throughout the learning phase.

Figure 1 shows an illustrative example of the novel-word learning task. A fixation cross was centrally presented for 200 ms on each trial, which was then followed by a nonword just above the centre, and 250 ms later an existing neutral or sexual–taboo word was presented just below the centre. This stayed on the computer screen for 1500 ms. Participants had 1800 ms from the onset of the existing neutral or sexual–taboo word to decide whether the two words were a match or a mismatch by pressing the *k*-key to indicate that the words were a match or the *s*-key to indicate that the words were not a match.

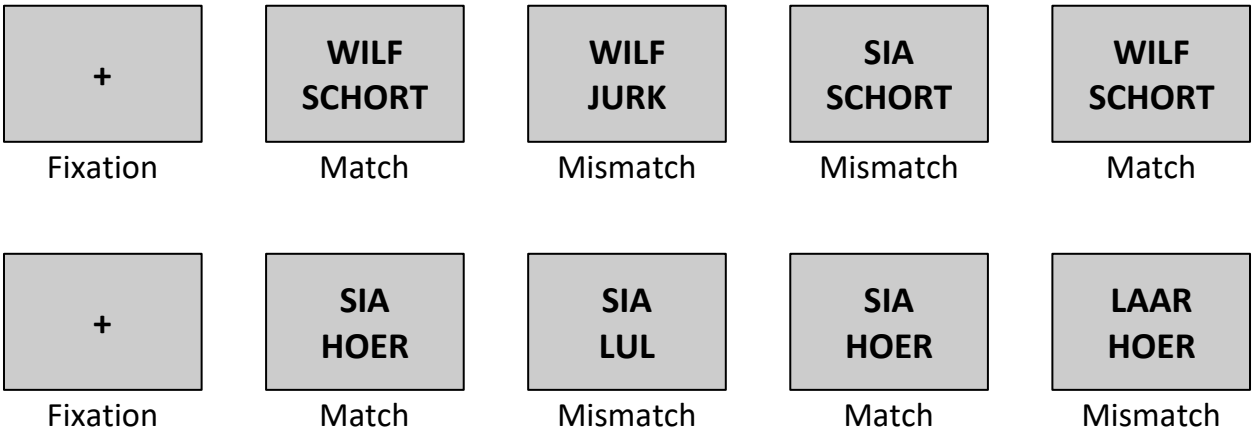
Participants were informed that it was initially impossible to know which words matched and which words did not, but that they could learn this as the learning phase progressed as a more frequent co-occurrence of word pairs indicated that those words were a match. Each nonword was presented 24 times with its to-be-associated existing neutral or sexual–taboo word (match), only once with each of the remaining nine existing neutral or sexual–taboo words (mismatch), and only once with 15 different nonword fillers. The word pairs were presented in random order. Participants received no trial feedback, but a feedback message appeared with "*Te langzaam!*" (= "too slow!") for 600 ms only if the participant took too long to respond (> 1800 ms). After a

response was made, or after the time-out feedback, the next trial started after an inter-trial interval of 250 ms.

The learning phase consisted of 960 trials. The neutral word and sexual–taboo word blocks consisted of 480 trials each, with a break in between the two blocks that lasted until the participant resumed the experiment. At the end of the learning phase, participants were asked about their gender and age.

Figure 1

Illustration of the Novel-Word Learning Task



Note: The figure shows an example of a nonword-word match in the neutral word block (upper row) and a nonword-word match in the sexual–taboo word block (lower row).

Test phase

The test phase used in this experiment was adapted from the RSVP paradigm described by Arnell et al. (2007) and was conducted one day after the learning phase. The participants were instructed to identify the target colour word in each trial and to ignore all other words in the RSVP stream. Participants first completed five practice trials before starting the experimental trials. The test phase was also separated into two blocks; in one block, the critical distractors were existing neutral or sexual–taboo words, and in the other block, the critical distractors were novel neutral or novel sexual–taboo words. The novel word block was always presented first, followed by the existing word block.

