Psychological Research
https://doi.org/10.1007/s00426-020-01294-4

ORIGINAL ARTICLE

Is internal source memory recognition modulated by emotional encoding contexts?

Diana R. Pereira[1] · Adriana Sampaio[1] · Ana P. Pinheiro[1,2]

Received: 12 April 2019 / Accepted: 18 January 2020

Abstract
The influence of emotion on memory has been mainly examined by manipulating the emotional valence and/or arousal of critical items. Few studies probed how emotional information presented during the encoding of critical neutral items modulates memory recognition, particularly when considering source memory features. In this study, we specified the role of emotional encoding contexts in internal source memory performance (discrimination between encoding tasks) using a mixed (Experiment 1) and a blocked design (Experiment 2). During the study phase, participants were required to evaluate a set of neutral words, using either a self-referential or a semantic (common judgment) encoding strategy. Prior and concomitantly with each word, negative, neutral or positive pictures were presented in the background. The beneficial effect of self-referential encoding was observed for both item and internal source memory in both experiments. Remarkably, item and internal source memory recognition was not modulated by emotion, even though a secondary analysis indicated that the consistent exposure to negative (vs. positive) information led to worse source memory performance. These findings suggest that internal source memory of neutral items is not always affected by changing or repetitive emotional encoding contexts.

Introduction

Emotional information appears to have a privileged status in cognitive processing relative to non-emotional information: we are faster at detecting, identifying and directing our attentional resources to emotional stimuli (Calvo & Lang, 2004; Carretié, Hinojosa, Martín-Loeches, Mercado, & Tapia, 2004; Meinhardt & Pekrun, 2003; Pratto & John, 1991; see also Hamann, 2001). Such advantage has been also demonstrated in the context of episodic memory. The emotion-enhanced memory (EEM) effect indicates that emotional stimuli are remembered better than neutral ones (Dolcos & Cabeza, 2002; Kensinger, Gutchess, & Schacter, 2007; Marchewka et al., 2016; Talmi, Anderson, Riggs, Caplan, & Moscovitch, 2008; see Murphy & Isaacowitz, 2008 for a meta-analytic review). Whereas most studies addressed the impact of emotional encoding conditions on memory for neutral target items (item memory), other aspects of episodic memory such as memory binding and source memory have received less attention. Specifically, source memory represents the memory for qualitative features of a study episode, which might include perceptual, contextual (e.g., spatiotemporal features), cognitive (e.g., elaboration processes), and affective (e.g., feelings elicited by the situation) details, being also permeable to the effects of previous experiences (e.g., stereotypes; beliefs; Johnson, Hastroudi, & Lindsay, 1993; Johnson & Raye, 1981).

Studies probing the effects of emotional stimuli on source memory have yielded mixed findings (see Appendix table from Pereira, Sampaio, & Pinheiro, 2019 for a selective overview). Emotional stimuli have been associated with improved source memory compared to neutral ones (e.g., Doerksen & Shimamura, 2001; Kensinger & Corkin, 2003). Notwithstanding, other studies reported impaired source memory for emotional stimuli (e.g., Cook, Hicks, & Marsh,

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s00426-020-01294-4) contains supplementary material, which is available to authorized users.

✉ Ana P. Pinheiro
appinheiro@psicologia.ulisboa.pt

Diana R. Pereira
diana.r.pereira@gmail.com

Adriana Sampaio
adriana.sampaio@psi.uminho.pt

1 Psychological Neuroscience Lab, CIPsi, School of Psychology, University of Minho, Campus de Gualtar, 4710-057 Braga, Portugal

2 Faculdade de Psicologia, Universidade de Lisboa, Alameda da Universidade, 1649-013 Lisbon, Portugal

Published online: 14 February 2020

2007; Ferré, Comesaña, & Guasch, 2019, Experiments 2 and 3; Mitchell, Mather, Johnson, Raye, & Green, 2006; Newsome, Dulas, & Duarte, 2012), whereas others reported null effects (e.g., Ferré et al., 2019, Experiment 1; Kensinger & Schacter, 2006; Koenig & Mecklinger, 2008; Pereira et al., 2019, Experiment 1).

The study of the factors that may account for these discrepant results (e.g., retention interval; type of stimuli; intentionality of encoding; encoding strategy) may shed light on the relationship between memory and emotion (Murphy & Isaacowitz, 2008). In this context, the way emotion is manipulated during encoding should also be considered (e.g., Han, Mao, Kartvelishvili, Li, & Guo, 2018). Specifically, the EEM effect is usually observed by manipulating stimulus valence (the hedonic value of the stimuli, ranging from unpleasant/negative to pleasant/positive) and/or arousal (the degree of activation elicited by the stimuli, ranging from a relaxed/calm to an excited/aroused state; Lang, Bradley, & Cuthbert, 1990; Lang, Greenwald, Bradley, & Hamm, 1993). In this case, emotional salience represents an intrinsic feature of the target stimuli. Nonetheless, emotional cues might be unrelated and extrinsic to the target stimuli, such as when emotional information is concomitantly presented (an emotional context/background—e.g., face; picture; sound) during the encoding of neutral items (e.g., Cui et al., 2016; Smith, Henson, Dolan, & Rugg, 2004; Takashima, van der Ven, Kroes, & Fernández, 2016). For example, the processing of neutral items in emotional vs. neutral contexts has been associated with differences in electrophysiological brain responses, reflected in larger amplitudes of the Late Positive Complex (LPC) in emotional conditions during encoding (Ventura-Bort, Löw, Wendt, Dolcos, et al., 2016), and by enhanced parietal old-new differences during retrieval (Ventura-Bort, Löw, Wendt, Moltó, et al., 2016; Ventura-Bort et al., 2017).

Even though some studies support an EEM effect for neutral stimuli studied in emotional contexts relative to neutral contexts (Takashima et al., 2016; Ventura-Bort, Löw, Wendt, Moltó, et al., 2016), others report a memory advantage only in the case of positive contexts (Smith et al., 2004; Smith, Henson, Rugg, & Dolan, 2005). Null effects were also documented (Jaeger, Johnson, Coronna, & Rugg, 2009; Jaeger & Rugg, 2012). One could hypothesize that the presentation of an emotional context interferes with the encoding of critical items since emotional information receives prioritized processing and requires additional resources that otherwise could be exclusively devoted to the target stimuli (Lv, Wang, Tu, Zheng, & Qiu, 2011; Meinhardt & Pekrun, 2003; Pereira et al., 2006). Such interference has been shown when emotional target stimuli, particularly negative/arousing items, disrupted the associations between the targets and their backgrounds (e.g., Bisby & Burgess, 2013, Experiment 1; Mather, Gorlick, & Nesmith, 2009, Experiment 3), and between target items as observed in some associative memory studies (e.g., Bisby & Burgess, 2013, Experiment 3; Bisby, Horner, Hørlyck, & Burgess, 2016; Han et al., 2018; see also Bisby & Burgess, 2017 for a review). Nonetheless, when considering neutral targets presented in emotional contexts, emotional encoding conditions were found to elicit beneficial or null effects on memory performance (e.g., Jaeger et al., 2009; Jaeger & Rugg, 2012; Takashima et al., 2016; Ventura-Bort, Löw, Wendt, Moltó, et al., 2016).

The studies reviewed so far indicate that an emotional context may influence how a neutral critical stimulus is encoded and remembered, specifically when both stimulus and context are deemed relevant during encoding. However, concurrent emotional information is not always relevant for the task, and sometimes it is necessary to control for possible interference effects elicited by distracting emotional information (Dolcos, Iordan, & Dolcos, 2011; Iordan, Dolcos, & Dolcos, 2016). In this context, it is important to clarify in which conditions the processing of contextual emotional cues facilitates or hampers task performance, such as when one needs to code and subsequently remember certain types of information. This may also have practical implications, namely to the development of strategies targeting the reappraisal of emotional distractors. These strategies could be valuable, for example, in mood disorders characterized by a processing bias towards negative information (e.g., Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007; Koster, De Raedt, Goeleven, Franck, & Crombez, 2005; Mogg, Bradley, Williams, & Mathews, 1993; Watson, Dritschel Jentzsch, & Obonsawin, 2008). Furthermore, in conditions wherein the presence of emotion is beneficial, this knowledge can also be used to develop strategies aiming to boost the encoding and retrieval of neutral information in daily life.

Typically, emotional interference paradigms involve the presentation of an emotional stimulus (e.g., face; odor; picture; sound) prior, after and/or together with a critical neutral item (Erk et al., 2003; Guo, Li, Zhang, Cui, & Wei, 2018; Macri, Pavard, & Versace, 2018; Pierguidi et al., 2016; Ventura-Bort et al., 2017). Contrary to the studies discussed before, here the emotional context is task-irrelevant since participants are not required to associate context and item. When considering memory for neutral target stimuli, results are mixed and seem to vary according to the type of context (e.g., face vs. scenes: Bowen & Kensinger, 2017). Some studies support an EEM for both positive and negative information (Bridge, Chiao, & Paller, 2010; Brierley, Medford, Shaw, & David, 2007; Graf & Yu, 2015), whereas others indicate selective benefits of either positive (Erk et al., 2003; Martínez-Galindo & Cansino, 2015, 2017; Pierguidi et al., 2016) or negative contexts (Bowen & Kensinger, 2017). However, some studies do not find such emotion-related enhancement (Baeken et al., 2012; Bowen

& Kensinger, 2017; Fenker, Schott, Richardson-Klavehn, Heinze, & Düzel, 2005; Macri et al., 2018), and some even report a deleterious effect, particularly when high-arousing stimuli are used (Guo et al., 2018; Zhang, Liu, An, Yang, & Wang, 2015). Despite the putative role played by the type of encoding contexts and their arousal properties in the explanation of the mixed findings (e.g., Bowen & Kensinger, 2017; Guo et al., 2018; Zhang et al., 2015), it is also critical to examine the mechanisms underpinning the effects of emotional irrelevant information.

