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Please cite the final published version:

Staugaard, S.R., Berntsen, D. Gender differences in the experienced emotional intensity of experimentally induced memories of negative scenes. *Psychological Research* (2020). https://doi.org/10.1007/s00426-020-01334-z

Publication metadata

Title:	Gender differences in the experienced emotional intensity of experimentally induced memories of negative scenes
Author(s):	Søren Risløv Staugaard & Dorthe Berntsen
Journal:	Psychological Research
DOI/Link:	https://doi.org/10.1007/s00426-020-01334-z
Document version:	Accepted manuscript (post-print)

"This is a post-peer-review, pre-copyedit version of an article published in Psychological Research. The final authenticated version is available online at: https://doi.org/10.1007/s00426-020-01334-z

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Gender Differences in the Experienced Emotional Intensity of Experimentally Induced Memories of Negative Scenes

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Abstract

It is well documented that women have an increased risk of emotional disorders, such as anxiety and depression. Such disorders are typically characterized by intrusive memories and rumination of past events, but findings are mixed as to whether women have enhanced access to memories of emotional events. Some studies have found that women, compared with men, report more frequent and more intense memories of emotionally stressful events, whereas other studies have failed to replicate this effect. These conflicting findings may reflect the use of different memory sampling techniques (e.g., retrospective versus experimental data) and limited control for factors associated with both gender and emotional memory. The purpose of the present study was to investigate gender differences in memory for emotionally negative events, using three different sampling methods, while at the same time controlling for parameters that might co-vary with gender. Consistent with some previous studies, we found that women and men did not differ in their frequencies of emotionally negative involuntary memories. However, women rated their memories as more intense and arousing than men did, and women also reported higher increases in state anxiety after retrieval. Female gender accounted for unique variance in the emotional intensity and subjective arousal associated with negative memories, when controlling for other theoretically derived variables. The findings provide evidence that female gender is associated with a stronger emotional response to memories of negative events, but not that women remember such events more frequently than men do.

Keywords: Gender Differences, Autobiographical Memory, Emotion and Memory, Intrusions

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Gender Differences in Experimentally Induced Memories of Emotionally Negative Scenes

Compared with men, women show an increased prevalence of PTSD (Kilpatrick et al., 2013; Olff, Langeland, Draijer, & Gersons, 2007; Rubin, Berntsen, & Bohni, 2008; Tolin & Foa, 2006). Researchers have hypothesized that there could be a connection between women's increased risk of the disorder and an enhanced access to emotional memories (e.g., Birkeland, Blix, Solberg, & Heir, 2017; Rubin et al., 2008; Soni, Curran, & Kamboj, 2013). However, there are inconsistencies in the literature on gender differences in negative involuntary memories, which could be related to the diverse sampling methods used. The purpose of the present study is to test the prediction that women have more frequent and more intense memories for negative material using three different sampling methods, and controlling for differences in levels of depression, anxiety, and dysfunctional cognitive processes.

A key to understanding and treating PTSD is to understand the retrieval mechanisms of emotionally negative memories (Marks, Franklin, & Zoellner, 2018). In the field of autobiographical memory, there is a common distinction between voluntary and involuntary memory retrieval. Whereas voluntary memories are brought to mind by a deliberate, effortful search, involuntary memories appear spontaneously and effortlessly in consciousness (Berntsen, 2009). This distinction has particular relevance to posttraumatic stress disorder, since involuntary memories of a traumatic event is a central clinical aspect of the diagnosis (American Psychiatric Association, 2013).

In terms of voluntary memory, studies have found that women generally remember emotional events with greater emotional intensity (Fujita, Diener, & Sandvik, 1991; Niedzwienska, 2003; Seidlitz & Diener, 1998), and a higher level of detail (Bloise & Johnson, 2007; Lindholm & Christianson, 1998). One explanation for these gender

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differences is that women encode more details of emotional events and subsequently rehearse memories of the events more than men do (Andreano & Cahill, 2009; Pfieke & Fink, 2005; Seidlitz & Diener, 1998). The enhanced encoding may be related to different activation patterns of the amygdala between the genders (Andreano & Cahill, 2009), whereas the increased rehearsal in part may be explained by sociocultural differences in how girls and boys are brought up to talk about emotional events (Bauer, Stennes, & Haight, 2003; Davis, 1999). Another theoretical view shifts the emphasis to retrieval factors, specifically emotion-regulation during retrieval (Del Palacio-Gonzalez, Watson & Berntsen, 2017; Rubin et al., 2008). According to this view, individual differences in emotional memory are related to emotion-regulation efficiency, and it has been hypothesized that men, compared with women, may find it easier to downregulate their negative emotions (McRae, Ochsner, Mauss, Gabrieli, & Gross, 2008).

If a direct relationship exists between women's increased risk of PTSD and enhanced emotional memory, we should expect to find similar gender differences in involuntary memory as have been found in voluntary memory. In accordance with this prediction, a number of studies have shown that women, compared with men, report a higher frequency of negative involuntary memories (i.e., intrusions) following stressful events. For example, Egberts, van de Schoot, Geenen, and Van Loey (2017) asked parents of children with burn injuries to fill out the Impact of Event Scale (IES, Horowitz, Wilner, & Alvarez, 1979) at different time points following their child's injury. The IES measures intrusions through items such as "pictures about [the stressful life event] keeps popping into my mind" (Horowitz et al., 1979). In the study by Egberts et al. (2017), mothers reported more frequent intrusions than fathers at all time points, while the initial emotional response to their child's injury appeared to be similar between parents. Another study using the IES also found that women reported more intrusions following negative personal events (Boals, 2010), while a

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third study found that women reported more intrusions during a 48-hour interval after watching a holocaust video (Schmaus, Laubmeier, Boquiren, Herzer, & Zakowski, 2008).

These studies consistently show a higher frequency of intrusions to a variety of negative events in women compared with men. However, this literature has an important limitation in that the IES is administered at a variable delay after the traumatic event and participants are asked to think back on the time passed since the event and retrospectively judge the general level of intrusions during that time. It is therefore possible that women do not objectively experience a greater frequency of intrusive thoughts and memories during the retention interval, but rather that they are more aware of such memories, which in turn influences their retrospective judgment.

We were able to identify only a few experimental studies on gender differences in intrusive memory that did not rely on retrospective judgments. Verwoerd, Wessel, de Jong, Nieuwenhuis, and Huntjens (2011) found that men and women reported comparable numbers of intrusive memories in a diary after watching a stressful film clip. Brewin and Soni (2011) also failed to find gender differences on vividness or frequency of involuntary memories that occurred in response to a word association task. One issue with this study is that the cuing method was not designed to elicit intensely negative memories. Indeed, most of the memories reported were positive. Finally, Kamboj et al. (2014) used highly stressful film clips of injury and death during encoding and then asked participants to record intrusions on their phones for seven days. On the eight day, they returned to the lab for a cued recall task. As in Brewin and Soni (2011), men and women did not differ in frequency of intrusions.

Although the diary method reduces retrospection, a potential limitation of this method is that the retrieval situation is uncontrolled and likely to differ between participants. This could lead to gender differences if men and women differ in how much they discuss the encoding experience with others during daily life or in how they process environmental cues.

