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Associating LIPS and SWOLLEN: delayed attentional disengagement following words in sex contexts

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\textbf{ABSTRACT}

With a series of three studies, using an adapted dot-probe paradigm, we investigated the elicitation of spontaneous affective meaning. Although it is well established that humans show delays in disengaging their attention from conventional affective stimuli, it is unknown whether contextually acquired affective meaning similarly impacts attention. We examined attentional disengagement following pairs of neutral or slightly ambiguous words that in combination could evoke sex, violence or neutral associations. Study 1 demonstrated slower disengagement following words that conveyed sex or violence associations compared to words that conveyed neutral associations. This pattern was only present for participants who were aware of sex or violence associations. Study 2 replicated these results in a large sample, but only for sex associations. Study 3 replicated the effect while instructing participants explicitly to expect sex and violence associations. Finally, two control studies countered reasonable alternative explanations for our findings. Together, these studies show that contextually driven affective associations can arise quickly with the potential to influence attentional processes. These findings are consistent with theoretical models of emotion and language that highlight the importance of context in the generation of affective meaning.

The construction of affective and emotional meaning is often a context-dependent process. Although some stimuli may be inherently affective (e.g. mutilation pictures), other stimuli only become arousing, positive, negative or emotional because the context in which the stimulus is processed triggers certain associations (Barrett, 2006, 2012). For instance, clowns, mirrors and little girls are usually not frightening, but may become so in the context of a horror movie. Words or objects that are neutral in one context can be highly amusing or provoking in another context; a phenomenon used abundantly in humour (Martin, 2007). Nevertheless, research aimed at identifying how affective stimuli influence basic psychological processes rarely use neutral or ambiguous stimuli that derive their affective meaning from contextual manipulations. Instead, affective scientists focus mainly on stimuli that readily convey affective or emotional meaning (e.g. facial expressions, disturbing images, taboo words). In the present studies, we aimed to create affective meaning by presenting neutral or ambiguous words that, only when combined in pairs, could evoke sex or violence associations. Our goal was to show that stimuli that acquired affective meaning “on the spot” influenced the fast and basic process of attention allocation.

Several scientists have incorporated context into theoretical models that aim to understand the generation of meaning generally (Barsalou, 2009; Hagoort, 2005), and the generation of affective and emotional meaning specifically (e.g. Barrett, 2012; Roy, Shohamy, & Wager, 2012). According to Barrett
(2012, 2006), for instance, emotional meaning emerges from a constructive process that is highly situated. In this view instances of emotion vary dynamically with the situational context that is present during processing and with the internal context of the individual that is constructing the emotion. Several experimental studies support this view by demonstrating the importance of context in emotion perception (see for a review Barrett, Mesquita, & Gendron, 2011). For example, research has shown that identical facial expressions can be interpreted as different emotions depending on body postures or objects displayed in the immediate surroundings (Aviezer et al., 2008; Aviezer, Trope, & Todorov, 2012). Furthermore, several experiments have shown that emotion words can shape the perception of emotion in faces (e.g. Gendron, Lindquist, Barsalou, & Barrett, 2012; see for a review Barrett, Lindquist, & Gendron, 2007). Nevertheless, although the literature supports the important role of context in the perception of facial expressions, research rarely investigated the role of context in tasks involving stimuli other than facial expressions (but see Wilson-Mendenhall, Barrett, Simmons, & Barsalou, 2011). Furthermore, most previous studies on context focused on altering the meaning of facial expressions through contextual manipulations. The present project focused on the spontaneous elicitation of affective meaning by the mere association between two neutral (or slightly ambiguous) words.

We decided to study the elicitation of spontaneous affective meaning with an implicit measure, because asking people to explicitly report on the occurrence of affective associations could have introduced demand effects and would have precluded the conclusion that the associations were spontaneous. We chose an implicit measure borrowed from the field of emotion and attention, because it is well-established that affective and emotional stimuli impact the basic psychological process of attention allocation. For example, it has been shown that stimuli that represent threat (e.g. angry faces, symbols paired with shock) and stimuli that are unambiguously arousing (e.g. taboo words) both draw and hold people’s attention (e.g. Fox, Russo, Bowles, & Dutton, 2001; Fox, Russo, & Dutton, 2002; Gal, Luria, Fukuda, & Gross, 2013; Georgiou et al., 2005; Koster, Crombez, Verschueren, & De Houwer, 2004; Koster, De Raedt, Goel even, Franck, & Crombez, 2005; Lipp & Derakshan, 2005; Yiend & Mathews, 2001; see for a meta-analysis Bar-Haim, Lamy, Bakermans-Kranenburg, Pergamin, & van Ijzendoorn, 2007). Based on this literature, we reasoned that if an attentional paradigm is informative to study the impact of classic affective stimuli (e.g. angry faces, mutilation images, taboo words) then an attentional paradigm may also be informative to indicate whether a contextual manipulation generated spontaneous affective meaning.

In short, the primary aim of the present paper is to contribute to the science of emotion and affect by demonstrating, as a “proof of principle”, that contextual manipulations can evoke spontaneous affective meaning. In addition, since the attention literature has predominantly focused on the impact of stimuli that readily convey affective meaning, the second aim of the present paper is to provide with a novel contribution to the field of emotion and attention by showing that contextually derived affective meaning influences attention allocation.