Even when emotional stimuli are used as distractors, they could still easily attract attentional resources due to their evolutionary and motivational value (Bradley et al., 2003; Lang et al., 1990; Lang, Bradley, & Cuthbert, 1997). Consequently, the resources available for concurrent tasks could be reduced, resulting in longer response times and/or increased errors (e.g., Blair et al., 2007; Erthal et al., 2005; Lv et al., 2011; Meinhardt & Pekrun, 2003; Mitchell et al., 2007; Pereira et al., 2006). These deleterious effects appear particularly problematic when both emotional distractors and ongoing task are presented in a short temporal window or in contiguity. Notwithstanding, when this competition is minimized, the processing of emotional information may have a positive effect on the concurrent task (Bocanegra & Zeelenberg, 2009). The presentation of emotional stimuli may also lead to interference effects by inducing transient mood changes (e.g., Pereira et al., 2006; Sakaki, Gorlick, & Mather, 2011). Furthermore, the presentation of negative pictures before tasks requiring semantic processing was found to result in longer response times but not before perceptual tasks (Sakaki et al., 2011). This suggests that negative irrelevant information may only interfere with tasks that strongly rely on semantic processing (see also Kensinger, 2009). This hypothesis fits well with evidence showing that memory for negative items is associated with more internal details such as thoughts and feelings than positive items, whereas there is no difference with respect to visual and temporal features (Mickley & Kensinger, 2009).

The evidence presented so far emerged from item memory studies. Few studies have addressed how emotional encoding conditions impact upon other features of source memory. In this context, the current study examined how emotional (negative/positive) and neutral encoding contexts modulate internal source memory, that is, the ability to discriminate between internally derived processes (e.g., 'did I judge this item as self-descriptive or as commonly used?'; Johnson et al., 1993). Internally derived memories usually include information concerning the cognitive operations (e.g., encoding strategy; imagery; organization of the information; autobiographical elaborations; verbal thoughts) taking place during encoding (Ferguson, Hashtroudi, & Johnson, 1992). Thus, this provides an ideal opportunity to probe how irrelevant emotional information affects the elaborative process during encoding and consequently impacts upon source memory.

As far as we know, no previous study has examined emotional interference effects on internal source monitoring. Notwithstanding, more recent studies (Macri et al., 2018; Ventura-Bort et al., 2017; Xie & Zhang, 2017) offer some indirect evidence for these effects. Macri et al. (2018) presented negative and neutral odors during the learning phase. In the test phase, the source memory task consisted of remembering the locations of each item: source memory performance was improved for items presented in a negative relative to a neutral context. Ventura-Bort et al. (2017) used neutral objects paired with emotional and non-emotional scenes during encoding and tested the memory for spatial locations of the objects one week after the encoding session. Their results revealed no emotion effects on source memory. Finally, Xie and Zhang (2017) presented negative, positive, and neutral picture contexts and asked participants to memorize a neutral object including its color and orientation. During test, participants needed to reproduce the color and the orientation of each object: source memory for both color and orientation benefited from negative encoding conditions compared to neutral and positive conditions (Xie & Zhang, 2017). Overall, this evidence suggests that negative emotional encoding contexts facilitate the distinction between different externally derived sources (i.e., external source memory; Johnson et al., 1993). Specifically, the benefit associated with negative contexts (Macri et al., 2018; Xie & Zhang, 2017) suggests that the presence of emotional information can enhance the ongoing processing of the main tasks (Bocanegra & Zeelenberg, 2009). These findings are also consistent with the idea that negative information interferes less with the processing of perceptual features (Sakaki et al., 2011), such as location or color of critical items, when compared to semantic processing.

As internal source memory requires discriminating memories of different cognitive operations, the impact of negative information on internal source memory may also differ from external source memory, which is based on more perceptual, temporal, and spatial features (Ferguson et al., 1992). Thereby, the effects of emotion on source memory may vary as a function of the type of detail that is manipulated (Schmidt, Patnaik, & Kensinger, 2011). To the best of our knowledge, this is the first study to explore how emotional information might affect the cognitive operations taking place during encoding and subsequent internal source memory decisions. Two possible outcomes were considered. First, negative information could have a deleterious effect on internal source memory. This hypothesis is grounded in the study of Sakaki et al. (2011), which revealed that negative information might interfere with semantic processing and hence affect encoding and subsequent recognition. Second, a null effect could be expected if we consider the chance-level results reported by Ventura-Bort et al. (2017). As a matter of fact, the experimental design adopted in the current study had more in common with the former study than with the studies of Macri et al. (2018) and Xie and Zhang (2017). Nonetheless, since we adopted an immediate study-test interval and intentional encoding conditions, source memory performance is likely to be above chance-level. To test these predictions, neutral and emotional (negative and positive) pictures were presented together with target items in a self-reference task or a common judgment task (Experiment 1). Both emotional/neutral pictures and semantic tasks were intermixed during the study phase. Response times during encoding and recognition were also considered given that they provide additional evidence about which conditions modulate performance.

Considering that the time of exposure to item and background in memory studies is usually long, transient affect changes could account for the effects observed in emotional interference studies (e.g., Pereira et al., 2006; Sakaki et al., 2011; Xie & Zhang, 2017). Thereby, this possibility was explored in a second experiment wherein the neutral vs. emotional (positive and negative) encoding conditions were presented in a blocked design. Such design is commonly used in studies probing the effects of the sustained exposure to emotional stimuli, such as pictures (e.g., Figueira et al., 2017; Güntekin & Tülay, 2014; Pinheiro, Barros, Dias, & Niznikiewicz, 2017; Smith, Bradley, & Lang, 2005; Subramaniam et al., 2016). Although few studies explored how affect changes modulate source memory performance, reality monitoring studies (testing our ability to distinguish internally from externally derived information; Johnson et al., 1993) revealed that participants in a positive affective state were more prone to source memory misattributions when compared to participants in a negative affective state (Gingerich & Dodson, 2013). Positive affect was also associated with more accurate source memory performance when compared to a neutral condition (Subramaniam et al., 2016; Subramaniam, Ranasinghe, Mathalon, Nagarajan, & Vinogradov, 2017). Specifically, source memory performance in a reality monitoring task (self-generated vs. externally presented information) was found to be improved in a positive (vs. neutral) condition, particularly in the case of self-generated information (Subramaniam et al., 2016). No difference in source memory performance was found between the negative and the neutral conditions. Such results stand in contrast with studies probing external source memory (Macri et al., 2018; Ventura-Bort et al., 2017; Xie & Zhang, 2017). Thereby, Experiment 2 aimed to specify how affect impacts upon internal source memory performance.

Experiment 1

In this experiment, the influence of emotional encoding contexts on internal source memory was examined by presenting emotional (negative and positive) and neutral pictures together with to-be-remembered neutral words. The study phase was followed by an old–new recognition test in which participants were instructed to discriminate between two internally derived sources associated with the neutral words during encoding. To enhance interference effects during encoding, we manipulated the valence of the distractor stimuli while keeping their arousal constant for two main reasons. First, differences in the neurofunctional mechanisms underlying effects of valence vs. arousal on memory have been documented (amygdala–hippocampal interactions in the case of arousal, and prefrontal cortex–hippocampal interactions in the case of valence; Kensinger, 2004; Kensinger & Corkin, 2003, 2004). Hence, the control of stimulus arousal properties is required to establish that any observed effects are due to valence. Second, previous studies indicated that whereas arousal effects are associated with a biological advantage of high-arousing stimuli, valence effects seem to rely on additional deliberate encoding resources through semantic and autobiographic elaborations (Cook et al., 2007; Kensinger, 2004; Kensinger & Corkin, 2004). In the latter case, by manipulating valence, interference effects may emerge from a conflict between the elaborative processes elicited by the emotional information and the elaborative processes required by the ongoing task, particularly in the case of negative information, which appears to elicit more thoughts and feelings than positive information (Mickley & Kensinger, 2009).

Also, to enhance control over the elaborative processes associated with each item during encoding, we used two tasks requiring a semantic and thus a deep analysis of the word following the levels of processing framework (Craik & Lockhart, 1972; Craik & Tulving, 1975): a common judgment task in which participants evaluated if the word was frequently used by people in their everyday life; a self-reference task in which participants stated if the word described or was related to them. The self-referential processing is a well-known approach to boost memory performance as items encoded self-referentially are better remembered than items encoded in other deep and perceptual processing tasks (e.g., Culcea & Freitas, 2017; Leshikar, Dulas, & Duarte, 2015; Leshikar & Duarte, 2012; Rogers, Kuiper, & Kirker, 1977; Symons & Johnson, 1997). The contrast between the self-referential task and the common judgment task provides an opportunity to explore how emotional encoding contexts, particularly negative ones (Sakaki et al., 2011), interfere with tasks putatively involving distinct levels of processing. Although the common judgment task may be considered a deep semantic processing task, the self-referential processing has been proposed to enhance organization and elaboration (Symons & Johnson, 1997). Accordingly, Fan et al. (2016) reported that, relative to a neutral condition, the self-reference effect was weakened when participants were exposed to negative information, which was reflected in electrophysiological changes: reduced amplitudes of the P200, N200 and P300 event-related potential components for words processed self-referentially and preceded by negative pictures when compared to words processed self-referentially and preceded by neutral pictures. Although negative information is expected to interfere with both self-referential and common encoding tasks (Sakaki et al., 2011), it is not clear how it modulates internal source memory. As such, during the test phase of Experiment 1, the internal source memory task involved recognizing whether a certain item was studied in the self-referential condition, in the common condition, or whether it was a new item.