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For example, women have been shown to elaborate emotional events more than men do during retellings (Pasupathi, 2003), and men and women have been shown to respond differently to emotional cues (Kret & De Gelder, 2012). For this reason, experimental control of the cuing situation is important.

Taken together, findings regarding gender differences in memory for emotional events are mixed. In particular, there is a discrepancy in findings between studies using voluntary retrieval to measure negative emotional memories, retrospective self-report of intrusions, and direct measures of involuntary memories. Voluntary memory measures generally find that women have enhanced emotional memory in terms of greater level of detail and intensity. Retrospective reporting of intrusions consistently finds a higher frequency for women. Finally, experimental studies of involuntary memories consistently find no differences between men and women in terms of frequency of intrusions. These mixed findings may to some extent reflect differences between studies in the memory sampling methodologies employed rather than effects of gender. Furthermore, the gender differences reported in some previous work might also be influenced by factors that are associated with both gender and memory affectivity, such as depression and anxiety. For this reason, it is important to control for other known predictors of emotionally negative memories when investigating effects of gender.

The present study

The study consisted of two parts. During part 1, participants completed an experimental design as described below. They were then invited to participate in part 2, which consisted of a 48-hour smartphone diary.

The purpose of the present study was to investigate potential gender differences in the frequency and emotional impact of involuntary memories. We used three different sampling methods to reflect the methods most commonly used in the literature: Involuntary memories

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measured experimentally, voluntary memories measured experimentally (part 1), and involuntary memories sampled in a smartphone diary study (part 2). Based on previous research, we expected women to report greater emotional impact (intensity and bodily arousal) in response to both voluntary and involuntary memories of negative scenes, but not in response to voluntary and involuntary memories of neutral scenes. We did not expect to find gender differences in the frequency of memories in the two involuntary conditions, since prior research has failed to find gender differences using direct measurements of involuntary memories.

The experimental part of the study (i.e., part 1) was based on a paradigm developed in our lab (Berntsen, Staugaard, & Sørensen, 2013). In this paradigm, participants watch a series of picture scenes paired with sounds. Some scenes and sounds are highly distinct, while others are highly similar, which creates varying levels of cue-item discriminability (e.g., how easily a cue isolates an item in memory; Rubin, 1995). During retrieval, participants in the involuntary condition perform a simple attention task, while listening to the sounds from encoding. They are instructed to stop the task, whenever they experience an image spontaneously popping into their minds. In the voluntary condition, participants listen to the sounds from encoding and attempt to retrieve the associated scene. In addition, we included a range of individual difference measures in order to investigate the effects of gender over and above known predictors for emotionally negative memories. Specifically, we included measures of emotional intensity during encoding, trait and state anxiety, depression, thought suppression, visual imagery ability, and trait dissociation. Several of these measures have been shown to be associated with frequency of intrusions (anxiety and depression: McWilliams, Goodman, Lyons, Newton, & Avila-Mora, 2014; dissociation: Brewin & Soni, 2011; McWilliams et al., 2014; thought suppression: Rassin, 2003), while visual imagery

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ability has been associated with more general memory ability (Sheldon, Amaral, & Levine, 2017; Vannucci, Pelagatti, Chiorri, & Mazzoni, 2016).

Method

We based the sample size on three experimental studies that found gender differences in memory for negative pictures from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2008). The three studies were Arnone, Pompili, Tavares, and Gasbarri (2011), Canli, Desmond, Zhao, and Gabrieli (2002), and Spalek et al. (2015). The average effect size was Cohen's $d = 0.5$. In order to detect this effect size with an alpha level of 0.05 and a power of 0.70, a study would need 102 participants.

We recruited 104 participants from a subject pool at Aarhus University, consisting of students as well as community volunteers. Participants were only eligible for the study if they had not participated in any previous experiments using the same methods and/or materials. Inclusion criteria were age (18-60 years) and a score on Beck's Depression Inventory-II (BDI-II; Beck, Steer, & Brown, 1996) of less than 19, which is the cut-off for moderate to severe depression according to the original paper. We excluded three participants due to having a BDI score above 19, and we excluded a further three participants for not reporting any memories during the task. Finally, one participant decided to leave the experiment due to emotional distress and another participant was excluded due to problems following instructions. This left 96 participants. Men and women were randomly assigned to either a voluntary or an involuntary retrieval condition in part 1. The questionnaire data for men and women in the involuntary and voluntary retrieval conditions can be seen in Table 1. The procedure and materials were approved by the Regional Committee on Health Research Ethics for the Central Denmark Region.

Part 1: Materials and tasks

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Questionnaires. Danish versions of the following questionnaires were included in the study: (a) Beck's Depression Inventory-II (BDI-II; Beck et al., 1996) is a 21-item measure of depression with excellent psychometric properties (Beck, Steer, Ball, & Ranieri, 1996). In the present study, the internal consistency of the BDI-II as measured by Cronbach's α was .73.

(b) State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983) is a 40-item measure of anxiety divided into one form measuring state anxiety (i.e., how anxious the respondent feels in this moment) and one form measuring trait anxiety (i.e., how anxious the respondent generally feels). The STAI has high validity and reliability (Spielberger, 1989; Spielberger et al., 1983). In the present study, internal consistency of the STAI as measured by Cronbach's α was .90 for the state form .92 for the trait form.

(c) Dissociative Experiences Scale (DES; Bernstein & Putnam, 1986) is a 28-item measure of the frequency of dissociative experiences such as realizing that you can't remember parts of a trip you just underwent. The scale has excellent psychometric properties (Ijzendoorn & Schuengel, 1996). In the present study, internal consistency for the DES as measured by Cronbach's α was .93.

(d) White Bear Suppression Inventory (WBSI; Wegner & Zanakos, 1994) is a 15-item measure of failures to suppress thoughts. The scale has very good reliability and validity (Muris, Merckelbach, & Horselenberg, 1996). In the present study, the internal consistency of the WBSI as measured by Cronbach's α was .72.

(e) Vividness of Visual Imagery Questionnaire (VVIQ; Marks, 1973) is a 16-item measure of the ability to visualize scenes. Participants report the visual imagery ability both with their eyes open and closed. The scale has been found to have very good psychometric properties (Campos & Pérez-Fabello, 2009). The internal consistency of the VVIQ as measured by Cronbach's α was .95 in the present study.

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Stimuli. Thirty-two pictures of scenes were taken from the IAPS. Sixteen of them were of highly negative emotional valence according to the ratings included with the set (valence: M = 1.81, SD = 0.09; arousal: M = 6.17, SD = 0.42), while the other 16 were neutral (valence: M = 4.57, SD = 0.11; arousal: M = 3.27, SD = 0.48). Examples of the highly negative scenes included severely scarred or mutilated bodies and children starving. The neutral scenes included people in neutral settings as well as objects. In addition, 32 pictures of scenes were found using Google's image search. Each of these pictures was selected to match an individual IAPS picture in terms of visual similarity and content to be used as foils in a recognition task. All pictures were rescaled to 1,024 x 768 pixels. Forty-eight sounds were selected from various royalty-free sound libraries. All sounds were normalized and cut short at 4 s. Alternate versions were created of all sounds by panning them 75 % to the right or the left. While 16 of the sounds were dissimilar (e.g., a person coughing or a telephone ringing), the remaining 32 sounds consisted of four sets of highly similar sounds (birds singing, dogs barking, car engines revving and busy pedestrian streets). Each sound was presented only once during encoding, but the dissimilar sounds appeared unique to the participant while the similar sounds appeared repeated, since they derived from the same category (e.g., dogs barking) and were difficult to distinguish from one another. All sounds were emotionally neutral according to nine independent judges (M = 2.89, SD = 0.27, on a scale of 1–5, with 1 = highly negative, 3 = neutral and 5 = highly positive, see Staugaard & Berntsen, 2014). Finally, an additional 32 sounds were collected using the same procedure described above, to be used as filler sounds in the involuntary condition.