The present paradigm

We adapted the classic dot-probe task (MacLeod, Mathews, & Tata, 1986) to examine whether stimuli that derive affective meaning from contextual manipulations influence attention allocation. In our studies we focused exclusively on attentional disengagement, or the phenomenon that stimuli “capture” attention and delay attention allocation to other locations, for two reasons. First, the strength of our stimuli lies in semantic associations and not in specific perceptual features. Therefore we assume that the effect of our stimuli will manifest primarily in “holding” attention (disengagement) and not in “drawing” attention (engagement; cf. Fox et al., 2001). Second, we aim to test our hypothesis in a non-clinical sample and previous findings suggest that the impact of affective stimuli on attention in healthy populations is most pronounced in attentional disengagement (Fox et al., 2001; Koster et al., 2004).

We examined changes in attentional disengagement for neutral words that were not affectively provoking in isolation, but only became affectively provoking in the context of a preceding neutral word. Because previous findings suggest that arousal may be the driving factor in attentional disengagement effects (Vogt, De Houwer, Koster, Van Damme, & Crombez, 2008) and because we aimed to test our hypothesis for positive and negative meaning, we chose violence as an instance of high-arousal negative meaning and sex as an instance of high-arousal positive meaning. Crucially, we compared attentional
disengagement between four conditions. In the violence comparison, we compared a condition that evoked violence associations by priming neutral “focus” words with neutral context words, with a condition that evoked affectively neutral associations by priming the same neutral focus words with different neutral context words. In the sex comparison, we compared a condition that evoked sex associations by priming neutral “focus” words with neutral context words, with a condition that evoked affectively neutral associations by priming the same neutral focus words with different neutral context words. For example, combining the word SWOLLEN with the word LIPS generates a different association than combining the word SWOLLEN with the word RIVER. Assuming that the former association is more affectively provoking than the latter, we predicted that people will linger in attention on the word SWOLLEN when it is preceded by LIPS as compared to RIVER. In short, we hypothesised delayed disengagement following word pairs that evoked sex or violence associations compared to word pairs that evoked neutral associations.

**Study 1**

**Participants**

In total, 68 students (50 females; Mean age = 22.3) from the University of Amsterdam participated for course credit or financial compensation. All participants gave informed consent.

**Design**

The study, and all other studies reported in this paper, had a 2x2 design. The factor context (affective vs. neutral) and the factor category (sex vs. violence) were varied within subjects.

**Stimulus materials**

We created 64 word pairs geared towards evoking sex associations, violence associations or neutral associations. All word pairs consisted of a context word and a focus word. Sixteen sex word pairs were matched with 16 neutral word pairs containing the same focus words and different context words. In the same way, 16 violence word pairs were matched with 16 neutral word pairs. For example, the sex word pair LIPS (context word) – SWOLLEN (focus word) was matched with the neutral word pair RIVER (context word) – SWOLLEN (focus word). The violence word pair FLESH (context word) – SAW (focus word) was matched with the neutral word pair WOOD (context word) – SAW (focus word). We deliberately chose Dutch words that were either neutral (“NOSE”; neus; SUITCASE; koffer, or RHYTM; ritme) or ambiguous (AXE; bijl, TEETH; tanden, LICK; likken). The complete list of word pairs can be found in Table 1.

**Frequency and word length**

Words were fully matched on corpus frequency ([http://celex.mpi.nl](http://celex.mpi.nl), Max Planck Institute for Psycholinguistics) and word length (means and standard deviations are presented in Table 1). Sex context words did not differ from matched neutral context words in frequency, \( F(1, 30) = .06, p = .81 \) and word length, \( F(1, 30) = .46, p = .50 \). Violence context words did not differ from matched neutral context words in frequency, \( F(1, 30) = .00, p = .94 \) and word length, \( F(1, 30) = .39, p = .53 \). Focus words from different categories (i.e. sex/neutral and violence/neutral) did not differ in frequency, \( F(1, 30) = .91, p = .35, \) and word length, \( F(1, 30) = .00, p = 1.00 \).

**Valence and arousal**

Since we aimed to show that attentional disengagement is affected by self-generated and contextually acquired affective meaning, it was important to assure that experimental context words and neutral context words were matched in terms of valence and arousal. In order to test this we asked an independent sample of undergraduate students (n = 22) to rate the words in a computerised task. Participants rated how stimulating/arousing the words were on a scale from 0 (little stimulating) to 100 (very stimulating) and the extent to which the words were positive or negative on a scale from −50 (negative) to 50 (positive).

Analysis of the mean ratings (means and standard deviations are presented in Table 2) showed that sex context words did not differ from matched neutral context words in terms of arousal, \( t(21) = .58, p = .57 \), and valence, \( t(21) = 1.23, p = .23 \). Furthermore, violence context words did not differ from matched neutral context words in terms of arousal, \( t(21) = 1.44, p = .17, \) and valence, \( t(21) = .98, p = .34 \). As a result, changes in attentional disengagement between experimental word pairs and neutral word pairs cannot be explained by differences in established affective meaning. Focus words for sex/neutral associations did have higher arousal ratings, \( t(21) =
4.41, \( p < .001 \), and more positive valence ratings, \( t(21) = 6.76, p < .001 \), than focus words for violence/neutral associations \( (M = 34.2, SD = 15.5; M = 0.6, SD = 8.8 \text{ vs. } M = 23.81, SD = 13.6; M = −13.7, SD = 9.9) \). Nevertheless, differences in valence and arousal between focus words do not pose a problem for our main analysis, since focus words are held constant across experimental and neutral word pairs.