Methods

Participants

The initial sample included 32 college students, who received course credit for their participation in the experiment. The Beck Depression Inventory-II (BDI-II; Beck, Steer, & Brown, 1996; Coelho, Martins, & Barros, 2002; Martins, Coelho, Ramos, & Barros, 2000) and the State-Trait Anxiety Inventory—Form Y (STAI-Y; Santos & Silva, 1997; Silva & Campos, 1998; Silva & Spielberger, 2007) were used to rule out the presence of mood disorders. This control was necessary considering evidence showing that the processing of mood-congruent information is favored in relation to less congruent information, reflected in a processing bias towards negative information in depression or dysphoria (e.g., Koster et al., 2005; Watson et al., 2008), or a bias towards negative and threatening information in anxiety disorders (e.g., Bar-Haim et al., 2007; Mogg et al., 1993). Accordingly, data from two participants were discarded, one due to self-reported depression diagnosis, and another due to moderate depressive symptoms (score equal or above 20; Kendall, Hollon, Beck, Hammen, & Ingram, 1987). The final sample was composed of 30 participants (27 females; 28 right-handed), with ages between 18 and 36 years ($M=21.00$, $SD=4.15$), with an average of 13.63 years of education ($SD=2.40$). These participants reported no past/current medical or psychiatric conditions that could affect task performance. They also reported normal or corrected-to-normal vision, hearing, and motor abilities. Written informed consent was obtained from all participants, and all the procedures were approved by the local Ethics Committee of the University of Minho.

As no previous study explored how the presentation of emotional information during encoding of neutral items influence internal source memory, the study of Macri and colleagues (2018) and a previous experiment with a similar source memory task (Pereira et al., 2019) were used as references to estimate sample size based on reported values of partial eta squared (η_p^2). The η_p^2 values ranged between 0.08 and 0.56 in the case of source memory performance, using samples between 24 and 32 participants. Hence, using G*Power software (Faul, Erdfelder, Lang, & Buchner, 2007), a sample of at least 14 participants was indicated as necessary to achieve an effect size of 0.08 (calculated as in SPSS and using a 3 [valence: negative/neutral/positive] × 2 [source: self/common] repeated-measures ANOVA as the statistical test of reference), with a power parameter of 0.80, and an alpha significance level of 0.05.

Materials

Stimuli were 180 neutral adjectives and 90 pictures differing in emotional valence (see Supplementary Table S1). Adjectives were selected from the European Portuguese (EP) version of the Affective Norms for English Words (ANEW) (Bradley & Lang, 1999; Soares, Comesaña, Pinheiro, Simões, & Frade, 2012), and also from a pilot study aiming to extend the ANEW database. A brief description of the procedure and main results from the pilot study is presented as Supplementary Material. The valence ratings of the adjectives ranged between 4.00 and 6.11 ($M=5.03$, $SD=0.61$), with medium arousal ratings ($M=5.10$, $SD=0.81$; see Supplementary Table S1). The 180 adjectives were randomly distributed across six lists of 30 items, which were used in both study and test phases. No statistically significant differences were found between lists regarding valence ($p=0.84$), arousal ($p=0.92$), frequency per million ($p=0.42$), number of letters ($p=0.81$), and number of syllables ($p=0.98$). Additionally, 14 adjectives were selected to be used as training and filler items.

Pictures were selected from the EP adaptation of the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2008; Soares et al., 2015). Specifically, using the IAPS valence ratings as reference, 30 negative, 30 neutral, and 30 positive pictures were selected.[1] As expected,

[1] The pictures selected from the EP version of the IAPS were: negative—1271, 1274, 1280, 2120, 2276, 2694, 2700, 2722, 6010, 6200, 6800, 7135, 8231, 9001, 9008, 9031, 9160, 9171, 9186, 9290, 9330, 9390, 9440, 9468, 9480, 9582, 9584, 9592, 9830, 9832; neutral—1303, 1321, 1505, 1560, 1726, 2309, 2312, 2590, 2605, 3360, 4233, 5920, 5950, 5961, 6910, 7360, 7450, 7497, 7632, 7640, 7920, 8060, 8116, 8117, 8160, 8192, 8220, 8325, 9070, 9422; positive—1540, 1710, 1720, 1722, 1920, 2070, 2080, 2155, 2170, 2360, 4601, 5300, 5621, 5623, 5626, 7340, 7350, 7430, 7501, 7660, 8031, 8163, 8185, 8186, 8193, 8370, 8420, 8496, 8500, 8501.

statistically significant differences were found between negative, neutral, and positive lists regarding valence (positive > neutral; positive > negative; neutral > negative; all $p < 0.001$), but no significant differences regarding arousal ratings were observed ($p = 0.22$), so arousal was held constant at medium levels. Furthermore, a similar count of human [$X^2(2, 90) = 1.16$, $p = 0.56$], animal [$X^2(2, 90) = 0.58$, $p = 0.75$], common objects [$X^2(2, 90) = 3.75$, $p = 0.15$], landscape [$X^2(2, 90) = 1.19$, $p = 0.38$], food [$X^2(2, 90) = 2.17$, $p = 0.34$], and animate [$X^2(2, 90) = 1.35$, $p = 0.51$] elements was ensured between valence categories. The 30 images of each valence category were divided into three lists including 10 negative, 10 neutral, and 10 positive images each. Each list served as a study block. Additional 14 images were used as fillers and training items. Different picture–word compounds were arranged to ensure that each picture was presented with different words across participants.

Procedure

At the beginning of the experimental task, participants were told they were about to perform a memory task, in which words and pictures would be shown. For some words, participants were asked to evaluate if the word described or related to themselves (self-referential condition) by responding "yes" or "no". For other words, they were asked to evaluate if those words were frequently used by people in day-by-day settings (common [non-self-referential] condition; see Leshikar et al., 2015) and were required to respond "yes" or "no". A picture was presented concomitantly with each word. Participants were instructed not only to look at the pictures as they would be asked to rate them later (see Pinheiro et al., 2013; Pinheiro et al., 2015), but also to focus on the words as they would have to recognize them and their source (self-referential or common) among new words (intentional learning conditions). Participants were instructed to respond as fast as possible in all phases of the experiment and to be as accurate as possible particularly during the test phase. They were also informed that they were going to perform three independent study-test cycles. Each study phase was composed of 30 word-picture trials, 10 with negative, 10 with neutral, and 10 with positive pictures presented in a random order. In half of the trials, participants had to make self-referential judgments, while in the other half they had to perform common judgments. The participants were also required to keep their right and left index fingers on the "v" and "n" keys to respond "yes" or "no", respectively. The "yes"/ "no" responses were counterbalanced across participants. In each test phase, 30 old adjectives presented during the study were randomly mixed with 30 new adjectives, and participants had to perform old–new recognition judgments. Also, every time the participants judged an item as "old", they were asked if they remembered the emotional content of the image that appeared together with the item. The aim of this question was twofold: first, to check whether participants remembered the emotional content of the pictures of a specific valence category better; second, to evaluate whether participants made additional efforts to associate word and picture, even if they were not instructed to do so and asked to prioritize the words and their source. During the test phase, participants were required to keep their right and left index and middle fingers on the "c", "v", "n", and "m" keys to provide a response. The response mapping of these keys was also counterbalanced across participants. Prior to the experimental trials, participants performed a brief training to get familiarized with the instructions and procedures.

Specifically, each study trial started with a black fixation cross ("+") displayed on the center of the screen in a light gray background, for 500 ms. A negative, neutral or positive picture appeared first alone for 1000 ms and then together with a superimposed neutral adjective for 3000 ms, on the center of the screen. Hence, each image was displayed on the screen for a total of 4000 ms. We decided to present pictures before and together with the target items, since we were interested in the effects of distractor stimuli on encoding and not on consolidation processes (e.g., Anderson, Wais, & Gabrieli, 2006). Together with both picture and word, the instruction "Self-description" or "Common" was presented on top of the screen to inform the participants about the judgment they should perform in each trial. Two small cues "Y" and "N" were also added to the bottom of the screen to remember the participants when they should respond, and to minimize the cognitive load of remembering the response mapping (see Fig. 1). Participants had to provide a response within the 3000 ms after word onset. If time elapsed and no response was registered, the next trial was automatically presented to ensure all participants had the same exposure time to both picture and word. The first two and the last two trials of each study phase were filler items to mitigate possible primacy and recency effects, and they were not considered in the statistical analysis.