Task. The computerized task was based on a previous version by Staugaard and Berntsen (2014). It was programmed and run using E-Prime 2.0 Professional (Psychology Software Tools). The task consisted of three separate phases: (a) an encoding phase, where participants heard sounds paired with pictures of scenes; (b) a retrieval phase (between

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subjects), where participants heard the sounds from the encoding phase and either attempted to deliberately recall the scenes (voluntary condition) or performed a simple attention task while registering if a memory of a scene spontaneously came to mind (involuntary condition); (c) a recognition phase, where participants were presented with the scenes from the encoding phase paired with foils, and asked to decide which ones they had previously seen. Only the retrieval phase differed between the voluntary and involuntary condition. Each phase is described in detail below.

Encoding phase. Participants saw 32 trials of scenes paired with sounds. For a full description of the pairings, please see Supplementary Materials. On each trial, a sound and a scene were presented simultaneously for 4 s. Participants were asked to indicate on a 5-point scale how emotionally intense they thought the scene was, with 1 = Not at all intense to 5 = Very intense. Next, the same scene was presented without any sound, and participants were asked to try to remember the sound that it had been paired with. After the second presentation, they were asked if they could relate the scene to an event from their own lives, with 1 = Not at all to 5 = To a large extent. The purpose of this second presentation was to increase the strength of encoding by facilitating a deeper, self-referential processing (Symons & Johnson, 1997). The encoding phase then proceeded to the next trial.

Retrieval phase. In the involuntary condition, participants heard each of the 32 sounds from the encoding phase presented once to each ear (i.e., to the left or to the right) for a total of 64 presentations of familiar sounds. They also heard 32 unfamiliar filler sounds presented once to each ear for a total of 64 presentations. The unfamiliar sounds were selected to be of similar categories to the familiar sounds (yet easily distinguishable from them), such as animal, human, and natural sounds, and they would also appear unique or repeated. The involuntary condition consisted in total of 128 trials. On each trial, the sound was presented together with a fixation cross on the screen. One and a half seconds into the

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playback of the four second sound, a bright star appeared in either the left or the right side of the screen. Participants indicated in which side of the screen the star was located by pressing "1" for left and "2" for right. This simple attention task was used as a cover task to minimize the possibility that participants deliberately searched for memories of scenes but also to simulate the conditions under which involuntary memories are most likely to appear (i.e., during monotonous or non-demanding tasks, e.g., see Berntsen, 1998, 2009; Schlagman & Kvavilashvili, 2008). While performing this cover task, participants were told to immediately press "3" whenever they spontaneously remembered a scene from the encoding phase. This paused the task and displayed a digital questionnaire on the screen. The questionnaire included space to write a brief description of the retrieved scene and three questions to be answered on 5-point scales. The first question concerned the specificity of the retrieved scene (from 1 = Not specific at all to 5 = Highly specific); the second question concerned the emotional intensity of the retrieved scene (from 1 = Not intense at all to 5 = Very intense); the third question concerned bodily reactions to the retrieved scene, such as increased heart rate, nervousness or tension (from 1 = Not at all to 5 = Very much).

In the voluntary condition, participants heard the 32 sounds from the encoding phase presented once to both ears (i.e., centered). There were no unfamiliar sounds in the voluntary condition, thus the total number of trials was 32. Participants were asked to recall the scene that was paired with the sound during the encoding phase. If they did so, they were to press "1." If they could not remember a scene, they were to press "2." When participants indicated that they had recalled a scene, they were presented with the same digital questionnaire as in the involuntary condition. The reason for the unequal number of cues in the involuntary versus voluntary condition was the fact that the involuntary memories by definition are activated by chance in an "accidental" fashion for which reason only some of the cues would be likely to be followed by a memory. The goal-directed search used in the voluntary

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condition, on the other hand, generated memories in response to a greater number of the cues[1]. Thus, a high number of cues in the voluntary condition could prolong this condition relative to the involuntary condition and potentially reduce the quality of the responses. The current design is identical to the one used in our previous research (Staugaard & Berntsen, 2014).

Recognition phase. All participants reviewed the 32 scenes from the encoding phase one at a time for a total of 32 trials. This time, each scene was presented alongside a foil. Participants were asked to indicate which of the two scenes they had seen before, as well as rate the confidence in their own response on a 5-point scale (from 1 = Very uncertain to 5 = Very certain). The trials were presented in a counterbalanced, fixed order, where the foils would be on the left side of the screen half the time, while also making sure that the same type of trial was not repeated more than twice in a row. The purpose of the recognition task was to check whether participants actually looked at all of the scenes during the encoding phase, since some might feel inclined to avoid the negative scenes due to their content. Each foil was selected to carefully match the corresponding IAPS scene in terms of content and composition. The difficulty of the recognition task differed from trial to trial with some foils being better matches than others, but in general it was not difficult as long as participants paid attention to the scenes during encoding. We expected high confidence ratings and high

[1] We compared the raw frequency of voluntary memories to the raw frequency of involuntary memories in response to the first 32 familiar cues in each condition. Participants in the voluntary condition reported about twice as many memories in response to their 32 cues compared with participants in the involuntary condition (vol: M = 16.1, SD = 7.0; inv: M = 7.0, SD = 6.1; $t(90) = 6.56$, $p < .0001$).

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accuracy for all scenes during this phase as a sign that participants had indeed followed instructions on all trials.

Procedure. Participants received a written invitation, which explained the experiment in general terms (e.g., "You will be seeing pictures with emotional or neutral content"), while avoiding any suggestions that it was a memory experiment. The invitation contained a warning that the pictures could be considered "frightening, unpleasant, or offensive." Participants were also not told to which condition they had been assigned or that there was another condition. Participants in the involuntary condition were misinformed that the primary focus of the study was attention (rather than memory). Finally, participants were not told about the recognition task before they actually had to do it. Upon arriving at the laboratory, participants were again informed that they would see pictures with a strong negative content, that participation was completely voluntary, and that they could withdraw consent to participate at any time. They gave written consent and then filled out all the questionnaires. They were seated in front of a computer with a 19-in. (48.26-cm) monitor set at 1,280 x 1,024 resolution. The computer had headphones and a keyboard attached. Participants completed the encoding and retrieval phases separated by a brief interval of a few minutes. They filled out the state anxiety part of the STAI and then completed the surprise recognition phase. Finally, participants watched 10 positively valenced pictures from the IAPS in order to induce a positive mood, were debriefed, and given a gift certificate.