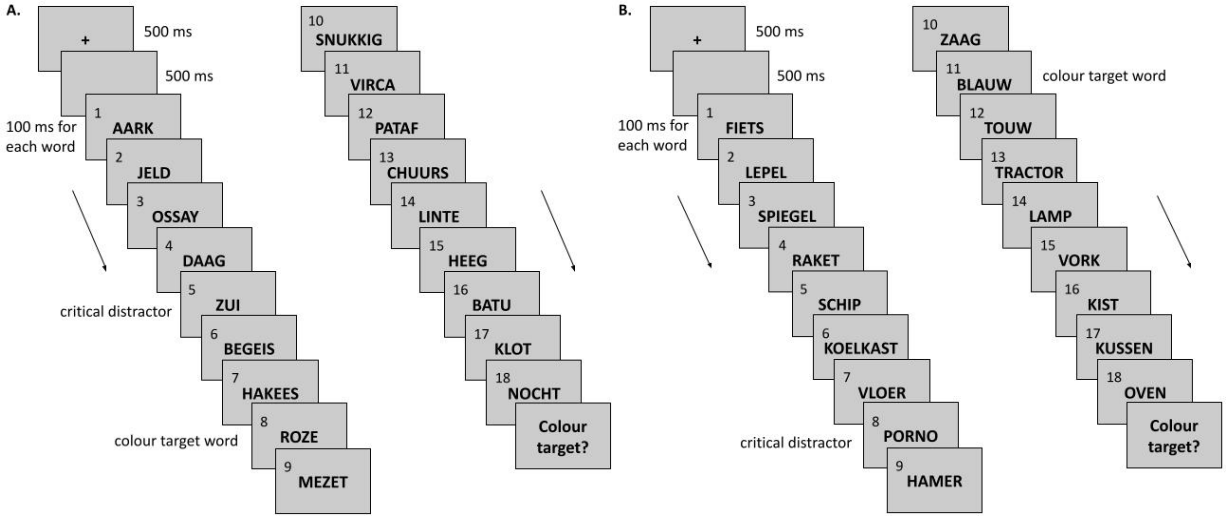
Figure 2 shows an illustrative example of a stream in the RSVP task. At the beginning of each trial, a fixation point was presented for 500 ms. This was then followed by a 500 ms interval

before the start of the RSVP stream in which each stimulus was presented for 100 ms. After each stream, participants had to press the number key that matched the target colour word that they believed was presented in each trial. Response accuracy was recorded. Immediately after the participants made their response via button press, the fixation cross appeared on the screen to indicate the start of the next trial.

The test phase consisted of 240 trials. The blocks consisted of 120 trials each, with a break in between the two blocks that lasted until the participant resumed the experiment.

Figure 2

Illustration of the RSVP Task



Note: Numbers in the grey boxes indicate the position in the RSVP stream. (A) This is an example of an RSVP stream in the novel word block with the critical distractor in position 5 and the target colour word in position 8. (B) This is an example of an RSVP stream in the existing word block with the critical distractor in position 8 and the target colour word in position 11.

Results

Learning phase

By the end of block 4, participants reached an overall learning performance of 82.2% in the neutral word block and 83.3% in the sexual–taboo word block, indicated by the number of hit rates and correct rejections. Percentages of blank responses, implicating that participants

responded too late, were as follows: 2.06% in block 1, 0.86% in block 2, 0.69% in block 3, and 0.76% in block 4 in the sexual–taboo word block (M = 1.09%), and 2.04% in block 1, 0.83% in block 2, 0.63% in block 3, and 0.83% in block 4 in the neutral word block (M = 1.08%). To assess learning performance, the proportions of hit rates and false alarms were calculated over the course of the four blocks. Hit rate proportions were calculated by dividing the number of correct trials by the number of matched trials (60) in a block. False alarm proportions were calculated by dividing the number of false alarms by the number of mismatched trials (60) in a block. This was done separately for the neutral word block and the sexual–taboo word block. This resulted in a 2 (hit rate vs. false alarms) x 4 (blocks 1-4) repeated measures analysis of variance (ANOVA), where both factors were within-subjects factors. A violation of assumption of sphericity was corrected using Greenhouse-Geisser estimates of sphericity. Table 1 shows the average learning performance based on hit rates and false alarms in each block for the neutral word and sexual–taboo word blocks.