During the test phase, each trial started with a black fixation cross (500 ms), followed by an old or new word that remained on the center of the screen until a response was made (self-paced). For each word, participants had to choose one of four options: "self-description"; "common"; "evaluated, but do not know if self-description/common"; "new". The "do not know option" was included to minimize guessing and response bias following previous studies (e.g., Dulas & Duarte, 2014; Leshikar & Duarte, 2012, 2014; Newsome et al., 2012; Sharot & Yonelinas, 2008). In a similar vein, if the participant judged an item as "old" by responding "self-description", "common" or "evaluated, but do not know if self-description/common", an additional screen was displayed, and participants were required to report if they recalled the emotional content of the image paired with the

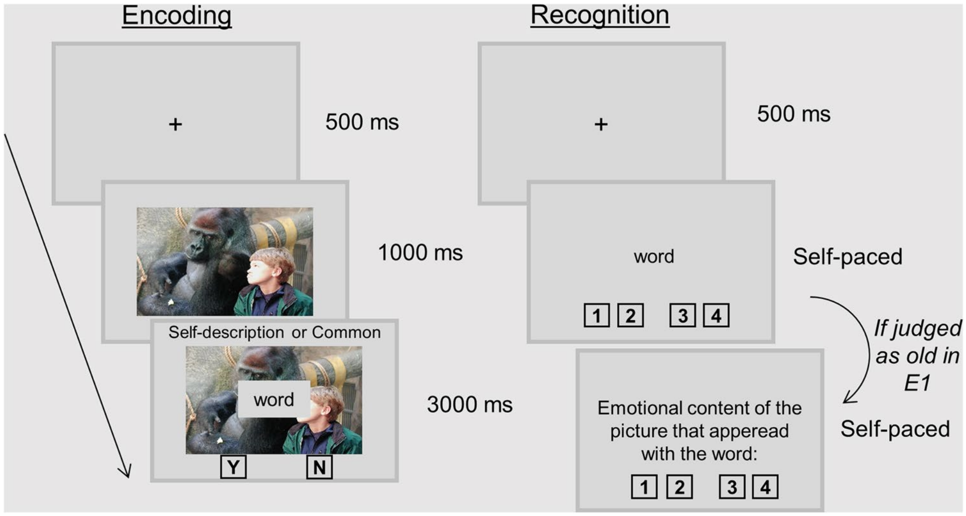

Fig. 1 Schematic illustration of an experimental trial from encoding and retrieval phases. Whereas in Experiment 1 each block included mixed trials with negative, neutral and positive pictures, in Experiment 2 each block was composed by pictures of the same valence category. In the encoding phase, the position of "Yes" (Y) and "No" (N) keys was counterbalanced across participants. In the retrieval phase, keys "1" to "4" could be mapped into "self-description", "common", "evaluated, but do not know if self-description/common" or "new" for both experiments, and into "negative", "neutral", "positive", "do not know" in the case of Experiment 1

previously judged word. Another four options were available in this case: "negative"; "neutral"; "positive"; "do not know". The mapping between options and response keys was always shown on the bottom of the screen (see Fig. 1).

At the end of the session, as a manipulation check, participants were also required to rate the valence of the pictures shown during the experimental task, using the 9-point Self-Assessment Manikin (SAM) scale (Bradley & Lang, 1999; 1 = the most unpleasant/negative, 9 = the most pleasant/positive). Superlab software 5.0 (Cedrus Corporation, 2015) was used to program and control stimulus presentation.

Data analysis

Item recognition accuracy was based on the Snodgrass and Corwin (1988) recognition measure: Pr = ([*p*(hits) – *p*(false alarms)]). Of note, the *p*(hits) were obtained by merging correct/incorrect source responses, and "do not know" responses. The response bias was also computed: Br = ([*p*(false alarms)/(1 – Pr)]). Values below 0.50 are indicative of a conservative response criterion, whereas values above 0.50 suggest a liberal response criterion (Snodgrass & Corwin, 1988). Following previous studies (e.g., Dulas & Duarte, 2014; Leshikar et al., 2015; Newsome et al., 2012), source memory recognition accuracy was based on the difference between correct source responses and incorrect source responses, [*p*(correct) – *p*(incorrect)]. After computing these measures, a 3 (valence: negative vs. neutral vs. positive) × 2 (source: self vs. common) repeated-measures analysis of variance (ANOVA) was run. Of note, a Friedman's ANOVA was used in the case of response bias as data were non-normally distributed. To support the ANOVA results, a Bayesian analysis with JASP (JASP Team, 2018; Wagenmakers, Love et al., 2018; Wagenmakers, Marsman et al., 2018; see Supplementary Table S8–S9 and Figure S1) and a multinomial model approach were implemented, as described elsewhere (Pereira et al., 2019; see Supplementary Material section and Supplementary Tables S2–S4).

A similar 3 (valence: negative vs. neutral vs. positive) × 2 (source: self vs. common) repeated-measures ANOVA was used to examine response times obtained during the encoding phase, in the specific case of correct source responses. As a manipulation check, a one-way ANOVA was conducted with the picture valence ratings provided by the participants at the end of the session, in order to confirm if their valence ratings match those originally extracted from the EP version of the IAPS database (Soares et al., 2015).

In the Supplementary Material section, together with the results from the Bayesian and multinomial analysis, we present additional findings regarding the one sample *t*-tests run on item and source recognition measures to ensure that old–new and self-common source discriminations were not at chance level. Additional analyses are also presented regarding the proportion of incorrect source responses, "do not know" responses, misses, correct rejections, false alarms, "yes" responses provided during encoding, and a repeated-measures 2 (congruency: "yes" vs. "no" response in the encoding) × 3 (valence) × 2 (source) ANOVA including the factor congruency.

Statistical analyses were performed with the IBM Statistical Package for the Social Sciences Statistics, version 24 (IBM SPSS Statistics for Windows, Armonk, NY). The Greenhouse–Geisser approach was applied as correction when violations of sphericity were observed, and Bonferroni-corrected post-hoc tests were used to explore significant differences between conditions.

Results

Table 1 presents a summary of the main descriptive statistics regarding the behavioral performance in Experiment 1.

Recognition accuracy

Item recognition

The 3 × 2 repeated-measures ANOVA yielded a main effect of source, $F(1, 29) = 28.25$, $p < 0.001$, $\eta_p^2 = 0.49$, but no effect of valence, $F(2, 58) = 0.66$, $p = 0.521$, $\eta_p^2 = 0.02$, nor an interaction effect between source and valence factors, $F(2, 58) = 1.33$, $p = 0.272$, $\eta_p^2 = 0.04$. Pairwise comparisons supported a beneficial effect of self-referential encoding on item memory: words encoded in a self-referential manner ($M = 0.72$, $SE = 0.02$) were better recognized than words encoded in the common condition ($M = 0.60$, $SE = 0.02$; $p < 0.001$, $d = 0.97$, 95% CI [0.07, 0.15]; see Table 1 and Fig. 2a). Regarding response bias, the 3 × 2 Friedman's ANOVA revealed a statistically significant effect, $X^2(5) = 27.89$, $p < 0.001$. Specifically, for words presented together with positive pictures, the Br values were higher in the case of self-referential condition in comparison with the common condition ($p = 0.002$; significant for $p < 0.006$ applying the Bonferroni correction for multiple comparisons). Following the Snodgrass and Corwin (1988) interpretation of the Br value, participants were less conservative in the self-referential condition than in the common condition (see Table 1 and Supplementary Table S6). Nonetheless, on average, Br values were below 0.50, suggesting an overall conservative response criterion.

Source recognition

In the case of source memory, a main effect of valence, $F(2, 58) = 4.30$, $p = 0.018$, $\eta_p^2 = 0.13$, and a main effect of source, $F(1, 29) = 77.47$, $p < 0.001$, $\eta_p^2 = 0.73$, were observed, but no interaction effect emerged, $F(2, 58) = 0.68$, $p = 0.511$, $\eta_p^2 = 0.02$. Bonferroni-corrected post-hoc tests revealed that the source (self-referential/common) of words studied with neutral pictures as background was better recognized ($M = 0.42$, $SE = 0.04$) when compared to words studied in a negative background ($M = 0.36$, $SE = 0.03$; $p = 0.009$, $d = 0.59$, 95% CI [0.01, 0.11]). Even though Bayesian analysis supported a main effect of source, i.e., an advantage in source memory recognition for words in the self-referential condition ($M = 0.52$, $SE = 0.04$) relative to the non-self-referential condition ($M = 0.26$, $SE = 0.04$; $p < 0.001$, $d = 1.61$, 95% CI [0.20, 0.32]; see Table 1 and Fig. 2c), it did not support the valence effect nor the difference between words studied in negative vs. neutral contexts (see Supplementary Material section).

Given the importance of the valence effect for the current study and considering that participants provided valence ratings for each picture, the measure of source memory accuracy was recomputed for each participant based on these ratings instead of the EP IAPS ratings. Based on prior studies (e.g., Kensinger & Corkin, 2004; Ritchey, LaBar, & Cabeza, 2011), pictures receiving valence ratings between 1 and 3 were considered negative, between 4 and 6 were considered neutral, and between 7 and 9 were considered positive. Then a 3 (valence) × 2 (source) repeated-measures ANOVA was run on source memory accuracy. When stimulus ratings are organized in a bidimensional valence x arousal affective space, ratings typically fit a boomerang- or U-shape distribution (Lang et al., 1997; Lang, Bradley, & Cuthbert, 1998), revealing that more extreme valence scores are also associated with more extreme arousal scores. Thus, by selecting trials containing pictures rated with more extreme valence scores, it is possible to examine the influence of more arousing emotional pictures on source memory. In this context, a second 3 × 2 repeated-measures ANOVA was also run using the most extreme valence values, i.e., 1 and 2 for negative and 8 and 9 for positive stimuli, while keeping the neutral category within the same range.