Part 1: Data preparation

Retrieval errors were determined in the following way: First, if participants in the involuntary condition recorded a memory of a scene in response to a filler sound, this was recorded as an error. If participants in either condition described a scene that could not be readily identified (e.g., a task-unrelated thought or an autobiographical memory), this was also recorded as an error. Second, if participants in either condition described a scene to the

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wrong sound cue, this was recorded as an indiscriminately cued memory. The coding of memories was performed by the first author. An independent judge with no knowledge of the hypotheses coded 20 % of the memories to ensure the reliability of the original coding. Interrater agreement was 89 % for involuntary memories and 90 % for voluntary memories (based on the proportion of identical ratings relative to the total number of ratings). In cases of disputes, we retained the first author's coding. We calculated the proportion of error types to the total number of recorded scenes in each gender. For errors this was: 17 % (men) and 15 % (women). For indiscriminately cued memories the numbers were: 18 % (men) and 17 % (women). Errors were omitted from all analyses unless explicitly stated, while indiscriminately cued memories were included as valid responses. The reasons for not excluding indiscriminately cued memories were the following: (a) Indiscriminately cued memories represented memories of encoded scenes. In this sense they were valid memories, albeit retrieved in response to the wrong sound cue. (b) In the involuntary condition, participants were not asked to monitor for accuracy of their memories, but to indicate if any scene came to mind. (c) It did not make sense to distinguish between the highly similar repeated sounds in our coding scheme. As a result of this, the two conditions with repeated cues showed a much lower rate of indiscriminately cued memories compared with conditions with unique cues, also speaking against excluding such cases.

Part 2: Materials and task

After completing part 1, all participants were invited to participate in part 2. It was made clear that part 2 was separate from part 1 and participation was voluntary. However, most participants decided to participate: 16 men and 20 women from the involuntary condition, and 18 men and 18 women from the voluntary condition. Importantly, and different from part 1, participants were not assigned to a retrieval condition. Thus, all of them received the same instructions and completed the study in the same way as described below.

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Each participant received a smartphone to take home and carry on their person for 48 hours as they went about their daily lives. Participants were instructed to open a digital questionnaire on their smartphone, whenever they experienced a spontaneous memory of a scene from part 1. The digital questionnaire was kept short and simple in order not to tire participants. It consisted of three questions measuring emotion and specificity, effort, and cuing of each recorded memory. First, participants indicated the valence and specificity of their memory by choosing one of five categories: 1 = a specific neutral image; 2 = a specific negative image; 3 = a mix of several neutral images; 4 = a mix of several negative images; 5 = a mix of neutral and negative images. Second, in order to determine if memories were voluntary or involuntary, participants indicated the cognitive effort during retrieval on a 3-point scale: 1 = The image came to me completely by itself without any effort (i.e., involuntary); 2 = It took a little effort to retrieve the image (i.e., voluntary); 3 = It took a lot of effort to retrieve the image (i.e., voluntary). Third, participants indicated the type of cue they believed had triggered their memory by choosing one of three categories: 1 = It was an association to something in my surroundings; 2 = It was an association to something in my thoughts; 3 = It came entirely "out of the blue".

After 48 hours, participants returned to the lab to hand over the smartphone and receive a gift card worth 100 DKR (approximately $16).

Statistical analyses

Part 1. Since we were not interested in cuing in the present study, and since it did not show any statistically significant interactions with gender (see Supplementary Materials), we did not include it in the analyses described below. For the same reasons, we also report the analyses of indiscriminately cued memories in the Supplementary Materials. In order to test the hypothesis that women experience an increased emotional impact of their memories for negative scenes compared with men, we calculated mean ratings of bodily reaction,

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emotional intensity, specificity, and reaction time for each participant and entered these values into separate mixed ANOVAs. For each analysis, retrieval condition and gender were between-group variables, while valence of the scenes (emotional vs. neutral) was a repeated measure.

For the frequency of emotional memories, we calculated the proportion of retrieved memories in relation to the total number of cues. We then conducted a 2 (Emotion: emotional vs. neutral scenes) x 2 (Retrieval: involuntary vs. voluntary) x 2 (Gender: men vs. women) repeated-measures ANOVA, with Retrieval and Gender as between-group variables and Emotion as a repeated measure.

Part 2. We calculated the proportion of memories described as either neutral and specific, negative and specific, neutral and unspecific, and negative and unspecific according to the categories of memories described in the method section (we excluded the category "a mix of neutral and negative images", since we were interested in the effect of valence). We then entered these proportions into an ANOVA with specificity (specific vs. unspecific) and emotion (negative vs. neutral) as repeated measures and gender as a group variable.

Part 1: Results

The datasets analyzed during the current study are available from the Open Science Framework website (https://osf.io/evtmj/). In the following, we describe the results of part 1, using an experimental manipulation to study the frequency and intensity of involuntary and voluntary memories of negative and neutral scenes in male versus female participants. Consistent with the aim of the study, we focus on effects involving gender, emotion, and retrieval condition.

Demographical and individual differences variables

Table 1 shows the age and individual differences measures in men and women in the two experimental conditions. Women had significantly higher scores on state anxiety

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following the retrieval task, suggesting that women were more emotionally influenced by the task than men (Table 1). In addition, women reported higher visual vividness (as measured by the VVIQ) than men did, and participants in the involuntary retrieval condition reported higher visual vividness (measured by the VVIQ) than participants in the voluntary retrieval condition. Finally, there was an interaction between gender and retrieval condition on depression[2]. Inspection of means showed that the interaction was due to women scoring higher than men in the involuntary condition, but lower in the voluntary condition (Table 1).

Ratings obtained at encoding

We analyzed ratings of intensity in the encoding phase by means of a 2 (Emotion: emotional vs. neutral scene) x 2 (Gender: men vs. women) repeated-measures analysis of variance (ANOVA). We found a main effect of emotion, $F(1, 94) = 1{,}365.96$, $p < .001$, $\eta_p^2 = .94$, a main effect of gender, $F(1, 94) = 7.77$, $p = .006$, $\eta_p^2 = .08$, and an interaction between Emotion and Gender, $F(1, 94) = 9.73$, $p = .002$, $\eta_p^2 = .09$. One-way ANOVAs revealed that this interaction was the result of women's intensity ratings being higher than men's for the emotional scenes (women: $M = 4.38$, $SD = 0.43$, men: $M = 3.91$, $SD = 0.82$), but not the neutral scenes (women: $M = 1.63$, $SD = 0.47$, men: $M = 1.59$, $SD = 0.42$, see Figure 1A). We analyzed ratings of self-reference using the same strategy as above. We again found a main effect of emotion, $F(1, 94) = 209.13$, $p < .001$, $\eta_p^2 = .69$, since participants found it easier to relate neutral scenes compared with negative ones to themselves (neutral: $M = 2.49$, $SD =$

[2] In order to examine the effect of this interaction on memory, we conducted all of the main analyses described below (proportion, bodily reaction, emotional intensity, specificity, and reaction time) with the BDI-II as a covariate. None of these analyses showed any significant effects of depression (ps > .148, $\eta_p^2 < .03$).