The analysis in the neutral word block showed a significant main effect of response type, $F(1, 35) = 243.13$, $p < .001$, $\eta^2 = .87$, indicating that participants had more hit rates than false alarms. There was also a significant main effect of block, $F(2.01, 70.31) = 19.22$, $p < .001$, $\eta^2 = .36$, indicating that participants' accuracy increased slightly across the different blocks. A significant response type x block interaction was found, $F(2.00, 70.10) = 47.62$, $p < .001$, $\eta^2 = .58$. The difference between hit rates and false alarms increased across the different blocks as participants gradually got better at successfully matching nonwords with their to-be-matched existing neutral words and as participants gradually got better at successfully identifying mismatches.

The analysis in the sexual–taboo word block showed a significant main effect of response type, $F(1, 35) = 241.06$, $p < .001$, $\eta^2 = .87$, indicating that participants had more hit rates than false alarms. There was also a significant main effect of block, $F(2.30, 80.38) = 23.82$, $p < .001$, $\eta^2 = .41$, indicating that participants' accuracy increased slightly across the different blocks. A significant response type x block interaction was found, $F(2.00, 68.82) = 60.02$, $p < .001$, $\eta^2 = .63$. The difference between hit rates and false alarms increased across the different blocks as participants gradually got better at successfully matching nonwords with their to-be-matched existing sexual–taboo words and as participants gradually got better at successfully identifying mismatches.

Table 1

Mean Hit Rates and False Alarms in the Novel-Word Learning Task

	Hit rate				False alarm			
	Block 1	Block 2	Block 3	Block 4	Block 1	Block 2	Block 3	Block 4
Neutral word block	.59 (.03)	.81 (.03)	.85 (.02)	.87 (.02)	.24 (.03)	.22 (.04)	.23 (.04)	.20 (.04)
Sexual–taboo word block	.60 (.03)	.80 (.03)	.85 (.02)	.86 (.03)	.21 (.02)	.18 (.03)	.18 (.03)	.20 (.04)

Note: The numbers indicate the proportion of hit rates and false alarms. The standard errors of the mean are provided in parentheses.

Test phase

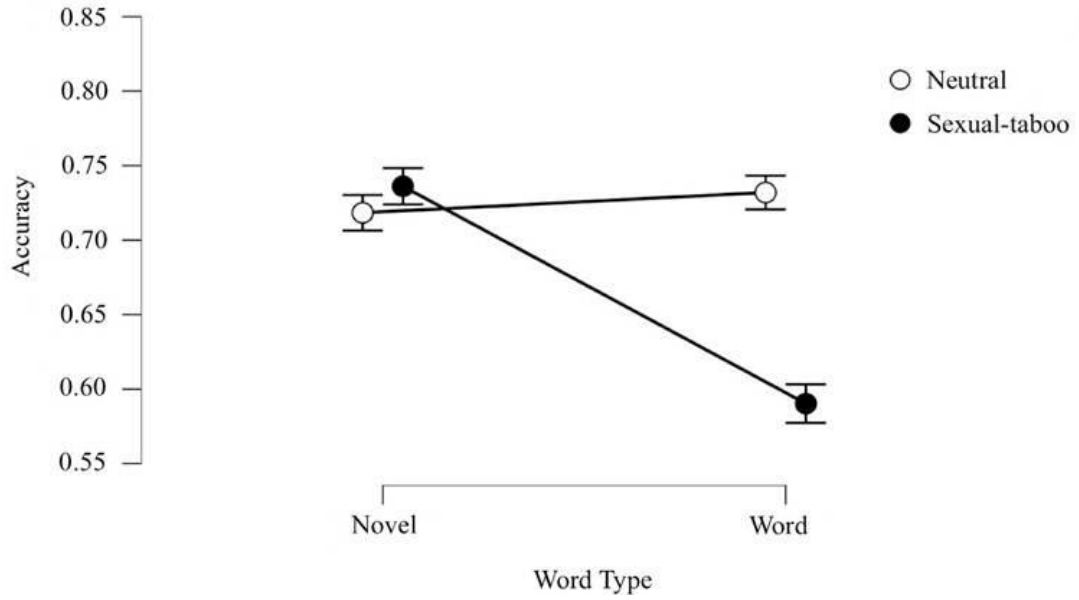
A repeated measures analysis of variance (ANOVA) was performed on target accuracy with the within-subjects factors of word type of the critical distractor and arousal as repeated measures, resulting in a 2 (word vs. novel) x 2 (neutral vs. sexual–taboo) factorial design. A violation of assumption of sphericity was corrected using Greenhouse-Geisser estimates of sphericity. Figure 3 shows the mean target accuracy in the RSVP task.