It is important to note that, at the request of an anonymous reviewer, we re-analysed the words using the valence and arousal ratings from a large database of Dutch words (Moors et al., 2013). These additional analyses forwarded very similar results as our own rating procedure, and verified that our words were properly matched in terms of valence and arousal.

### Table 1. Original Dutch words and English translations for each word pair evoking sex, violence and neutral associations.

<table>
<thead>
<tr>
<th>Experimental context word</th>
<th>Focus word</th>
<th>Neutral context word</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sex word pairs and matching neutral word pairs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NAVEL</td>
<td>Belly button</td>
<td>LIKKEN</td>
</tr>
<tr>
<td>GULP</td>
<td>Fly</td>
<td>HARD</td>
</tr>
<tr>
<td>KLOPPELN</td>
<td>Throbbing</td>
<td>EIKEL</td>
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<tr>
<td>BORST</td>
<td>Breast</td>
<td>VOELEN</td>
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<td>TONG</td>
<td>Tongue</td>
<td>KUSSEN</td>
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<td>Finger</td>
<td>NAT</td>
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<td>Sigh</td>
<td>ZWETEN</td>
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<td>RITME</td>
<td>Rhythm</td>
<td>STOTEN</td>
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<tr>
<td>VOCHT</td>
<td>Moist</td>
<td>KLIT</td>
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<tr>
<td>LIPPEN</td>
<td>Lips</td>
<td>GEZWOLLEN</td>
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<tr>
<td>ZUIGEN</td>
<td>Suck</td>
<td>STUF</td>
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<tr>
<td>ONDERBUIK</td>
<td>Belly</td>
<td>GOLVEN</td>
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<tr>
<td>LIJF</td>
<td>Body</td>
<td>STRAK</td>
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<tr>
<td>OPRICHTELEN</td>
<td>Erect</td>
<td>GESLACHT</td>
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<tr>
<td>GESCHOREN</td>
<td>Shaven</td>
<td>SPELEET</td>
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<tr>
<td>OPENING</td>
<td>Opening</td>
<td>SAPPEN</td>
</tr>
</tbody>
</table>

**Violence word pairs and matching neutral word pairs**

| KNAPPEN | Snap | ADER | Vein | STROMEN | Flow |
| BEDEKKEN | Cover | PUIN | Rubble | STEEN | Stone |
| OOG | Eye | BEITEL | Chisel | HAND | Hand |
| SLAPEN | Sleep | GAS | Gas | KOKEN | Cook |
| VLEGTUIG | Airplane | STORTEN | Crash/deposit | REKENING | Account |
| HOOFD | Head | BUL | Axe | STEEL | Handle |
| KEEL | Throat | DICHTKNUPEN | Squeeze | TUBE | Tube |
| KOFFER | Suitcase | ROMP | Torso | KLEDING | Clothes |
| MASKER | Mask | SLUIPEN | Sneak | DIER | Animal |
| PROP | Gag/ball | MOND | Mouth | PROEVEN | Taste |
| NEUS | Nose | BREKEN | Break | GLAS | Glass |
| NAGEL | Nail | NUPTANG | Pincer | WERKBANK | Workbench |
| SPRINGEN | Jump | TREIN | Train | WACHTEN | Wait |
| TANDEN | Teeth | SCHEUREN | Tear | PAPIER | Paper |
| VUURWERK | Firework | STOMP | Stump | BOT | Blunt |
| VLEES | Flesh | ZAAG | Saw | HOUT | Wood |

Note: All word pairs consist of a context word and a focus word. Sixteen sex word pairs were matched with 16 neutral word pairs containing the same focus word and different context words. In the same way, 16 violence word pairs were matched with 16 neutral word pairs containing the same focus word and different context words. In some cases, the ambiguity of Dutch words does not translate into ambiguity in English. For example, the word “klit” can refer both to a clitoris and a hair-tangle. In other cases the English translation may be less neutral than the original word, for instance, in the case of “oprichten” translated as “erect”.

### Table 2. Mean arousal rating, valence rating, frequency and word length for violence, sex and neutral context words (standard deviation in parentheses).

| | Violence word pairs | | | Sex word pairs | | |
| | | | | | | |
| **Arousal** | | 28.4 (13.1) | | 26.1 (12.7) | | 31.6 (15.5) | | 30.5 (15.1) |
| **Valence** | | 0.8 (8.1) | | 2.4 (6.6) | | 9.8 (6.1) | | 11.6 (7.9) |
| **Frequency** | | 5709 (9580) | | 5985 (10,737) | | 2127 (2002) | | 2367 (3434) |
| **Length** | | 5.9 (1.7) | | 5.5 (1.6) | | 6.1 (1.7) | | 5.7 (1.9) |
Task and procedure

Participants judged the presence of a letter-probe (X or Y) in an adapted dot-probe task (see Fox et al., 2002; Georgiou et al., 2005, for a similar experimental design) programmed in Presentation (Neurobehavioral Systems). Each trial presented two words in succession in the middle of the computer screen. The two words were followed by a letter-probe presented in the upper-left, upper-right, lower-left or lower-right corner. Each letter-location combination occurred equally often. Participants were instructed to indicate whether the letter-probe was an X or a Y using the “A” or the “L” key on the keyboard. Response labels were counterbalanced across participants. To assure that participants were attending to the words, we added catch trials in which the two words presented in succession were the same. Participants were instructed to refrain from responding to the letter-probe if the second word was the same as the first word.