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0.78, negative: M = 1.47, SD = 0.52. There were no other significant effects (ps > .240, η_p^2 < .02).

Emotional impact of memories during retrieval

Since not all participants recorded both neutral and emotional memories, only responses from 40 participants in the involuntary condition (21 men and 19 women) and 47 participants in the voluntary condition (23 men and 24 women) were available. Descriptive statistics can be seen in Table 2, while all main effects and interactions with their effect sizes can be seen in Table 3. Importantly, retrieval condition was not statistically significant for the measures of emotional impact (ps > .085), suggesting that voluntary and involuntary retrieval were highly similar.

For emotional intensity, we found a main effect of Gender, with women rating their memories as more intense than men (p < .001), a main effect of Emotion (p < .001), and the predicted interaction between Gender and Emotion (p = .034), indicating that higher ratings of intensity in women were more pronounced for emotional memories. Follow-up one-way ANOVAs showed that the gender difference was only statistically significant for emotional memories, $F(1, 90) = 14.89$, p < .001, η_p^2 = .14, but not for neutral memories, $F(1, 91) = 1.38$, p = .244, η_p^2 = .02, see Figure 1B.

For bodily reactions, we again found a main effect of Gender (p < .001), a main effect of Emotion (p < .001), and the predicted interaction between Gender and Emotion (p < .001), indicating that the increased bodily response in women was more pronounced for emotional memories. Again, follow-up one-way ANOVAs showed that the gender difference in bodily response was only statistically significant for emotional memories, $F(1, 90) = 16.51$, p < .001, η_p^2 = .16, but not for neutral memories, $F(1, 91) = 0.72$, p = .397, η_p^2 = .01, see Figure 1C.

Regression analysis of characteristics of memories during retrieval

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In order to test if female gender explained unique variance in frequency and intensity of emotionally negative memories over and above other individual differences variables, we conducted three separate hierarchical linear regression analyses for the frequency, bodily reaction, and emotional intensity of emotional memories, respectively. The independent variables were the individual differences measures and the rating of intensity during encoding as well as retrieval condition. We excluded state anxiety before encoding since this measure correlated highly with trait anxiety. The individual differences measures, intensity during encoding, and retrieval condition were added in the first step, while gender was added in the second step. The results for frequency, bodily reaction, and intensity of emotional memories can be seen in Table 4. The correlations between the variables in the models can be seen in Supplementary Materials, Table S1.

The individual differences measures entered in step 1 explained 43 % of the variance in frequency of emotional memories, 35 % of the variance in bodily reaction, and 57 % of the variance in intensity. Gender was not significantly associated with frequency over and above the individual differences measures, but it was significantly associated with bodily reaction and intensity experienced at retrieval, also when controlling for the other variables (Table 4). The statistically significant variables in the analysis of frequency were retrieval condition, post-retrieval state anxiety, and dissociation, while thought suppression could be considered a trend in the final model. The statistically significant variables in the analysis of bodily reaction were post-retrieval state anxiety, female gender, intensity of scenes during encoding, and dissociation. The statistically significant variables in the analysis of intensity of emotional memories were intensity of scenes during encoding and female gender (Table 4). In short, female gender explained unique variance in the emotional response to the memories, even when controlling for levels of depression, anxiety, and dysfunctional cognitive processes. In addition, we also conducted the regression analyses for the characteristics of

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neutral memories. None of these showed a significant effect of gender. The results of these analyses can be seen in Supplementary Materials, Table S2.

Frequency of involuntary and voluntary memories during retrieval

We found no significant effects of Gender or Emotion on percentage of memories retrieved (*p*s > .449). A main effect of retrieval condition showed that participants in the voluntary condition retrieved a greater percentage of memories relative to the amount of cues than participants in the involuntary condition ($p < .001$) (see Table 3).

Specificity and reaction time of involuntary and voluntary memories during retrieval

For memory specificity, there was a main effect of Emotion with emotional memories being less specific than neutral memories ($p < .001$). No other effects were statistically significant (*p*s > .453). For reaction time, there were a main effect of Emotion with retrieval of emotional memories being slower than neutral memories ($p < .001$). Retrieval condition was also highly significant, reflecting that voluntary memories were much slower than involuntary memories ($p < .001$). No other effects were statistically significant (*p*s > .679) (see Table 3).

Recognition

We calculated accuracy as the percentage of trials where the scene was correctly identified. Accuracy during the recognition task was nearly perfect and did not differ between men and women (see Table 1), indicating that participants had successfully encoded all scenes as intended. Confidence was also very high (see Table 1).

Part 2: Results

In Part 2, we investigated the frequency, specificity, and valence of involuntary memories. Participants carried a smartphone for 48 hours and were instructed to answer a short questionnaire on the phone, whenever they experienced a spontaneous memory of a

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scene from part 1. The datasets are available from the Open Science Framework website (https://osf.io/evtmj/).

Demographical variables

Thirty-four men (mean age = 23.7, *SD* = 6.3) and 38 women (mean age = 22.5, *SD* = 2.1) volunteered for part 2. The men reported significantly higher levels of dissociative experience than women (*M* = 11.7, *SD* = 11.9 vs. *M* = 7.3, *SD* = 5.8), but there were no statistically significant gender differences on depression, trait anxiety, state anxiety, thought suppression, or visual imagery in this subgroup of participants (*p*s > .166, η_p^2 < .03). In order to examine if the retrieval condition participants had been assigned to in part 1 showed carry-over effects in part 2, we conducted a series of one-way ANOVAs with retrieval condition from part 1 as a group variable and the outcome measures from part 2 as dependent variables. These analyses did not show any statistically significant effects or interactions with the memories recorded on the smartphones (*p*s > .304, η_p^2 < .02), so we excluded retrieval condition from part 1 from the analyses below.

Specificity and valence of memories

Participants recorded a total of 714 memories across the 48-hour interval (women: *M* = 8.8, *SD* = 8.0; men: *M* = 11.2, *SD* = 14.8; *F*(1,70) = 0.75, *p* = .390, η_p^2 = .01). We found a main effect of emotion, showing that participants generally recorded a greater proportion of negative (*M* = .29, *SD* = .13) than neutral (*M* = .15, *SD* = .14) memories, *F*(1, 70) = 19.35, *p* < .001, η_p^2 = .22. We also found a main effect of specificity, indicating that most memories were of specific images (*M* = .30, *SD* = .15) rather than a mix of several images (*M* = .15, *SD* = .14), *F*(1, 70) = 23.23, *p* < .001, η_p^2 = .25. The interaction between specificity and gender could be considered a trend, where women tended to have fewer specific memories than men, *F*(1, 70) = 3.82, *p* = .055, η_p^2 = .05. There were no other statistically significant effects (*F*s < 1.71, η_p^2 < .03).

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Effort and cuing

We calculated the proportion of memories described as retrieved with either no effort, some effort, or much effort and entered these proportions into an ANOVA with effort as a repeated measure and gender as a group variable. We found a main effect of effort showing that most memories were recorded as being effortlessly retrieved (M = .61, SD = .32) versus retrieved with some effort (M = .35, SD = .29) or with much effort (M = .05, SD = .13), $F(2, 140) = 54.49$, $p < .001$, $\eta_p^2 = .44$. The remaining effects, including gender, were not statistically significant (Fs > 1.71, $\eta_p^2 < .03$).