The analysis showed a significant main effect of word type, $F(1, 35) = 20.81$, $p < .001$, $\eta^2 = .37$, and arousal, $F(1, 35) = 28.65$, $p < .001$, $\eta^2 = .45$. There was also a significant word type x arousal interaction, $F(1, 35) = 66.29$, $p < .001$, $\eta^2 = .65$. Participants had a lower target accuracy when the targets were preceded by sexual–taboo critical distractors compared to neutral critical distractors, but this difference was smaller in the novel word condition compared to the existing word condition.

Follow-up *t*-tests showed that target accuracy in the existing sexual–taboo condition ($M = .59$, $SD = .12$) was significantly lower than in the existing neutral condition ($M = .73$, $SD = .13$), $t(35) = 9.27$, $p < .001$, $d = 1.54$. However, there was no difference in target accuracy when the critical distractor was a novel sexual–taboo word ($M = .74$, $SD = .10$) compared to when it was a novel neutral word ($M = .72$, $SD = .12$), $t(35) = -1.18$, $p = .245$, $d = -0.20$.

Figure 3

Mean Target Accuracy in the RSVP Task



Note: Error bars represent the within-participant standard errors of the mean.

Discussion

The goal of the present study was to investigate whether there is a carry-over effect of arousal and meaning when nonwords were paired with sexual–taboo words. The present study was largely based on the studies conducted by Geukes et al. (2015) and Arnell et al. (2007). This study contributes to the literature on associative learning and emotional attentional capture by testing if participants gradually perform better through associative learning in a novel-word learning task. Moreover, the effect of sexual–taboo words high in arousal on task performance in an RSVP task is investigated. Lastly, it is investigated whether arousal and meaning are transferred to novel words and can elicit an emotional-induced blindness effect similar to that of existing sexual–taboo words. The present study found that participants were able to gradually perform better and associate the nonwords with their to-be-associated sexual–taboo or neutral words. Furthermore, this study demonstrated that the existing sexual–taboo words had a detrimental effect on the identification of target words in the RSVP task. This emotional-induced blindness effect, however, was not found for the novel sexual–taboo words.

First, this study investigated whether participants were able to match the correct nonword-word pairs and if they would gradually perform better. In line with Geukes et al. (2015), it was

found that participants gradually got better at identifying which word pairs were a match or not, which they could derive from the co-occurrence frequencies of the word pairs. The gap between hit rates and false alarms increased from block 1 to block 4, suggesting an improved discrimination accuracy over time as participants became more proficient in the novel-word learning task. These findings suggest that the participants were able to successfully associate the nonword with their matching existing sexual–taboo or neutral word and provide additional evidence for the associative learning literature (Dittinger et al., 2016; Geukes et al., 2015). The use of nonwords ensured a high level of experimental control. Because nonwords lack pre-existing semantic or emotional associations, any learning or emotional response can be more confidently attributed to the experimental manipulation, reducing potential confounds.