Contrary to the initial analysis following the EP IAPS norms (Soares et al., 2015), the analyses using the participants' ratings only yielded a main effect of source ($F(1, 28) = 54.77$, $p < 0.001$, $\eta_p^2 = 0.66$ for the first analysis; $F(1, 24) = 25.73$, $p < 0.001$, $\eta_p^2 = 0.52$ for the second analysis), confirming the memory advantage for words studied self-referentially ($M = 0.50$, $SE = 0.04$; $M = 0.54$, $SE = 0.05$) in contrast to words studied in the common condition ($M = 0.26$, $SE = 0.04$; $p < 0.001$, $d = 1.37$, 95% CI [0.18, 0.32] for the first analysis; $M = 0.28$, $SE = 0.05$; $p < 0.001$, $d = 1.02$, 95% CI [0.16, 0.37] for the second analysis; see Supplementary Table S12). Thus, in line with the Bayesian results, no support was found in favor of a valence effect in the current analyses.

Table 1 Descriptive statistics of the behavioral performance for each experimental condition (source × valence) considering both experiments

	Experiment 1—*M* (*SD*)						Experiment 2—*M* (*SD*)					
	Self			Common			Self			Common		
	Negative	Neutral	Positive	Negative	Neutral	Positive	Negative	Neutral	Positive	Negative	Neutral	Positive
Correct source	0.57 (0.20)	0.60 (0.22)	0.60 (0.19)	0.36 (0.17)	0.43 (0.19)	0.37 (0.21)	0.59 (0.17)	0.62 (0.18)	0.61 (0.18)	0.35 (0.19)	0.37 (0.19)	0.40 (0.18)
Incorrect source	0.08 (0.07)	0.06 (0.06)	0.06 (0.08)	0.12 (0.12)	0.12 (0.09)	0.13 (0.09)	0.06 (0.09)	0.07 (0.11)	0.09 (0.12)	0.13 (0.10)	0.12 (0.14)	0.10 (0.11)
Source DNK	0.14 (0.11)	0.14 (0.13)	0.14 (0.13)	0.20 (0.17)	0.16 (0.13)	0.16 (0.16)	0.20 (0.15)	0.16 (0.15)	0.14 (0.12)	0.27 (0.19)	0.27 (0.16)	0.21 (0.16)
Source miss	0.21 (0.14)	0.20 (0.15)	0.19 (0.14)	0.31 (0.17)	0.29 (0.15)	0.34 (0.17)	0.15 (0.14)	0.14 (0.11)	0.15 (0.11)	0.25 (0.16)	0.24 (0.17)	0.29 (0.15)
Item Pr measure	0.70 (0.15)	0.71 (0.17)	0.73 (0.14)	0.60 (0.15)	0.63 (0.14)	0.58 (0.17)	0.72 (0.16)	0.74 (0.13)	0.72 (0.16)	0.63 (0.17)	0.64 (0.16)	0.59 (0.18)
Item Br measure	0.30 (0.26)	0.35 (0.31)	0.37 (0.31)	0.25 (0.25)	0.25 (0.24)	0.23 (0.23)	0.45 (0.34)	0.45 (0.33)	0.41 (0.33)	0.33 (0.25)	0.36 (0.29)	0.29 (0.24)
SM measure	0.48 (0.24)	0.54 (0.24)	0.54 (0.21)	0.23 (0.20)	0.31 (0.22)	0.24 (0.24)	0.53 (0.20)	0.55 (0.22)	0.53 (0.26)	0.23 (0.21)	0.26 (0.23)	0.30 (0.20)
RT – Study phase	2058 (267)	2038 (279)	2027 (259)	1961 (252)	1927 (279)	1915 (255)	2005 (273)	1914 (248)	1974 (248)	1937 (264)	1822 (233)	1862 (262)
RT – Correct source	2518 (794)	2522 (671)	2494 (697)	2987 (805)	3014 (858)	3088 (1122)	1911 (645)	1971 (557)	1986 (598)	2480 (1148)	2379 (974)	2499 (960)
	New						New negative		New neutral		New positive	
CR	0.92 (0.08)						0.87 (0.11)		0.88 (0.09)		0.88 (0.11)	
FA	0.08 (0.08)						0.13 (0.11)		0.12 (0.09)		0.12 (0.11)	
RT – CR	1546 (520)						1409 (459)		1391 (437)		1442 (445)	
RT – FA	3102 (1496)						2119 (794)		2759 (1763)		2807 (1522)	

CR correct rejections, *DNK* do not know, *FA* false alarms, *RT* response time, *SM* source memory

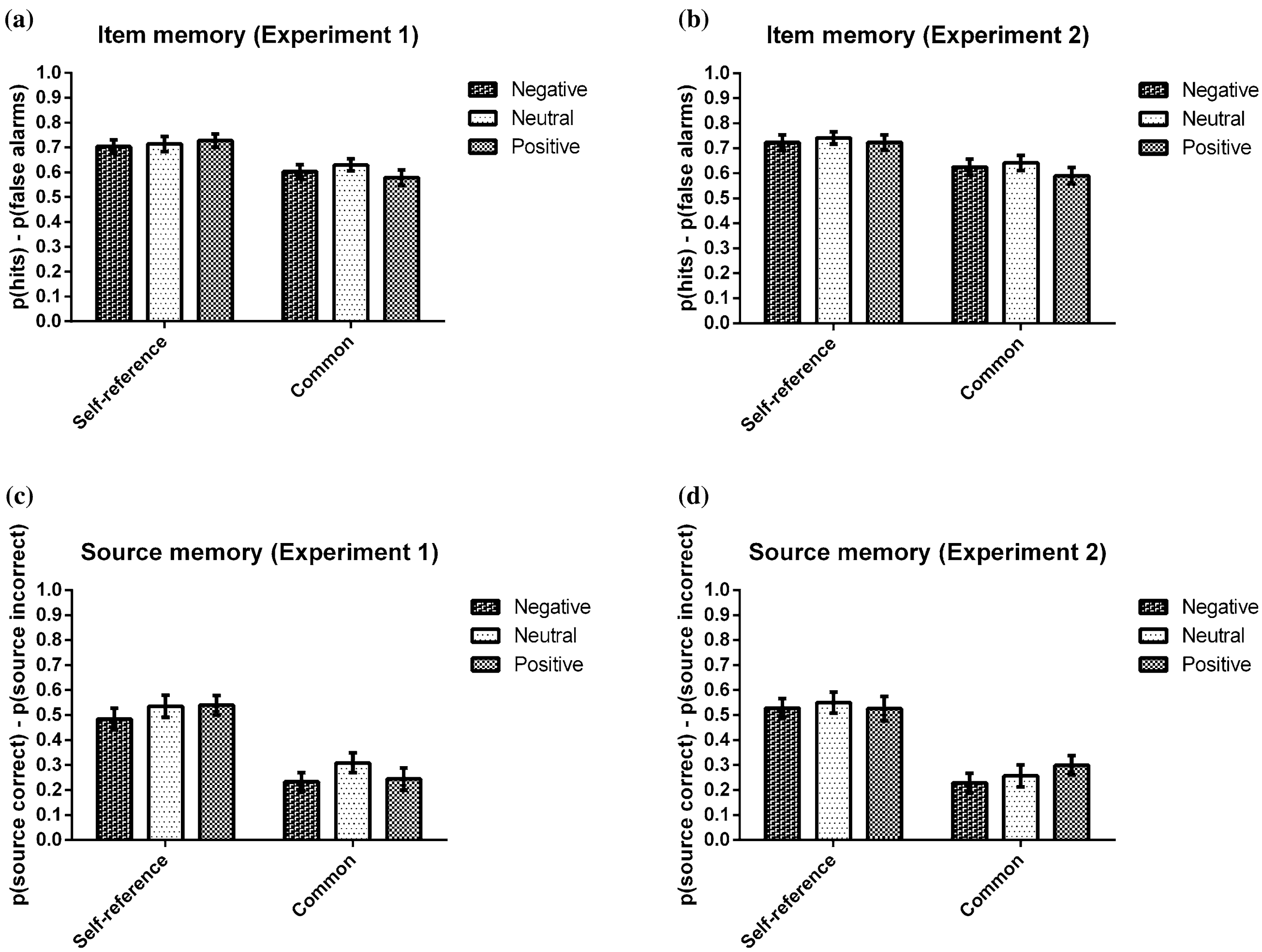

Fig. 2 The recognition scores obtained for item (panel **a**—Experiment 1; panel **b**—Experiment 2) and source memory (panel **c**—Experiment 1; panel **d**—Experiment 2) are plotted on the *y*-axis as a function of source (self-reference/common) and valence of the background picture (negative/neutral/positive) presented during encoding. The error bars indicate the standard errors of the means

Response time

Study phase

The mean response times inform about possible interference effects and elaborative processes taking place during the encoding phase. The statistical analysis yielded a main effect of source, $F(1, 29) = 17.99$, $p < 0.001, \eta_p^2 = 0.38$ [valence: $F(2, 58) = 1.25$, $p = 0.294$, $\eta_p^2 = 0.04$; interaction: $F(2, 58) = 0.073$, $p = 0.929$, $\eta_p^2 = 0.003$], showing that participants responded faster to words in the common condition ($M = 1934$, $SE = 45.01$) than to words in the self-referential condition ($M = 2041$, $SE = 44.19$; $p < 0.001$, $d = 0.774$, 95% CI [55.34, 158.42]; see Table 1 and Fig. 3a).