Discussion

We examined gender differences in memory for emotionally negative and neutral scenes across three different sampling methods. The first part of the study involved an experimental design previously used to investigate voluntary and involuntary memory for emotionally negative scenes (Staugaard & Berntsen, 2014). The second part of the study was a 48-hour smartphone diary.

The experimental part of the study clearly showed that women experienced more intense memories for the negative scenes, irrespective of retrieval type. Specifically, women rated memories for the negative scenes as more intense than men did, while the response to memories of neutral scenes was comparable between genders (Figure 1B). Similarly, women reported an increased bodily response to memories of emotional scenes, but not to memories of neutral scenes (Figure 1C). Finally, women also reported higher state anxiety than men following the retrieval task (but not prior to the encoding task), indicating that the memories affected their mental state to a greater extent than was the case for men. Women also had higher ratings of emotional intensity in response to the emotional, but not neutral, scenes during encoding (Figure 1A). As reviewed in the introduction, these findings are consistent with studies showing that women evaluate negative memories as more emotionally intense

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and arousing than men do. An important question is whether this gender difference is related to the emotional response during encoding or other factors, such as trait dissociation.

We found that intensity during encoding explained a large amount of variance in intensity of emotional memories during retrieval, but female gender also explained unique variance. This suggests that women's higher intensity ratings at retrieval were not simply an effect of having a more intense response to scenes during encoding. None of the other variables were statistically significant. However, it is possible that the unique contribution of gender is related to cognitive-emotional processing not measured in the present study, such as emotion regulation strategies (McRae et al., 2008).

In relation to bodily reactions, we found that state anxiety after retrieval, gender, emotional intensity during encoding, and dissociation all explained unique variance. As for emotional intensity, gender again explained unique variance when controlling for the other variables. Increased bodily response may be a symptom of an increase in state anxiety, which was particularly pronounced in women. The effect of trait dissociation could point to a propensity to experience emotional memories as more intense (Brewin & Soni, 2011).

We found that men and women had comparable frequencies of negative involuntary memories in the experimental part of the study. While null-effects can be difficult to interpret, particularly in smaller samples such as the present one due to reduced statistical power, we note the consistency across several experimental studies using different methodologies (Brewin & Soni, 2011; Kamboj et al., 2014; Verwoerd et al., 2011). A safe conclusion at this point is that there is no evidence for gender differences in the frequency of involuntary memories for negative material when investigated in a controlled laboratory setting. At a glance, this appears to contradict findings in retrospective survey studies where women generally report more intrusions than men do (e.g., Boals, 2010; Egberts et al., 2017; Schmaus et al., 2008). Importantly, however, we cannot be certain that the involuntary

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memories in the present and previous laboratory studies correspond to the intrusive memories reported in survey studies. While both types of memories are negative and unintended, it is not clear if the involuntary memories reported in the present study were experienced as intrusive by the participants. It is possible that women and men have similar frequencies of negative involuntary memories, but that women retrospectively evaluate their negative memories as more intrusive. This is consistent with McRae et al. (2008) who hypothesized that men regulate their emotions with greater efficiency or less effort than women, perhaps in part due to automatic emotion-regulation processes. To further investigate the relationship between negative involuntary memories and retrospective reporting of intrusive memories, future studies should combine an experimental design like the one used here with self-report measures such as the IES.

The present findings also seem to go against studies showing a higher frequency of emotional memories in women examined via free or cued recall of autobiographical memories (e.g., Davis, 1999; Fujita et al., 1991). However, previous research is typically based on memory for autobiographical events and therefore may not be directly comparable to the present study. One important difference between the present study and studies of autobiographical memory is that we had experimental control of the encoding stage. Men and women therefore experienced the exact same events, and only differences in their processing of the events can explain the present results, whereas other factors could influence the recall of autobiographical events. For example, women's enhanced recall of emotional autobiographical events has been shown to be particularly pronounced for social situations, such as interpersonal conflicts (Bloise & Johnson, 2007). Some authors have theorized that women's memory advantage is a result of early socialization of rehearsal and elaboration of personal events (Bauer et al., 2003; Davis, 1999), which could be an explanation for why the

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advantage may not be evident in terms of memory frequency of non-social events, such as memories for negative scenes in an experimental setting.

Regression analyses showed that the frequency of emotional memories was related to trait anxiety, trait dissociation, and state anxiety reported after the retrieval task. This pattern of findings corresponds closely to previous studies investigating predictors of intrusion frequency following traumatic or stressful stimuli (e.g., Hall & Berntsen, 2008; Laposa & Alden, 2008; for a review, see James et al., 2016). As suggested by Brewin and Soni (2011), trait dissociation could reflect a general propensity to experience spontaneous mental contents, be they intrusive memories of negative experiences or other involuntary thoughts.

Interestingly, the variables explaining variance in frequency and intensity of emotional memories were different from each other and non-overlapping. While retrieval condition, post-retrieval state anxiety, and dissociation was specifically associated with a higher number of memories, intensity during encoding and female gender was specifically associated with memories that were rated more intense. This suggests that the frequency and intensity of emotional memories may depend on separate mechanisms, with only intensity experienced during retrieval showing a relationship with gender, whereas frequency is more related to anxiety and dissociation.

The present study does not allow us to explain causal mechanisms for gender differences in emotional memory. However, previous research has shown that gender differences in emotion processing are not specific to memory, but can be observed across a broad range of cognitive processes and materials, such as recognition of facial affect (Kret & Gelder, 2012). Thus, it is likely that some mechanisms may generalize across different domains. While structural and functional differences in brain anatomy and physiology may be important predictors at a biological level of analysis, our explanation centers around increased intensity and bodily reaction during retrieval of emotional memories in women.

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This explanation aligns with recent theoretical advances in intrusive memory research, where the emphasis is shifted away from encoding factors to factors operating at the time of retrieval, such as emotion regulation in response to the memories (del Palacio et al., 2017; Marks et al., 2018; Rubin, Dennis, & Beckham, 2011).

Finally, in the smartphone diary part of the present study, we found that participants recorded more negative than neutral memories, and most memories were of specific scenes from the encoding procedure in part 1. In addition, about 60 % of memories were recorded as being effortlessly retrieved. We did not find any statistically significant gender differences for frequency, valence, specificity, effort, or cuing in part 2. This finding is consistent with Verwoerd et al. (2011) and Kamboj et al. (2014), and again indicates that men and women do not appear to differ when recording involuntary memories online (that is, as they occur and not retrospectively).

Possible limitations and conclusion

When considering the present findings, some limitations should be taken into account. Based on previous research, we expected to find an effect of emotion on memory frequency. In addition to possible explanations discussed earlier, the lack of such an effect for both men and women in the present study could be related to the very short retention interval between encoding and retrieval we employed here. For example, if memory enhancement depends on rehearsal or consolidation then longer retention intervals might be required (e.g., Staugaard & Berntsen, 2014). It is also possible that gender effects would be evident only at longer delays. This should be explored in future research.