Second, the present study tested whether existing sexual–taboo words involuntarily capture attention at the expense of neutral target words. Consistent with previous findings (Arnell et al., 2007; Most et al., 2007), the present study found that existing sexual–taboo words had a detrimental effect on the identification of the T2 colour target words, suggesting the presence of an emotional-induced blindness effect. The existing sexual–taboo words involuntarily and automatically captured attention at the expense of the identification of the colour target word. This can be explained by the two-stage models of the attentional blink. It has been argued previously that the emotional-induced blindness effect is due to stage 2 processing of emotional stimuli, where they are detected and further processed and consolidated for conscious reporting (Bocanegra & Zeelenberg, 2009; Chun & Potter, 1995). The present study's results provide further evidence that emotional stimuli are consciously detected and processed, since sexual–taboo critical distractors had a detrimental effect on the identification of the neutral target stimuli that were presented in the RSVP task. Stage 2 processing enhances the processing of emotional stimuli and thus attract more attentional resources relative to neutral stimuli. The two-stage models of the attentional blink posit that this is the reason why emotional stimuli have a detrimental effect on the identification of neutral stimuli that are presented in an RSVP task after an emotional distractor has been presented.

It is important to note that this study did not examine if words were encoded into the awareness of the participants, like Arnell et al. (2007) did. They found that if words were not encoded in one's awareness, then these words should not impair the identification of the target stimulus resulting in a worse target accuracy, even though the words were high in arousal. They gave their participants a surprise checklist of the critical distractors after the RSVP task and the

participants indicated whether they remembered seeing those words in the RSVP stream. Arnell et al. found that the number of checks a word received was negatively related to target accuracy, and that the number of checks was predicted by arousal rating with words higher in arousal receiving more checks. However, if highly-arousing words were not checked off, indicating that the word was not encoded into awareness, target accuracy was not compromised. So, follow-up research should assess whether novel critical distractors were encoded into awareness, as it is relevant for gaining a more nuanced understanding into where an impairment in identification of the neutral target stimulus comes from.

Third, and most importantly, this research investigated whether novel sexual–taboo words inherited the arousal and meaning of the sexual–taboo words they were previously paired with. Against my expectations, the novel sexual–taboo words did not involuntarily and automatically capture attention at the expense of the neutral target word. Thus, the novel sexual–taboo words did not elicit an emotional-induced blindness effect. These results suggest that there was no carry-over effect of arousal and meaning from the existing sexual–taboo words to the nonwords. This is inconsistent with the findings of Geukes et al. (2015), where novel German colour words elicited a Stroop effect. Their findings suggest that the novel words automatically activated the meaning of the words they were previously paired with. A possible explanation why the present study has not found this carry-over effect of arousal and meaning is the implementation of a different research method. Geukes et al. used a Stroop task to assess whether the novel words activate the meaning of the words they were previously paired with, whereas this study used an RSVP task. While an RSVP paradigm is able to investigate automatic activation of meaning and has the benefit of also measuring attentional capture, the Stroop task may be considered a better paradigm to use when investigating the carry-over effect of meaning in novel words due to its methodological advantage in investigating the automaticity in word-concept links (Geukes et al., 2015; Hudson et al., 2023). The present study investigated whether the carry-over effect of meaning and arousal occurred using the RSVP task because of its quality to measure the emotional-induced blindness effect. However, follow-up research could consider using the emotional Stroop task after pairing nonwords with sexual–taboo words to specifically test whether a carry-over effect of arousal and meaning occurs for the novel sexual–taboo words.

Another possible explanation for this finding is that emotions are experienced more strongly in a first language (L1) compared to a second language (L2). A study conducted by