Participants completed 12 practice trials with response feedback. The experiment consisted of 73 trials, randomly presenting 64 experimental trials mixed with 9 catch trials. Experimental trials presented different context and focus words (see Figure 1); catch trials presented the same context and focus word (e.g. LUNGS-LUNGS). The nine catch trial words were (original Dutch word, English translation in parentheses): SCHUDDEN (shake), HAVEN (harbour), LONGEN (lungs), HANGEN (hang), LICHAAM (body), KOMEN (come), HUID (skin), BEZOEK (visit) and AUTO (car). The presentation of the different types of experimental trials and catch trials was fully randomised.

To preclude the possibility that participant would engage in elaborate processing of the word pairs, we chose a short presentation duration for the words in line with previous research targeting emotion word processing (e.g. Citron, 2012; Herbert, Junghofer, & Kissler, 2008). Every trial started with a fixation stimulus (500 ms) followed by a context word (250 ms), followed by an inter-stimulus-interval (70 ms), followed by a focus word (300 ms), followed by a letter-probe. The letter-probe was presented for a maximum duration of 1000 ms and was removed from the screen when the participant responded. Participants could not respond until 200 ms after presentation of the letter probe. Response times were measured relative to the onset of the letter probe. Trials were separated by a 2500 ms inter-trial-interval.

After the main task participants received a detailed exit questionnaire with six open questions asking whether they noticed anything about (1) the task categorising X or Y; (2) the words that were combined; (3) the first words that were shown; (4) the second words that were shown and (5) the combinations of words. The sixth question specifically mentioned that the word pairs had a theme in common, and asked participants to identify that theme.

Data analysis

Before data analyses, we excluded reaction times (RTs) for incorrect responses and RTs that differed more than three standard deviations from the overall individual mean. On average participants made 6.8 errors (SD = 4.8) in the experimental trials (11%) and .53 errors (SD = 1.1) in the catch trials (6%). We excluded seven participants (10%) from further analysis with error-rates that deviated two standard deviations or more from the sample mean.

Kolmogorov-Smirnov tests for each RT variable demonstrated a mild deviation from normality for mean RT following sex words in neutral contexts, $D (61) = .113; p = .051$. Although deviations of normality should not constitute a problem when sample size is above 30 (Field, 2013), it is important to note that none of the effects reported in the present paper changed when analyses were performed on square root transformed data. Finally, for simple effects, $d_z$ was calculated using the spreadsheet made available by Lakens (2013).

Results and discussion

A repeated measures ANOVA on the RTs with context (affective, neutral) and category (sex, violence) as
within-subjects factors revealed the predicted main effect of context, $F(1, 60) = 4.24$, $p = .044$, $\eta^2_p = .07$. Mean RT following focus words in sex or violence contexts was slower ($M = 599$, $SE = 8.6$) than mean RT following the same focus words in neutral contexts ($M = 592$, $SE = 8.5$). The absence of a context × category interaction indicated that this effect was equally strong for sex and violence contexts. Furthermore, the analysis demonstrated a main effect of category, $F(1, 60) = 38.19$, $p < .001$, $\eta^2_p = .39$, with slower mean RT following sex focus words ($M = 606$, $SE = 8.7$) as compared to violence focus words ($M = 585$, $SE = 8.4$) irrespective of context. An analysis of the error rates showed no significant effects (all $F$s < 1).

We explored whether delayed disengagement was stronger for participants who reported sex or violence associations. Based on the exit questionnaire we divided participants into two groups: those who explicitly mentioned sex or violence at least once ($n = 40$), and those who did not mention any reference to sex or violence in answer to all six exit questions ($n = 20$). The results showed a significant effect of context for participants who reported sex or violence, $F(1, 39) = 4.56$, $p = .039$, $\eta^2_p = .11$, whereas the effect of context did not reach significance for participants who did not report sex or violence, $F < 1$. Note that participants reported sex associations ($n = 37$) more often than violence associations ($n = 17$); only three participants reported violence without mentioning sex.

The findings from Study 1 support our hypothesis that stimuli with contextually derived affective meaning slow the allocation of attention. As predicted, participants were slower to disengage from words that conveyed sex or violence associations than from words that conveyed neutral associations. This effect was driven by the participants who reported sex or violence associations, which suggests that it is indeed affective meaning that is generated “on the spot” that drives the effect. In Study 2, we aimed to replicate the effect demonstrated by Study 1 in a large sample.

**Study 2**

**Method and participants**

The method of Study 2 was identical to Study 1. Because we judged it important to demonstrate our effect in a sample that did not consist solely of university students, we presented the paradigm to a sample of 608 participants (336 females; Mean age = 22.0) recruited from the general population. This group included participants in the age group of 18–24 years, with an educational distribution representative for that age-group in the Netherlands. This sample was collected as part of a large project on individual differences and brain anatomy, but we will only discuss behavioural findings. All participants gave informed consent.

Before data analyses, we excluded RTs for incorrect responses and RTs that differed more than three standard deviations from the overall individual mean. Participants made 7.4 errors ($SD = 7.2$) in the experimental trials (12%) and .93 errors ($SD = 1.7$) in the catch trials (10%). We excluded 49 (8%) participants with an error-rate more than 2 standard deviations from the sample mean. Kolmogorov-Smirnov tests for each RT variable demonstrated mild deviations from normality for mean RT following focus words in sex, $D(559) = .042; p = .22$, and violence contexts, $D(559) = .043; p = .017$.