Measures of the frequency of involuntary (and voluntary) memories are known to be sensitive to the amount of effort involved in registering the memories (Rasmussen, Ramsgaard & Berntsen, 2015) and therefore may be affected by individual differences in task

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compliance. Even if such a factor has influenced the results, the impact is unlikely to have had differential effects on data derived from men and women.

Emotionally negative events had lower ratings of self-relevance compared with neutral events. This may be an important difference from real-life traumatic experiences that are often perceived as highly self-relevant (for a review, see Berntsen & Rubin, 2014). In the current study, ratings of self-relevance did not differ between genders and were therefore unlikely to confound the observed gender differences. Still, future studies could try to make the scenes more self-relevant, for example by emphasizing a shared trait or vocation between the participants and the people in the scenes (e.g., Krans, 2013).

It might be suggested that the present studies only provide evidence for gender differences in subjective ratings, which might reflect response biases rather than differences in the actual experience of the memories and their emotional impact. However, this is contradicted by fMRI research showing reliable correlations between subjective ratings of the emotional intensity of memories and brain activity in the amygdala and hippocampus during remembering (Daselaar et al., 2008). In the present study, the increase in state anxiety from baseline to post-retrieval among women, but not men, lend further support to the interpretation that the memories did have a stronger emotional impact on the women than the men.

Another potential limitation is that we only had negatively valenced scenes in our emotion category. For this reason, we cannot be certain if women responded selectively to emotionally negative scenes or if they would also had shown increased intensity and bodily reactions in response to positive scenes. Some prior studies have found that women remember positive emotional events better than men do (Davis, 1999; Seidlitz & Diener, 1998), which could indicate that the effect is caused by differences in arousal rather than

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valence (Kensinger, 2004). Future research could investigate this possibility by including arousing positive stimuli.

Finally, since we did not ask for descriptions of the memories in part 2, we cannot be certain that participants' memories were actually of scenes from the encoding procedure in part 1. Still, this possible limitation is true for all participants and therefore is unlikely to affect the analyses of gender differences.

In conclusion, we found that women evaluated memories of emotional scenes as more intense and accompanied by greater bodily reactions than men did. This increased intensity did not translate into a higher frequency of emotional memories, since frequencies were comparable between the genders in both the experimental study and the 48-hour smartphone diary. This finding is consistent with other experimental studies of gender differences in involuntary memory for emotional events, while studies based on retrospective reporting have typically found a gender difference in the frequency of intrusions. One explanation for this discrepancy between laboratory and retrospective studies might be that women retrospectively evaluate their memories as more intrusive due to a greater subjective feeling of intensity, bodily response, and state anxiety, which in turn may elevate their retrospective frequency ratings of intrusive memories relative to the ones of men. Another, but related, explanation is that men have different emotion-regulation strategies than women, and downregulate the intensity of their negative memories to a greater extent (McRae et al., 2008). This could mean that men are more likely to forget their emotional memories. Future research using the present paradigm could examine this possibility by collecting intensity ratings for scenes that were unreported during the retrieval phase or not recognized during the recognition task. Another avenue for future studies is to investigate the influence of self-relevance and emotion-regulation on gender differences in the intensity of emotional memory.

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Acknowledgements

The authors are grateful to Nina Bylod Staugaard, Tine Blom Nielsen, Heidi Kamp Lærke Madsen, Mette Sørensen, and Niels Peter Nielsen for recruitment and data collection. The present research was supported by a grant from the Danish National Research Foundation (DNRF89). Søren R. Staugaard was also supported by a grant from The Danish Council for Independent Research | Humanities (DFF-4180-00153).

Compliance with Ethical Standards

The authors have no conflicts of interest to declare. All procedures performed in studies involving human participants were in accordance with the ethical standards of the Regional Committee on Health Research Ethics for the Central Denmark Region and with the 1964 Helsinki declaration and its later amendments. Informed consent was obtained from all individual participants included in the study.

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Table 1. Descriptive statistics of the individual differences measures, broken down by gender and retrieval condition in part 1.

	Involuntary retrieval		**Voluntary retrieval**				
	Men	**Women**	**Men**	**Women**	**Effect of**	**Effect of**	**Gender x**
	(N = 24)	**(N = 24)**	**(N = 24)**	**(N = 24)**	**gender**	**condition**	**condition**
Measure	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*	*F(1, 91)*	*F(1, 91)*	*F(1, 91)*
Age (years)	23.9 (7.3)	22.5 (2.4)	23.2 (2.2)	21.9 (1.6)	2.27	0.44	0.16
BDI-II	6.2 (3.9)	9.1 (5.8)	7.4 (5.6)	4.9 (3.6)	0.05	2.01	7.46**
STAI-A	35.7 (9.0)	38.6 (11.0)	35.5 (9.6)	33.9 (8.0)	0.01	3.08	2.85
STAI-B pre-encoding	31.4 (5.8)	33.3 (9.9)	30.1 (6.4)	29.0 (4.8)	0.05	3.80	1.11
STAI-B post-retrieval	33.0 (9.7)	37.9 (10.8)	33.9 (10.0)	38.4 (11.4)	4.44*	0.06	0.01
DES	10.1 (12.4)	8.6 (6.6)	10.3 (8.4)	5.7 (3.7)	0.76	0.76	0.84
WBSI	40.5 (14.1)	46.7 (12.0)	40.1 (10.1)	39.7 (13.2)	1.10	2.26	1.68
VVIQ	2.6 (0.7)[1]	2.9 (0.7)	2.2 (0.6)	2.4 (0.6)	4.92*	10.12**	0.36
Recognition accuracy	99.4 (1.5)	99.3 (2.7)	99.9 (0.6)	99.5 (1.4)	0.35	0.88	0.22
Recognition confidence	4.8 (0.2)	4.9 (0.1)	4.9 (0.1)	4.9 (0.2)	0.00	0.14	3.03

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BDI-II = Beck's Depression Inventory-II, STAI-A = State-Trait Anxiety Inventory form A, STAI-B = State-Trait Anxiety Inventory form B, DES = Dissociative Experiences Scale, WBSI = White Bear Suppression Inventory, VVIQ = Vividness of Visual Imagery Questionnaire, M = mean, SD = standard deviation, [1] = 23 men. * = $p < .05$, ** = $p < .01$

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Table 2. Descriptive statistics for the subjective characteristics of retrieved scenes by gender and retrieval condition during retrieval in Part I.