Correct source responses

Similarly to the study phase results, the repeated-measures ANOVA only revealed a main effect of source $F(1, 26) = 22.43$, $p < 0.001, \eta_p^2 = 0.46$ [valence: $F(2, 52) = 0.14$, $p = 0.872$, $\eta_p^2 = 0.005$; interaction: $F(2, 58) = 0.73$, $p = 0.487, \eta_p^2 = 0.03$], but the difference was in the opposite direction: whereas responses during the study phase were slower in the self-referential condition, the RTs associated with accurate source responses were faster in the self-referential condition ($M = 2536$, $SE = 117.18$) than in the common condition ($M = 3034$, $SE = 167.84$; $p < 0.001$, $d = 0.91$, 95% CI [281.49, 713.28]; see Table 1 and Fig. 3c).

Manipulation check

The valence ratings of the pictures presented during the experimental task were comparable to the ratings of the EP version

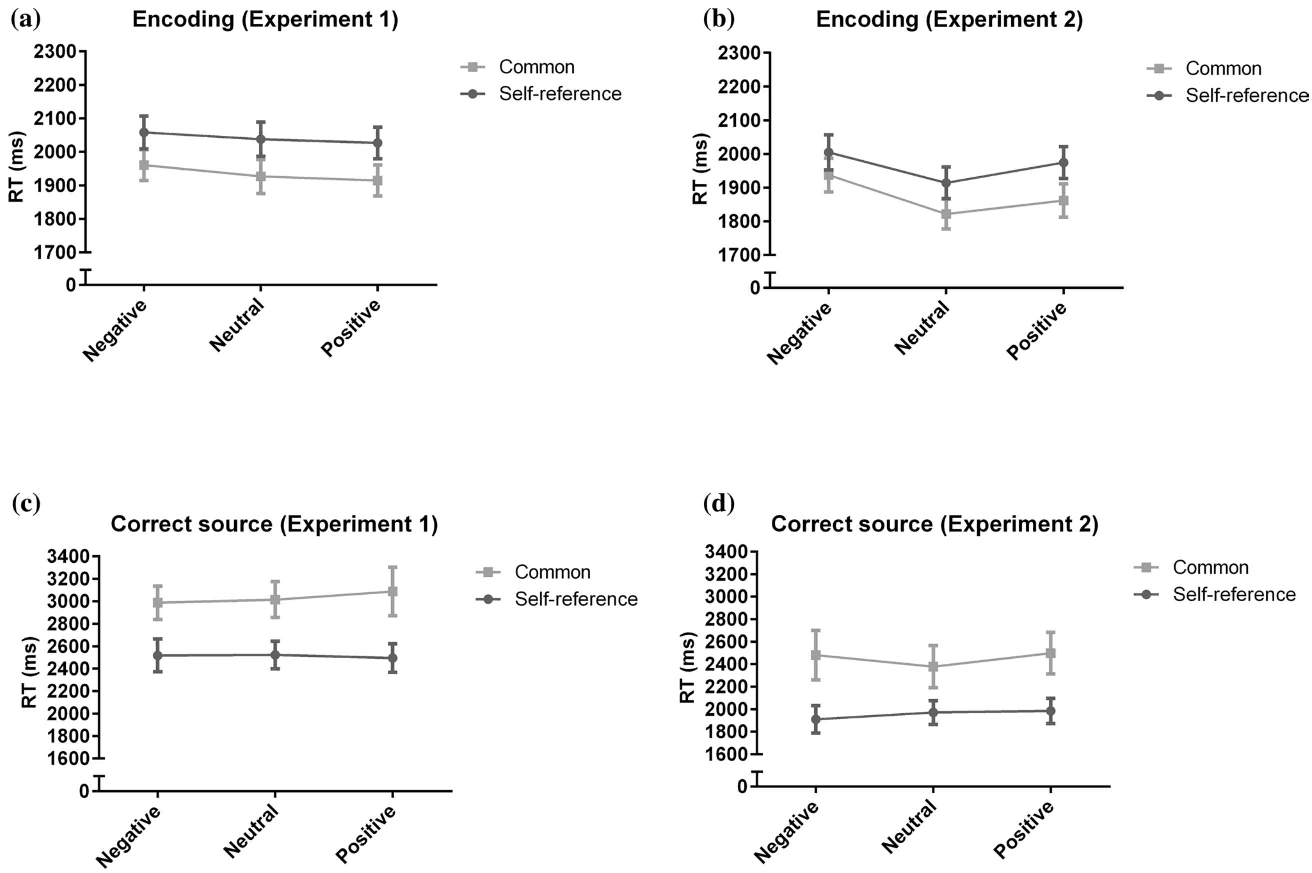

Fig. 3 The response times obtained during the study phase (panel **a**—Experiment 1; panel **b**—Experiment 2) and during the recognition phase for source hits are plotted on the *y*-axis as a function of source (self-reference/common) and valence of the background picture (negative/neutral/positive) shown during encoding. The error bars indicate the standard errors of the means

of the IAPS (Soares et al., 2015; see Supplementary Table S1). Specifically, statistically significant differences were observed between the mean valence ratings of the negative, neutral, and positive pictures presented in the current experiment, $F(2, 87) = 303.95$, $p < 0.001, \eta_p^2 = 0.88$. As expected, positive pictures received the highest valence ratings ($M = 7.00$, $SD = 0.61$), followed by neutral pictures ($M = 4.67$, $SD = 0.77$), with negative pictures receiving the lowest valence ratings ($M = 2.91$, $SD = 0.52$; $p < 0.001$ and $d > 2.66$ for all pairwise comparisons; positive vs. neutral: 95% CI [1.36, 2.17]; positive vs. negative: 95% CI [3.69, 4.50]; neutral vs. negative: 95% CI [1.93, 2.74]).

Discussion: Experiment 1

In the current experiment, the initial participant-based analysis (repeated-measures ANOVA) suggested that the internal source memory performance of neutral words encoded in a negative context was impaired when compared to words encoded in a neutral context. No statistically significant differences emerged when comparing positive encoding contexts with both negative and neutral encoding contexts. As source memory scores were computed based on incorrect source responses, the former finding was not due to significant differences in the proportion of incorrect source responses across valence conditions (see Supplementary Material section). However, additional participant-based analyses based on individual valence ratings and both Bayesian and multinomial models provided weak evidence in favor of such valence effect (see Supplementary Material section). Previous studies exploring the influence of emotional interference during encoding in external source memory reported a positive effect of negative information (Macri et al., 2018; Xie & Zhang, 2017) or null effects accompanied by a floor effect (Ventura-Bort et al., 2017). Thus, in the case of internal source memory, the current experiment did not find any memory advantage for stimuli encoded in emotional contexts, but rather supported the lack of an effect. In the case of item memory, even though the item memory scores were indirectly derived from correct/

incorrect source responses, and "do not know" responses, no EEM effect on recognition performance was observed (e.g., Baeken et al., 2012; Bowen & Kensinger, 2017; Fenker et al., 2005).

Considering that the external source memory features examined in previous studies were perceptual and spatial in nature (see Macri et al., 2018; Ventura-Bort et al., 2017; Xie & Zhang, 2017), and that internal source memory features are mainly characterized by cognitive operations (Johnson & Raye, 1981; Raye & Johnson, 1980), one of our hypothesis was that negative information would result in the worst internal source memory performance by interfering with semantic processing (Sakaki et al., 2011). Additionally, given previous evidence showing that the presence of negative stimuli can attenuate the degree of self-reference, at least at the electrophysiological level (Fan et al., 2016), we were also interested in exploring if the putative interference would differ across encoding tasks. Contrary to our hypothesis, the current experiment showed that the presentation of negative pictures during word encoding did not significantly affect either immediate memory performance, or the way participants behaviorally responded to the common condition and, particularly, to the self-referential condition (see Supplementary Material section).

Indeed, during encoding there was no evidence supporting a significant interference effect in the case of negative contexts when compared to both positive and neutral contexts. This claim is supported by our results regarding response time analysis as no significant negative valence modulations were observed during encoding. Slowed response times in main tasks have been reported for negative valence distractors and interpreted as an index of competition for attentional resources (Blair et al., 2007; Erthal et al., 2005; Mitchell et al., 2007; Nielen et al., 2009). Although the absence of a significant response time modulation is not unprecedented (e.g., Erk, Martin, & Walter, 2005), it could also be the case that the stimuli were not presented in enough temporal proximity to cause a deleterious competition for attentional resources (Bocanegra & Zeelenberg, 2009). Thus, considering the experimental conditions used in Experiment 1, another mechanism by which negative information might interfere with encoding is by inducing transient negative mood states (Pereira et al., 2006; Sakaki et al., 2011; Xie & Zhang, 2017), which have been associated with deleterious effects on memory performance (e.g., Ellis, Thomas, & Rodriguez, 1984; Gärtner & Bajbouj, 2014; Zlomuzica, Preusser, Totzeck, Dere, & Margraf, 2016). In this context, one possible way to enhance the interference effect is to repeatedly present negative information to produce such mood changes. This possibility was tested in Experiment 2.