**Results and discussion**

Study 2 replicated the main effect of context found in Study 1, $F(1, 558) = 6.39$, $p = .012$, $\eta^2_p = .01$. Mean RT following focus words in sex or violence contexts was slower ($M = 567$, $SE = 2.8$) than mean RT following the same focus words in neutral contexts ($M = 564$, $SE = 2.7$). The main effect was qualified by an interaction between context × category, $F(1, 558) = 9.10$, $p = .003$, $\eta^2_p = .02$. Simple effects demonstrated a significant difference ($p < .001$, $d_z = .16$) between mean RT following focus words in sex contexts as compared to neutral contexts, whereas there was no significant difference ($p = .69$) between mean RT following focus words in violence contexts as compared to neutral contexts (see Table 3 for the means and standard errors). As in Study 1, the analysis further demonstrated a main effect of category, $F(1, 558) = 109.42$, $p < .001$, $\eta^2_p = .16$, with slower mean RT following sex focus words ($M = 571$, $SE = 2.9$) as compared to violence focus words ($M = 559$, $SE = 2.7$). An analysis of the error rates also showed a significant effect of category, $F(1, 558) = 22.00$, $p < .001$, $\eta^2_p = .04$, with more errors for sex focus words ($M = 1.6$, $SE = .05$) than violence focus words ($M = 1.4$, $SE = .05$). The error rates showed no other significant effects (both $F$s < 1.1).

As in Study 1, we analysed delayed disengagement separately for participants who reported sex or violence associations ($n = 345$) and for those who did not ($n = 198$). Participants reported sex associations
(n = 333) more often than violence associations (n = 87); only 12 participants reported violence without mentioning sex. For participants who mentioned sex or violence we found a significant effect of context, F(1, 344) = 5.69, p = .018, η²p = .02, and a significant interaction between context and category, F(1, 344) = 5.29, p = .022, η²p = .02. Simple effects demonstrated that mean RT following focus words in sex contexts (M = 580, SE = 3.8) differed significantly (p = .002, d = .17) from mean RT following focus words in neutral contexts (M = 574, SE = 3.6), whereas there was no significant difference for violence (p = .99). The effect of context did not reach significance for participants who did not mention sex or violence, F(1, 197) = 1.01, p = .32. The interaction between context × category only approached significance, F(1, 197) = 3.05, p = .082.

Study 2 replicated the findings from Study 1 with one important difference. In Study 1, we found a main effect of context that was not qualified by an interaction, whereas in Study 2 we found a significant interaction demonstrating that participants only showed delayed attentional disengagement following sex associations. This suggests that the effect we report is only robust for sex associations, and that violence associations may not be potent enough to impact attentional disengagement reliably. We will address this issue further in the General Discussion.

Study 3

Studies 1 and 2 demonstrated that self-generated and contextually acquired affective associations impact attention. Importantly, attentional disengagement was only affected in participants who reported sex or violence associations, which suggests that people need to actively make an association in order for the experimental word pairs to influence attention. Study 3 is the final test of our main hypothesis. Based on the assumption that association is needed for our effect, we laid out the final study in the strongest way possible and informed all participants explicitly of the possibility of sex and violence associations prior to beginning the task. We predict that this study should reveal a strong effect of sex word pairs because preparing participants for sex associations makes those associations highly salient, with a strong disengagement effect as a result. Moreover, preparing participants for violence associations may reveal an effect of violence word pairs. If so, this could provide some insight into why we have not found a consistent effect of violence associations in the studies presented so far.

Interestingly, this manipulation may simultaneously address the question whether the attentional disengagement effect could be (partly) due to the unexpectedness of the affective associations. Based on earlier findings that have shown attentional disengagement effects for novel and surprising stimuli (Desimone, Miller, Chelazzi, & Lueschow, 1995; see also Brockmole & Boot, 2009; Hildebrand & Smith, 2014), one may argue that participants in our preceding studies lingered on the words in the sex contexts simply because the association was unexpected and therefore distracting. If the disengagement effect is driven by unexpectedness, then the effect should dampen or even disappear when participants are informed in advance of the possibility of sex and violence associations.

Method and participants

In Study 3, the instruction stated explicitly that the word pairs presented in the task could evoke neutral associations or associations of sexual acts and violent/fearful situations. Participants were instructed to ignore these associations and focus on categorising the letter-probe. In all other aspects the method was as described in Study 1.

<table>
<thead>
<tr>
<th></th>
<th>Study 1</th>
<th>Study 2</th>
<th>Study 3</th>
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<tbody>
<tr>
<td></td>
<td>Mean RT</td>
<td>SE</td>
<td>Mean RT</td>
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<tr>
<td>Sex experimental</td>
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<td>Delayed disengagement (ms)</td>
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<tr>
<td>Violence neutral</td>
<td>582</td>
<td>8.7</td>
<td>559</td>
</tr>
<tr>
<td>Delayed disengagement (ms)</td>
<td>7</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 3. Mean RTs (ms) and standard errors (SE) in Studies 1–3 following sex contexts and matched neutral contexts and violence contexts and matched neutral contexts.
In total, 78 students (39 females; Mean age = 21.1) from the University of Amsterdam participated for course credit or financial compensation. For 17 participants demographics were not recorded. All participants gave informed consent. Before data analyses, we excluded RTs for incorrect responses and RTs that differed more than three standard deviations from the overall individual mean. Participants made 8.4 errors (SD = 9.3) in the experimental trials (13%) and 1.11 errors (SD = 2.0) in the catch trials (12%). We excluded six (8%) participants with an error-rate more than 2 standard deviations from the sample mean. Kolmogorov-Smirnov tests for each RT variable demonstrated a mild deviation from normality for RTs in neutral contexts, $D(72) = .108; p = .037$.