Colbeck and Bowers (2012) found that native English speakers showed a stronger emotional-induced blindness effect following L1 taboo critical distractors, while native Chinese speakers showed a smaller emotional-induced blindness effect following the same taboo critical distractors in English. Research has also shown that native German speakers who were proficient L2 English speakers showed an equal comprehension of happy, fearful, and emotionally neutral Harry Potter passages in L1 and L2; but that the L1 texts elicited a stronger activation of the bilateral amygdala, which is a part of the emotional neural network (Hsu et al., 2015). Their study also showed that there was a better distinction in amygdala activation between the emotional and the neutral passages in L1 compared to L2, suggesting that an emotional experience is stronger and more distinctive when reading emotionally salient passages in L1 compared to L2. Another study conducted by Degner et al. (2012) found a significant affective priming effect in L1, whereas these effects were only found with high levels of language immersion and frequency of language use in L2. This suggests that the intensity of language use of L2 impacts how automatically emotional words are processed. These studies show the importance of the difference in processing of words and the difference of emotional intensity in L1 and L2. In the present study, the novel sexual–taboo and novel neutral words could be seen as a second language. Participants had not used the novel words to an extensive level and were only introduced to them 24 hours prior to the test phase, making this a possible explanation as to why the novel sexual–taboo words did not elicit an emotional-induced blindness effect in the RSVP task. Follow-up research could consider making the learning phase more comprehensive, for example through longer exposure, repetition or deeper engagement, to increase the learning intensity and allow for strong associative bonds or emotional resonance to be formed.

Language and meaning processing in a native language and a non-native language can thus differ, especially in the earlier stages of L2 acquisition, and is not limited to emotionally salient words. While L1 learners acquire vocabulary and world knowledge simultaneously, the correlation between lexicon and reality for L2 learners depends on their age or degree of exposure. L2 learners may adopt one of two strategies: directly associating new words with their referents, mirroring L1 acquisition, or establishing translation equivalents between L1 and L2. (Jisa & Chenu, 2009). L2 learners may equate a word in their non-native language with its native language translation, indicating a lack of distinct conceptual structure in the early stages of L2 lexicon development and a reliance on L1 to access meaning (Macwhinney, 2005). The study by Citron et al. (2020)

compared the processing of metaphorical expressions in L1 and L2 and showed that native speakers have an increased amygdala activation while L2 speakers had greater activation in the superior temporal gyri, which are associated with increased semantic processing. L1 speakers engaged the default mode network, while L2 speakers activated the switching network. The default mode network is typically active during rest and is associated with mind-wandering, exhibiting activation patterns reflecting easier processing compared to L2 speakers. Citron et al. argued that due to lower cognitive demands, L1 speakers are able to engage in deeper semantic processing. The switching network is typically engaged during tasks involving language alteration. This network may remain active even during silent reading, particularly in L2. This demonstrates L1 interference during L2 figurative language comprehension. These findings indicate that non-native speakers may perceive a greater similarity between conventional metaphors and their literal paraphrases compared to native speakers. These studies show that the processing of L2 is slower and relies more on L1 to access meaning. Furthermore, these studies show that L1 processing requires less cognitive effort, allowing for a more automated processing of meaning, which could be a possible explanation as to why existing sexual–taboo words elicited an emotional-induced blindness effect, whereas novel sexual–taboo words did not.

Conclusion

The present study shows that existing sexual–taboo words capture attention at the expense of neutral target words in an RSVP paradigm, but that novel sexual–taboo words did not. These findings suggest that the novel words did not acquire the arousal and meaning of the neutral or sexual–taboo word they were previously paired with. This study offers a unique approach by combining novel-word learning and RSVP, allowing for the investigation of both learning and attentional processes. While an emotional-induced blindness effect was not found for the novel sexual–taboo words, follow-up research could consider the implementation of paradigms more specifically designed to assess whether novel words inherited word meaning, like the Stroop task. Furthermore, follow-up research could consider making a more extensive learning phase to allow for stronger associative bonds to be formed and more emotional resonance to be developed.

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Appendix A

Learning Phase Stimuli

Table A1

Dutch Stimuli Used in the Learning Phase and Their Translations

Sexual–Taboo		Neutral	
Dutch words	English translation	Dutch words	English translation
Porno	Porn	Riem	Belt
Hoer	Whore	Schort	Apron
Orgie	Orgy	Jurk	Dress
Pijpen	Blowjob	Jas	Coat
Neuken	Fucking	Hoed	Hat
Geil	Horny	Laarzen	Boots
Orgasme	Orgasm	Sweater	Sweater
Lul	Dick	T-shirt	T-shirt
Kut	Pussy	Hemd	Shirt
Incest	Incest	Jeans	Jeans