Experiment 2

The repetitive exposure to emotional pictures of the same valence category has been shown to induce affective changes (Figueira et al., 2017; Pinheiro et al., 2017; Smith, Bradley et al., 2005; Subramaniam et al., 2016), to result in sustained interference effects on performance in the main task (Pereira et al., 2006), and even to modulate spontaneous brain oscillatory activity (Güntekin & Tülay, 2014). Thus, in this experiment, the emotional and neutral pictures of Experiment 1 were presented in three valence-related blocks: one negative, one positive, and one neutral. By presenting emotional and neutral trials in a blocked design, we aimed to increase the interference effect of negative information (see Pereira et al., 2006) and to probe changes in the mood state of participants. As such, after each study phase, participants were asked to report their subjective negative and positive affect. An internal source memory impairment was hypothesized for neutral words encoded in negative contexts through transient mood changes. Specifically, based on previous studies (e.g., Figueira et al., 2017; Pinheiro et al., 2017), we predicted an increase in subjective negative affect and a decrease in positive affect after the presentation of unpleasant pictures, but no significant affect changes after both positive and neutral blocks.

Method

Participants

The same inclusion/exclusion and ethical procedures implemented in Experiment 1 were adopted in Experiment 2. Even though the initial sample was composed of 33 young adults, three participants were excluded due to self-report of moderate to severe depressive symptomology as measured by the BDI-II (Beck et al., 1996; Coelho et al., 2002; Kendall et al., 1987; Martins et al., 2000), one was excluded due to medical diagnosis of depression, and another was excluded due to current pharmacological treatment with anticonvulsant drugs. The final sample was composed of 28 young adults (26 females; 23 right-handed), aged between 18 and 32 years ($M = 21.63$, $SD = 3.96$), and with 14.61 average years of formal education ($SD = 3.22$).

Materials

The same pool of adjectives and pictures described in Experiment 1 were used in Experiment 2. Besides the BDI-II (Beck et al., 1996; Coelho et al., 2002; Martins et al., 2000), and the STAI-Y (Santos & Silva, 1997; Silva & Campos, 1998; Silva & Spielberger, 2007), we also administered the EP version of the Positive and Negative Affect Schedule (PANAS; Galinha & Pais-Ribeiro, 2005; Watson, Clark, & Tellegen, 1988) four times across the experimental session. The PANAS is a self-report questionnaire that measures current positive and negative affect by asking the participants to rate, on a 5-point Likert-type scale (1 = "not at all"; 5 = "extremely"), a group of 20 adjectives (e.g., negative: distressed, nervous, guilty; positive: interested; inspired; attentive). Participants were required to assess their current mood state.

Procedure

The procedure followed Experiment 1 (see Fig. 1). Nonetheless, some changes were introduced. Specifically, before providing the instructions to perform the experimental task, participants were asked to complete the PANAS questionnaire, and they were told that the questionnaire would appear three more times during the experimental task. The first time served as a baseline measure, and then PANAS was administered immediately after the encoding phase of each study-test block.

Contrary to Experiment 1, in which negative, neutral, and positive pictures were mixed within a block, each study phase in Experiment 2 included only pictures of the same valence. Of note, the presentation of negative, neutral, and positive blocks was counterbalanced and randomized across participants. Additionally, whereas in the test phases of Experiment 1 participants were asked if they could recall the emotional content of the pictures that appeared together with words recognized as "old", in Experiment 2 this question was not included. Thus, each test trial was only composed of a fixation cross (500 ms) followed by an old or new item (self-paced).

Data analysis

The same data analysis procedure planned for Experiment 1 was followed in Experiment 2. The only exception was the use of a 3 (valence: negative vs. neutral vs. positive) × 2 (source: self vs. common) Friedman's ANOVA, instead of a repeated-measures ANOVA, for mean response time of source hits. This option was adopted as some of the data were non-normally distributed, following the Shapiro–Wilk test and the absolute values of skewness and kurtosis. Wilcoxon tests with corrections were used as follow-up comparisons in the case of statistically significant results. Concerning the PANAS mood scores, the difference between self-reported affect before and after each pictures block was computed, following previous studies (e.g., Figueira et al., 2017; Kohn et al., 2014). Second, a repeated-measures ANOVA was run with the difference scores for the positive affect scale, and the non-parametric equivalent, the Friedman's ANOVA, in the case of the negative affect scale as the data were non-normally distributed. In the latter case, Wilcoxon tests were planned for statistically significant results.

Results

Table 1 displays the main descriptive statistics of the behavioral performance obtained in Experiment 2.

Recognition accuracy

Item recognition

As in Experiment 1, we replicated the self-referential encoding advantage in word recognition ($M = 0.73$, $SE = 0.02$) when compared to the common condition ($M = 0.62$, $SE = 0.03$; $p < 0.001$), regardless of valence, $F(1, 27) = 29.43$, $p < 0.001, \eta_p^2 = 0.52$, $d = 1.03$, 95% CI [0.07, 0.15]; see Table 1 and Fig. 2b). No other significant effects were observed [valence: $F(2, 54) = 0.92$, $p = 0.404, \eta_p^2 = 0.03$; interaction: $F(2, 54) = 0.73, p = 0.489, \eta_p^2 = 0.03$]. The analysis of the response bias indicated a main effect of source, $F(1, 25) = 11.22, p = 0.003$, $\eta_p^2 = 0.31$, and no other significant effects were found [valence: $F(2, 50) = 1.12$, $p = 0.336, \eta_p^2 = 0.04$; interaction: $F(2, 50) = 0.19, p = 0.827, \eta_p^2 = 0.01$]. Specifically, participants were more conservative in the recognition of words encoded in the common condition ($M = 0.32$, $SE = 0.05$) than words encoded in the self-referential condition ($M = 0.44$, $SE = 0.06$; $p = 0.003$, $d = 0.66$, 95% CI [0.04, 0.18]; see Table 1). Once more, on average, participants showed a Br value below 0.50, which is indicative of a conservative response criterion (Snodgrass & Corwin, 1988).

Source recognition

Similarly to item recognition, only a main effect of source was observed, $F(1, 27) = 71.96$, $p < 0.001, \eta_p^2 = 0.73$. This effect showed once again a general benefit of the self-referential condition ($M = 0.54$, $SE = 0.04$) compared to the non-self-referential condition ($M = 0.26$, $SE = 0.03$; $p < 0.001$; $d = 1.60$, 95% CI [0.21, 0.34]; see Table 1 and Fig. 2d). Neither a main effect of valence, $F(2, 54) = 0.55$, $p = 0.580, \eta_p^2 = 0.02$, nor an interaction effect reached statistical significance, $F(2, 54) = 1.15, p = 0.314$, $\eta_p^2 = 0.04$, $\varepsilon = 0.77$.

As in Experiment 1, two additional repeated-measures ANOVA were run considering the individual IAPS valence ratings provided by the participants. Nonetheless, since a block design was used in Experiment 2, we only considered trials in a given block whose individual ratings matched the valence category previously assigned to that block. For example, in the positive block, we only considered trials in which pictures were deemed positive for a given participant. In the first analysis, a main effect of source, $F(1, 27) = 69.23$, $p < 0.001, \eta_p^2 = 0.72$, and a main effect of valence were found, $F(2, 54) = 3.58$, $p = 0.035, \eta_p^2 = 0.12$, yet no interaction effect, $F(2, 54) = 0.66$, $p = 0.482, \eta_p^2 = 0.02$, $\varepsilon = 0.75$. Once again, the source memory performance associated with words studied in the self-referential condition ($M = 0.55$, $SE = 0.04$) was improved compared to words studied in the common condition ($M = 0.27$, $SE = 0.03$; $p < 0.001$, $d = 1.57$, 95% CI [0.21, 0.34]). Moreover, the valence effect was reflected in an improved source memory performance for neutral words presented in the positive ($M = 0.46$, $SE = 0.04$) relative to the negative block ($M = 0.37$, $SE = 0.04$; $p = 0.030$, $d = 0.53$, 95% CI [0.01, 0.19]; see Supplementary Table S12). Bayesian analysis supported the two main effects model as well as the difference between negative and positive conditions (see Supplementary Material section). In the second analysis including trials with more extreme values of negative and positive valence only a main effect of source was observed, $F(1, 24) = 43.53$, $p < 0.001$, $\eta_p^2 = 0.65$ [valence: $F(1, 24) = 43.53$, $p < 0.001$, $\eta_p^2 = 0.65$; interaction: $F(2, 48) = 0.55$, $p = 0.582, \eta_p^2 = 0.02$], supporting the memory advantage for words studied in the self-referential condition ($M = 0.54$, $SE = 0.05$ for self-referenced items; $M = 0.27$, $SE = 0.04$ for items studied in the common condition; $p < 0.001$, $d = 1.32$, 95% CI [0.19, 0.36]).

Response time

Study phase

Statistically significant main effects of source, $F(1, 27) = 11.45$, $p = 0.002, \eta_p^2 = 0.30$, and of valence, $F(2, 54) = 3.66$, $p = 0.032, \eta_p^2 = 0.12$, were observed. No interaction effect emerged, $F(2, 54) = 0.39$, $p = 0.681, \eta_p^2 = 0.01$. The mean response time for words presented in the neutral block during the encoding phase was faster ($M = 1868$, $SE = 43.03$) than for words presented in the negative block ($M = 1971$, $SE = 46.40$; $p = 0.011$, $d = 0.60$, 95% CI [20.53, 185.63]). Additionally, participants were slower at responding in self-referential trials ($M = 1964$, $SE = 41.18$) compared to common trials ($M = 1874$, $SE = 39.34$; $p = 0.002$, $d = 0.64$, 95% CI [35.70, 145.74]; see Table 1 and Fig. 3b).