Results and discussion

A context × category repeated measures ANOVA replicated the main effect of context, $F(1, 71) = 5.50$, $p = .022$, $\eta^2_p = .07$. RTs following focus words in sex or violence contexts were slower ($M = 588, SE = 8.2$) than RTs following the same focus words in neutral contexts ($M = 581, SE = 7.7$). This main effect was qualified by an context × category interaction, $F(1, 71) = 7.34$, $p = .008$, $\eta^2_p = .09$. Simple effects demonstrated a significant difference between RTs following focus words in sex compared to neutral contexts ($p = .001$, $d_z = .43$), whereas there was no significant difference between RTs following focus words in violence compared to neutral contexts ($p = .92$). The means and standard errors are presented in Table 3. The analysis also showed a main effect of category, $F(1, 71) = 20.41$, $p < .001$, $\eta^2_p = .22$, such that RTs following sex focus words ($M = 593, SE = 8.7$) were slower than RTs following violence focus words ($M = 576, SE = 7.3$). A repeated measures analysis on the error rates showed a significant effect of category, $F(1, 71) = 7.38$, $p < .01$, $\eta^2_p = .09$. Participants made more errors following sex focus words ($M = 2.0, SE = .17$) than following violence focus words ($M = 1.6, SE = .15$). The analysis did not show a significant main effect for context, $F < 1$, nor a significant context × category interaction, $F < 1$.

Study 3 replicates the findings from Studies 1 and 2 by showing that stimuli with contextually derived affective meaning slow attention allocation, but only when the word pairs evoke sex associations. The sole difference with the previous studies was that the instruction in Study 3 announced the possibility of sex and violence associations and asked participants to ignore those. The fact that we replicated the effect for sex associations with this instruction is consistent with our interpretation that the evoked affective associations drive the effect, and not the unexpectedness of these affective associations per se.

Control studies

As a final step in this paper we report a summary of two control studies that we performed to rule out possible alternative interpretations of our findings. For reasons of brevity and readability a complete report of the method and results of these control studies can be found in the Supplementary Materials.

First, in our interpretation the association evoked by pairing context and focus words drives the effect on attentional disengagement (e.g. LIPS–SWOLLEN vs. RIVER–SWOLLEN). An alternative interpretation is that the context words in the experimental and neutral word pairs have different qualities, and that the context words drive the effect (e.g. LIPS vs. RIVER). This interpretation is countered by our procedure to carefully match the experimental and neutral context words on valence and arousal. Nevertheless, we decided to perform an additional control study (Control study 1) in which we tested whether the context words presented in isolation affected attentional disengagement. The results demonstrated that reactions to sex and violence context words presented in isolation were not slower than reactions to neutral context words presented in isolation. This finding counters the alternative interpretation that the context words drive the previously demonstrated effects, and strengthens our argument that the effect is driven by the associations evoked by the word pairs.

Second, another alternative interpretation of the effect on attentional disengagement is that the neutral word pairs (e.g. NERVE–FEEL or WOOD–SAW) were processed more fluently than the experimental word pairs (e.g. BREAST–FEEL or FLESH–SAW). Thus, the differences in response times following experimental word pairs and neutral word pairs may not reflect affective associations, but a processing advantage for neutral word pairs instead. We addressed this alternative explanation in a control study (Control study 2) in which we changed the neutral word pairs in such a way that they were harder to associate (e.g. SPORTS–FEEL or FLOW–SAW). If fluency of semantic associations would drive the effect, than this control study should demonstrate...
slower response times following neutral word pairs as compared to sex or violence word pairs, since neutral word pairs were relatively harder to associate than sex and violence words pairs. The results, however, showed a pattern of means that was highly similar to patterns found in the previous studies. Most importantly, among participants that explicitly reported affective associations mean response time following sex contexts was slower than mean response time following neutral contexts. This comparison approached significance ($p = .06$, one-tailed, $d_z = .24$) and was associated with a comparable effect size as in Studies 1 and 2. Based on this finding, we argue that an interpretation in terms of the relatively delaying impact of sex associations on attention allocation fits the data better than an interpretation in terms of the relatively accelerating impact of neutral associations.

**General discussion**

With an innovative paradigm, the present studies demonstrated that word pairs conveying sex associations delay attention allocation to a letter-probe in a healthy population. Our results support our interpretation that this effect is driven by the affective meaning evoked by the combination of the words, and not by pre-existing affective connotations. After all, both experimental and neutral context words were rated equally on valence and arousal dimensions (see materials section Study 1) and context words presented alone did not differentially impact attentional disengagement (Control study 1).

Studies 1 and 2 showed that responses were only delayed in participants that explicitly reported sex or violence associations (see Figure 2 for an overview of all studies). This suggests a relationship between the effect on attention and the extent to which people experienced an affective association in response to the words presented in the experiment. It is important to emphasise that the mere presentation of two words was enough to produce these affective associations without any instruction to associate the words with each other. Thus, our findings suggest that the influence on attentional disengagement as reported is not the result of deliberate association, but rather of spontaneous association. Study 2 replicated the attentional disengagement effect in a large sample showing that this effect is stable and reliable, but only for sex associations. Study 3 showed that delayed disengagement for sex word pairs persisted when people were instructed to expect sex and violence associations.