	Involuntary				**Voluntary**			
	Men		**Women**		**Men**		**Women**	
Measure	Emo	Neu	Emo	Neu	Emo	Neu	Emo	Neu
	M (SD)	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*
Intensity	3.20 (0.84)	1.39 (0.50)	3.97 (0.80)	1.73 (0.77)	3.63 (0.97)	1.47 (0.62)	4.19 (0.63)	1.51 (0.69)
Bodily reactions	2.04 (0.72)	1.18 (0.33)	2.95 (0.97)	1.32 (0.58)	2.23 (0.91)	1.22 (0.34)	2.98 (1.04)	1.31 (0.49)
Specificity	3.49 (0.95)	3.75 (1.09)	3.32 (1.12)	4.06 (1.12)	3.34 (0.68)	3.99 (0.82)	3.18 (0.67)	3.71 (0.76)
Reaction time	3794 (1752)	3643 (1540)	4371 (1777)	3625 (1240)	7587 (2397)	6564 (1876)	7045 (2023)	6279 (2280)
Percentage memories	19.66 (18.21)	17.84 (17.08)	17.84 (17.20)	18.23 (16.42)	48.18 (27.61)	51.82 (24.96)	42.71 (18.95)	44.53 (17.51)
	M (range)	*M (range)*	*M (range)*	*M (range)*	*M (range)*	*M (range)*	*M (range)*	*M (range)*
Raw frequency	6.3 (0-20)	5.7 (0-24)	6.0 (0-28)	5.8 (0-22)	8.1 (0-17)	8.6 (1-21)	7.5 (2-21)	7.2 (3-16)

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Emo = emotional memories, Neu = neutral memories, *M* = mean, *SD* = standard deviation

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Table 3. Main effects and interactions for the subjective characteristics of emotional memories by gender and retrieval condition during retrieval in Part I. Statistically significant results at the $p < .05$ level are in **bold**.

	Gender		**Emotion**		**Retrieval**		**Gender x Emotion**		**Gender x Retrieval**		**Emotion x Retrieval**		**Gender x Emotion x Retrieval**	
	***F*(1,83)**	η_p^2	***F*(1,83)**	η_p^2	***F*(1,83)**	η_p^2	***F*(1,83)**	η_p^2	***F*(1,83)**	η_p^2	***F*(1,83)**	η_p^2	***F*(1,83)**	η_p^2
Intensity	**15.17**	.16	**378.72**	.82	1.30	.02	**4.35**	.05	1.34	.02	3.02	< .04	0.04	< .01
Bodily reaction	**14.76**	.15	**184.30**	.69	0.27	< .01	**14.31**	.15	0.19	< .01	0.23	< .01	0.10	< .01
Specificity	0.22	< .01	**25.09**	.23	0.37	< .01	0.71	< .01	0.82	.01	0.17	< .01	1.76	.02
Reaction time	0.03	< .01	**13.70**	.14	**65.88**	.44	0.22	< .01	0.87	.01	1.51	.02	1.38	.02
Percentage memories[1]	0.93	.01	0.30	< .01	**59.75**	.39	< 0.01	< .01	0.59	< .01	0.89	.01	0.30	< .01

[1] Error degrees of freedom = 91

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Table 4. Hierarchical regression analyses predicting frequency of emotional memories (N = 95), bodily reaction (N = 90), and intensity (N = 90).

	Frequency					**Bodily reaction**					**Emotional intensity**				
	ΔR^2	*B*	*SE b*	β	*p*	ΔR^2	*B*	*SE b*	β	*p*	ΔR^2	*B*	*SE b*	β	*p*
Step 1	.43**					.35**					.57**				
Constant		-15.822	17.423				-.208	.762				.099	.555		
BDI-II		.088	.508	-.018	.862		.002	.022	.009	.936		.018	.016	.103	.271
STAI-B post retrieval		.607	.223	.261	.008		.033	.010	.362	.001		-.007	.007	-.087	.313
STAI-A		-.320	.293	-.120	.279		-.025	.013	-.234	.056		-.004	.009	-.042	.668
DES		.647	.258	.223	.014		.023	.011	.199	.044		.001	.008	.009	.911
WBSI		.290	.175	.148	.100		.003	.008	.040	.684		-.004	.005	-.063	.436
VVIQ		-1.951	3.069	-.055	.527		-.040	.125	-.029	.752		.029	.097	.023	.769
Encoding intensity		2.791	3.112	.078	.372		.527	.136	.373	<.001		.947	.099	.751	<.001
Retrieval condition		26.672	4.341	.543	<.001		-.008	.192	-.004	.968		.185	.140	.106	.188
Step 2	.02					.07*					.03*				
Constant		-22.951	17.423				.423	.755				.465	.561		
BDI-II		-.005	.508	-.001	.992		-.006	.021	-.031	.776		.013	.016	.077	.401
STAI-B post retrieval		.656	.224	.282	.004		.029	.009	.319	.002		-.009	.007	-.115	.176
STAI-A		-.384	.294	-.144	.195		-.019	.012	-.183	.118		-.001	.009	-.009	.924
DES		.556	.263	.191	.038		.030	.011	.261	.008		.005	.008	.050	.536
WBSI		.320	.174	.164	.070		.001	.007	.013	.889		-.005	.005	-.080	.308
VVIQ		-.630	3.169	-.018	.843		-.165	.133	-.119	.219		-.043	.099	-.035	.665
Encoding intensity		4.408	3.269	.124	.181		.391	.137	.277	.005		.868	.102	.688	<.001
Retrieval condition		26.724	4.309	.544	<.001		-.041	.183	-.021	.825		.166	.136	.095	.226
Gender		-6.935	4.587	-.141	.134		.588	.193	.301	.003		.341	.143	.196	.020

** p < .001, * < .05, BDI-II = Beck's Depression Inventory-II, STAI-A = State-Trait Anxiety Inventory form A, STAI-B = State-Trait Anxiety Inventory form B, DES = Dissociative Experiences Scale, WBSI = White Bear Suppression Inventory, VVIQ = Vividness of Visual Imagery Questionnaire.

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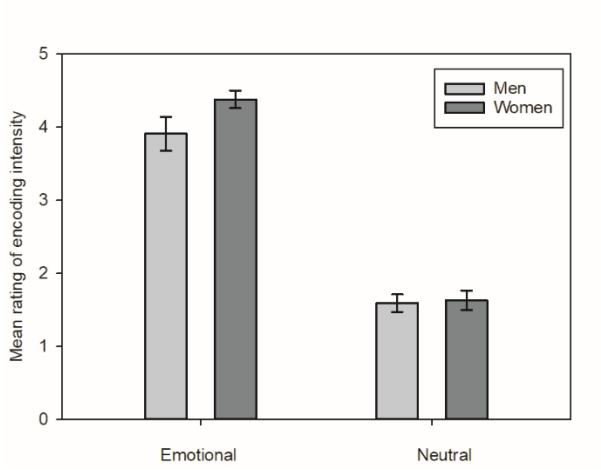
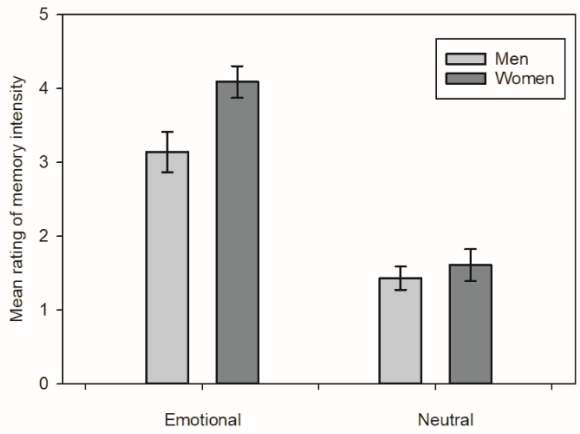
Figure 1. Gender differences in A) emotional intensity of negative and neutral picture scenes during encoding, B) emotional intensity of emotional and neutral memories during retrieval, and C) bodily reaction to emotional and neutral memories during retrieval. Error bars denote 95% confidence intervals.

A



B



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C