Table A2

Dutch Stimuli and Their Matched Nonwords

Version 1			
Novel Neutral	Old Neutral	Novel Taboo	Old Taboo
Margen	Riem	Zui	Porno
Wilf	Schort	Sia	Hoer
Hiek	Jurk	Gens	Orgie
Pode	Jas	Knag	Pijpen
Blinst	Hoed	Laar	Neuken
Lasul	Laarzen	Mend	Geil
Fanker	Sweater	Chaps	Orgasme
Dwerk	T-shirt	Reugel	Lul
Ner	Hemd	Aftends	Kut
Ane	Jeans	Conkuus	Incest
Version 2			
Novel Neutral	Old Neutral	Novel Taboo	Old Taboo
Zui	Riem	Margen	Porno
Sia	Schort	Wilf	Hoer
Gens	Jurk	Hiek	Orgie
Knag	Jas	Pode	Pijpen
Laar	Hoed	Blinst	Neuken
Mend	Laarzen	Lasul	Geil
Chaps	Sweater	Fanker	Orgasme
Reugel	T-shirt	Dwerk	Lul
Aftends	Hemd	Ner	Kut
Conkuus	Jeans	Ane	Incest

Note: Stimulus words were presented in a randomised order.

Table A3

Co-occurrence Frequencies of the Sexual–Taboo Word Pairings During the Novel-Word Learning Task

	Zui	Sia	Gens	Knag	Laar	Mend	Chaps	Reugel	Aftends	Conkuus
Porno	24	1	1	1	1	1	1	1	1	1
Hoer	1	24	1	1	1	1	1	1	1	1
Orgie	1	1	24	1	1	1	1	1	1	1
Pijpen	1	1	1	24	1	1	1	1	1	1
Neuken	1	1	1	1	24	1	1	1	1	1
Geil	1	1	1	1	1	24	1	1	1	1
Orgasme	1	1	1	1	1	1	24	1	1	1
Lul	1	1	1	1	1	1	1	24	1	1
Kut	1	1	1	1	1	1	1	1	24	1
Incest	1	1	1	1	1	1	1	1	1	24

Note: Numbers indicate how often each sexual–taboo word and each nonword were presented together during the learning phase. There were also 15 filler nonwords presented once with every existing word. The to-be-matched nonwords with their sexual–taboo words were swapped between participants in two different versions.

Table A4

Mismatch Filler Stimuli Used in the Learning Phase

Voes	Teep	Nuip	Nied	Durel
Ecaal	Fepel	Inder	Kaser	Ciltig
Dorker	Galden	Henger	Kezicht	Klibiek
Mas	Wog	Nip	Zilm	Roon
Teuk	Huim	Esken	Plark	Hurper
Mipaat	Schuik	Toepel	Bliesem	Deenter

Note: Filler words were presented in a randomised order.

Appendix B

Test Phase Stimuli

Table B1

Dutch Filler Stimuli Used in the Test Phase

Word fillers		Nonword fillers	
Glas	Tafel	Aark	Alvaat
Mes	Schip	Batu	Begeis
Fles	Vliegtuig	Daag	Chuurs
Koelkast	Wagen	Ekem	Donkel
Handdoek	Motor	Flet	Erdens
Oven	Tractor	Gant	Fatels
Pan	Helikopter	Heeg	Geupel
Schaar	Fiets	Iwem	Hakees
Vork	Vrachtwagen	Jeld	Inkouf
Lepel	Raket	Klot	Jommer
Stoel	Metro	Kamot	Pavapel
Kussen	Sleutel	Linte	Rapstok
Vloer	Touw	Mezet	Snukkig
Kast	Schop	Nocht	Talukel
Kist	Ploeg	Ossay	Ustraaf
Spiegel	Hamer	Pataf	Vialent
Kleed	Tang	Reget	Wartner
Schilderij	Spijker	Schet	Yothurt
Lamp	Zaag	Tagel	Zaarten
Stofzuiger	Grasmaaier	Virca	Zakdoep

Note: Stimulus words were presented in a randomised order in both the existing word block and novel word block.