It is important to note that the effect sizes of Studies 1 and 2 were relatively small. Nonetheless, effect sizes should be evaluated within the context of the research that is being performed (Cohen, 1988). The primary goal of the present paper was to demonstrate, with an implicit dependent variable

![Figure 2](https://example.com/image2.png)

**Figure 2.** Grey bars represent the difference between mean RT following focus words in sex contexts and mean RT following the same focus words in neutral contexts. Black bars represent the difference between mean RT following focus words in violence contexts and mean RT following the same focus words in neutral contexts. For Studies 1 and 2 and for Control study 2 (see Supplementary Materials) difference scores are displayed for those participants that report sex or violence associations (reports association). For Study 3, difference scores are displayed for the full sample (total). Error bars represent standard error of the difference.
and subtle stimuli, that contextual manipulations can evoke spontaneous affective meaning. Across multiple studies, we consistently demonstrated the occurrence of spontaneously affective associations as evidenced by a delayed disengagement effect. We think that this is a novel and important theoretical advance in the science of emotion and affect, irrespective of the small effect size. The contribution of our studies is that they explore the impact of affective meaning that is dynamic and individually variable. Although our studies demonstrate weaker effects than attention research using affective stimuli that readily convey affective meaning (e.g. angry faces, mutilation images, taboo words), the effect sizes in Studies 1 and 2 are similar to experimental research using contextual manipulations (Gendron, et al., 2012; LeBois, Wilson-Mendenhall, & Barsalou, 2014). Furthermore, when participants expected sex and violence associations (i.e. in Study 3), the effect size of the disengagement effect was markedly larger, and comparable to effect sizes forwarded by a meta-analysis of the attentional bias literature (Bar-Haim et al., 2007).

An interesting question is why we found consistent effects for sex associations, but not for violence associations. First of all, it is important to note that this finding is consistent with several other studies that have found that explicit sex words (Aquino & Arnell, 2007; Arnell, Killman, & Fijavz, 2007) and sexual images (Buodo, Sarlo, & Palomba, 2002) affect attention more strongly than threat stimuli. Nevertheless, other possible reasons may be sought in the specific qualities of our stimulus set. Pilot data demonstrated that sex focus words were rated as more positive and arousing than violence focus words. Although this cannot explain the differences in response times following sex and neutral words pairs (i.e. since the focus words were held constant), the higher affective ambiguity of sex focus words may have enhanced the potential for affective associations in sex word pairs as compared to violence word pairs. This interpretation is also supported by the consistent presence of a main effect of category, such that, irrespective of the context word, sex focus words were responded to slower than violence focus words.

A second aspect that is important to discuss in this context, is the fact that sex associations were more readily picked up by participants than violence associations. Averaged across studies, 59% of the participants reported sex associations, whereas only 25% of the participants reported violence associations. Perhaps noting sex associations obscured the generation of spontaneous violence associations. As a future direction, separating sex and violence word pairs into different experiments could test this possibility. Regarding the present studies, these percentages suggest that, within a sample of young adults, a sex theme has particular salience as compared to a violence theme. We can even speculate about the existence of something similar to a “white bear” effect (Wegner, Schneider, Carter, & White, 1987), such that when participants noted the possibility of sex associations it became difficult to ignore them. An interesting question in this regard is how the spontaneous generation of affective meaning develops over time. Is there a particular moment when people “make the connection”, after which certain associations suddenly become salient (with a corresponding slowing down in categorising the letter-probe as a result)? Unfortunately, the present studies were not well-designed to examine this question, but we believe that this is an interesting avenue for future research.

Even though our effect was only robust for sex, it is highly unlikely that the effect of contextually derived meaning is limited to sex associations. Other affective or arousing associations (e.g. associations that are unusual or funny; cf. Hildebrand & Smith, 2014) may influence attention in similar ways. Moreover, although the present violence word pairs did not show consistent effects, it may be possible to generate a stimulus set that will evoke more potent negative associations. The effect of these negative affective associations may be most pronounced in certain clinical populations that have been the main focus of attentional bias research (see Bar-Haim et al., 2007; Yiend, 2010). For example, individuals with generalised anxiety disorder or phobia may show delayed disengagement for word pairs conveying associations that are relevant to their disorder. Finally, it is important to note that most – if not all – stimuli involve semantic processing. Thus, it remains an open question whether semantic associations also play a role in disengagement effects for other affective stimuli, such as disturbing pictures, emotional faces or “biological stimuli”, both in normal and clinical populations (see Yiend, 2010 for a similar point). For example, an interesting question that follows from our findings is whether individuals who explicitly associate certain stimuli with fear, disgust, threat or pleasure show stronger attentional biases for those stimuli.
Implications and future research

The present findings have important implications for the field of emotion and affect broadly, for the field of language, and for the field of emotion and attention specifically.

First of all, with regards to the field of emotion and affect broadly, the present findings are in line with models of emotion that emphasise a situated meaning making process, such as the Conceptual Act Theory of emotion (CAT; Barrett, 2006, 2012) and the appraisal model of emotion proposed by Clore and Ortony (2013). Furthermore, our findings support perspectives in the emotion literature that emphasise the role of context in the generation of affective and emotional meaning (e.g. Barrett, 2006; Roy et al., 2012). Most importantly, our findings suggest that neutral or slightly ambiguous words that derive affective meaning from contextual manipulations may be similarly effective in influencing basic psychological processes as stimuli with pre-established affective meaning.

The Conceptual Act Theory of emotion (Barrett, 2006; 2012) may specify how the sex associations are produced in the mind of the individual. According to CAT, emotional meaning arises within a particular context when representations of previous experience and sensory and bodily states are integrated into rich, embodied, situated conceptualisations (see also Barsalou, 2009; Wilson-Mendenhall et al., 2011). Applying this principle to our word pairs, participants may have generated richer and more affectively charged situated conceptualisations in response to the sex word pairs than in response to neutral word pairs. For example, as compared to the context word FRUIT, the context word OPENING in combination with the target word JUICES may have generated a representation of a particular situation involving arousing sexual acts, that may have interfered with the allocation of attention to the letter-probe (see for a similar point Geer & Melton, 1997). The finding that word pairs were only effective in people who reported sex associations further supports this idea and emphasises that the construction of (affective) meaning is individually variable (see also Barrett, 2012).

Second, our findings are relevant to models of language processing that emphasise the link between semantic meaning and contextual factors (e.g. Wlotko & Federmeier, 2012; see for a review Federmeier, 2007). Models of semantic unification, for example, propose that meaning is constructed as an unfolding representation that incorporates the broader context (Hagoort, 2005; Hagoort, Baggio, & Willems, 2008). Consistent with this view, the present data suggests that the affective meaning of neutral words may change considerably depending on preceding words. This data extends previous work that focused on how a neutral context impacts the comprehension of words with strong negative and positive connotations (Holt, Lynn, & Kuperberg, 2008). The present findings are also consistent with grounded cognition theories that argue that the emergence of meaning does not occur in isolation, but often depends on the situational “background” in which concepts are processed (Barsalou, 2009; see also Wilson-Mendenhall, Simmons, Martin, & Barsalou, 2013).

Third, our findings are relevant for the attention literature since we show that delayed disengagement is not limited to stimuli with strong pre-existing affective connotations or clear perceptual affective features, such as taboo words or angry faces (e.g. Fox et al., 2001, 2002; Koster et al., 2004; Lipp & Derakshan, 2005). Instead, we show an attentional disengagement effect (i.e. slower categorisation of a letter-probe) for stimuli that receive sexual meaning from contextual manipulations “on the spot”. The characteristics of our paradigm (i.e. stimuli were presented for 250 and 300 ms in quick succession), in combination with the finding that our stimuli slow the fast and basic psychological process of attention allocation, suggest that affective meaning arises relatively quickly.

A limitation of the present set of studies is that our paradigm is not well-suited to answer questions about the mechanism that underlies delayed disengagement (see Cisler & Koster, 2010 for a comprehensive overview of attention effects related to threat). The first possible mechanism is that the changed meaning of the target word, as a result of the contextual manipulation, “locks” the subject’s attention to the spatial location of the target word, with a slower re-allocation (or “shifting”) of spatial attention to the letter probe as a result (Clark, MacLeod, & Guastella, 2013). Another possible interpretation of delayed disengagement does not involve spatial attention per se, but a more general “behavioral freezing” (Clark et al., 2013) or “slowing” effect. For example, Bertels and Kolinsky (2016) demonstrated general slowing effects when people process negative words or taboo words. These authors explain this effect by suggesting that subjects have difficulties disengaging...
their attention from the emotional aspects of a stimulus. Similarly, Geer and Melton (1997) describe a phenomenon called sexual content-induced delay (SCID) that demonstrates a general slowing of decision making with regards to sexual stimuli. Applying this "slowing" interpretation to the present paradigm, the disengagement effect may reflect an interference between constructing (or elaborating on) an affectively charged situated conceptualisation and attending to the task of categorising the letter-probe. In other words, sex associations, possibly because of their salience, may have caused a temporary distraction from the task that the participants needed to perform (see for similar interpretations regarding disengagement effects for threat, Bar-Haim et al., 2007; Beck & Clark, 1997; Eysenck, Derakshan, Santos, & Calvo, 2007).

As a future direction, we believe that our paradigm may be informative in answering questions about how affective meaning is grounded in the brain and body. According to grounded cognition perspectives, situated conceptualisations represent meaning in perception, (social) cognition, memory and language by integrating simulations of sensorimotor, interoceptive and introspective states (Barsalou, 2009; see for an overview Barsalou, 2008; see also Barrett, 2006). For example, multiple experiments demonstrate that processing emotion concepts or understanding emotion language activates bodily states (e.g. Niedenthal, Winkielman, Mondillon, & Vermeulen, 2009; Oosterwijk, Rotteveel, Fischer, & Hess, 2009; Oosterwijk, Topper, Rotteveel, & Fischer, 2010). Concerning the current task it will be interesting to investigate the role of sensory and bodily simulations in the production of affective associations. For example, using psychophysiology, it is possible to test whether engagement of the sympathetic nervous system while processing the word pairs predicts the delay in attentional disengagement. Another empirical question is to what extent individual differences in the vividness of visual simulation or mental imagery may relate to the effectiveness of the word pairs to influence attention. And finally, using functional neuroimaging, it would be interesting to investigate to what extent spontaneous sex associations produced by our word pairs engage neural systems that support bodily and sensory states (e.g. anterior insula; see Oosterwijk et al., 2012) and/or neural systems that support the generation of affective meaning (e.g. ventromedial prefrontal cortex; see Roy et al., 2012).

Although the present findings inspire many new research questions, for now they underline the importance of context in the emergence of semantic meaning in general and affective meaning specifically. In the real world, we are not regularly confronted with angry faces, snakes, or bloody images; many stimuli are ambiguous or even neutral and may only acquire affective meaning in our mind. This neglected process is an important avenue for future research in affective science.

Disclosure statement

No potential conflict of interest was reported by the authors.

References