Correct source responses

The 3×2 Friedman's ANOVA was statistically significant, $X^2(5) = 21.93$, $p = 0.001$. The follow-up Wilcoxon tests showed that, despite no significant differences between the response time of correct source responses in the distinct valence categories (see Supplementary Table S5), an effect of source was observed ($p < 0.006$ applying the Bonferroni correction for multiple comparisons). Specifically, a statistically significant difference in response time was found between common and self-encoding conditions for words presented in emotional backgrounds, both negative ($p = 0.002$) and positive ($p < 0.001$). This is in line with the main effect of source already described in Experiment 1 (see Supplementary Table S5, Table 1, and Fig. 3d).

Manipulation check

As in the original ratings reported in the ANEW (see Supplementary Table S1) and in Experiment 1, the mean valence ratings provided by the participants differed significantly between negative, neutral, and positive blocks, $F(2, 87) = 286.53$, $p < 0.001$, $\eta_p^2 = 0.87$. Negative pictures received the lowest ratings ($M = 2.99$, SD = 0.58), neutral images received intermediate ratings ($M = 4.69$, $SD = 0.84$), and positive images obtained the highest valence ratings ($M = 7.18$, $SD = 0.59$; $p < 0.001$ and $d > 2.35$ for all pairwise comparisons; positive vs. neutral: 95% CI [2.06, 2.92]; positive vs. negative: 95% CI [3.75, 4.61]; neutral vs. negative: 95% CI [1.26, 2.12]).

Of note, and relevant for the current experiment was the analysis of the PANAS difference scores considering both positive and negative affect scores (see Supplementary Table S7). For positive affect scores, the repeated-measures ANOVA yielded no statistically significant differences between negative, neutral, and positive encoding contexts, $F(2, 54) = 1.54$, $p = 0.224, \eta_p^2 = 0.05$ (negative: $M_{\text{difference}} = -2.11$, $SD = 4.87$; neutral: $M_{\text{difference}} = -2.75$, $SD = 4.59$; positive: $M_{\text{difference}} = -1.82$, $SD = 5.30$). A similar result was obtained in the case of negative affect scores, $X^2(2) = 3.62$, $p = 0.164$ (negative: $M_{\text{difference}} = 0.18$, $SD = 1.91$; neutral: $M_{\text{difference}} = -0.07$, $SD = 1.49$; positive: $M_{\text{difference}} = -0.43$, $SD = 0.92$). As a supplementary analysis, we also tested if there were any significant differences between the PANAS scores reported after the negative, neutral, and positive encoding blocks (without considering the baseline). Once again, for both positive and negative affect, no statistically significant differences emerged [$F(2, 54) = 1.54$, $p = 0.224, \eta_p^2 = 0.05$; $X^2(2) = 2.88$, $p = 0.237$, respectively]. Overall, in the current experiment, the repetitive exposure to emotional or neutral pictures did not result in significant changes in self-reported positive or negative affect.

Discussion: Experiment 2

In the current experiment, the main analyses failed to support a valence effect on both source and item memory recognition. Thus, the main effect of valence initially found in Experiment 1 did not emerge when considering the participant-based analysis in Experiment 2. Nonetheless, contrary to Experiment 1, the secondary analysis involving the participants' valence ratings yielded a main effect of valence, which was reflected in a worse source memory performance for neutral words encoded in the negative block in contrast to words encoded in the positive block. Even so, caution is warranted in the interpretation of these findings as only a portion of the initial trials was added to the analyses, creating an imbalance in the number of trials included across experimental conditions. Moreover, in the additional analysis of incorrect source responses, "do not know" responses, misses, and false alarms (see Supplementary Material section), no effects of valence were observed. Taken together, the absence of an EEM effect in the case of item memory was in line with Experiment 1 and with previous experiments (e.g., Baeken et al., 2012; Bowen & Kensinger, 2017; Fenker et al., 2005). Notwithstanding, in the case of source memory recognition, only one of the secondary analyses provided partial evidence in favor of the working hypothesis that an enhancement of sustained interference or the elicitation of mood changes during encoding, especially in a negative context, would affect internal source memory performance.

With respect to the self-reported positive and negative affect, the repetitive exposure to emotionally charged pictures, especially to negative ones, did not elicit significant changes in the subjective assessment of mood states. The qualitative observation of both negative and positive affect scores (see Supplementary Table S7) revealed that, despite a small change in negative affect between baseline and experimental blocks, the positive affect appeared to decrease after each experimental block as reported in previous studies (Denkova et al., 2010; Iordan, Dolcos, Denkova, & Dolcos, 2013). The decrease in positive affect was task-related and similar in all experimental blocks. Together with the small change in negative affect, this decrease might explain why the difference between experimental blocks and baseline did not reach statistical significance. Consequently, it may account for the memory performance findings.

The repetitive exposure to negative pictures was expected to enhance the interference effect on memory. Nonetheless, the slower response times observed during encoding in the negative block when compared to the neutral block represented the only evidence in favor of an interference effect on behavioral performance, which was not observed in Experiment 1. Slower responses in unpleasant blocks could be accounted for by mood changes, possibly associated with the activation of the motivational defensive system (Pereira et al., 2006).

The absence of subjective affect changes contrasts with previous studies (e.g., Figueira et al., 2017; Pinheiro et al., 2017). However, two main factors may explain the null effect. First, the emotional pictures used in other studies were more arousing than non-emotional ones (Bradley, Cuthbert, & Lang, 1996; Figueira et al., 2017; Güntekin & Tülay, 2014; Pinheiro et al., 2017), whereas in the current study pictures were controlled for arousal. Second, the time of exposure to each emotional picture and the number of pictures in each block was higher in prior studies (Bradley et al., 1996; Figueira et al., 2017; Smith, Bradley et al., 2005). Overall, under some specific circumstances (e.g., shorter blocks of emotional pictures that are controlled for arousal), the repetitive exposure to emotional stimuli might not lead to significant self-reported affect changes.

General discussion

The main goal of this study was to explore how emotional pictures presented during encoding might impact upon the internal source memory recognition of neutral words. Even though previous evidence revealed that the presence of negative (vs. neutral) information has a beneficial (Macri et al., 2018; Xie & Zhang, 2017) or a null effect (Subramaniam et al., 2016; Ventura-Bort et al., 2017) on source memory performance, at least when considering external source memory and reality monitoring, the effects of emotional encoding contexts on internal source memory remained to be clarified. In two experiments, one using a mixed design and another using a blocked design, we tested the hypothesis that emotional pictures, particularly negative ones, would interfere with the processing of neutral words (Sakaki et al., 2011) and, consequently, impact upon internal source memory. This hypothesis was based on the notion that accurate internal source memory performance relies on remembering details about cognitive operations that take place during encoding, such as how information was elaborated, organized or even imagined (Johnson et al., 1993). Also, it was based on prior evidence showing that the discrimination of externally vs. internally derived memories differs as the former memories are richer in temporal, spatial, and perceptual details, whereas the latter are mainly characterized by cognitive operations (Ferguson et al., 1992). Hence, the influence of emotional stimuli could also differ as a function of the nature and type of source memory discrimination (see Schmidt et al., 2011 for a similar argument), as already documented by the few available studies on external source memory (Macri et al., 2018; Ventura-Bort et al., 2017; Xie & Zhang, 2017) and reality monitoring (Subramaniam et al., 2016). Nonetheless, the results did not provide evidence supporting impaired internal source memory for neutral items initially encoded in negative contexts. The only partial evidence for a detrimental effect of negative valence on source memory was obtained in Experiment 2 considering an additional analysis based on participants' valence ratings. Notwithstanding, in both experiments we replicated the beneficial effect of self-referential conditions on both item and internal source memory when compared to other deep encoding tasks such as the common judgment task (Culcea & Freitas, 2017; Durbin et al., 2017; Fossati et al., 2004; Hamami, Serbun, & Gutchess, 2011; Leshikar & Duarte, 2012, 2014; Leshikar et al., 2015; Pereira et al., 2019; Serbun, Shih, & Gutchess, 2011; Rogers et al., 1977; Symons & Johnson, 1997). Additionally, the self-referential (vs. common) condition was associated with longer response times during encoding and faster response times in the case of source hits, which might indicate enhanced elaborative processes in the self-referential condition during encoding and easier access to self-referentially encoded items during recognition.

A null finding concerning source memory was also hypothesized given the behavioral findings of Ventura-Bort et al. (2017) on memory for the location of neutral objects, as well as the findings of Subramaniam et al. (2016) documenting the lack of an effect of negative affect on reality monitoring. It is worth noting that in studies probing emotion effects on internal source memory in which emotion is an intrinsic feature of the target stimuli (see Appendix table from Pereira et al., 2019 for a selective overview of studies on internal source memory), one of two possible outcomes have been reported: a null or an impairment effect for emotional stimuli when compared to neutral stimuli. The current findings indicate some degree of convergence between intrinsic and extrinsic manipulations of emotion during encoding on internal source memory performance. Even so, these findings also contrast with previous studies using an extrinsic manipulation of emotion, which reported a memory advantage for neutral items studied in negative contexts, considering location (Macri et al., 2018), orientation, and color features of neutral items (Xie & Zhang, 2017). Whereas these studies support the priority-binding theory (MacKay et al., 2004) by showing that negative arousing information facilitates the recollection of details associated with a specific item, the results of the current study are better accounted for by the arousal-biased competition theory (Mather & Sutherland, 2011). Specifically, as in the current study participants were instructed to pay attention to both item and background, they could have assigned similar relevance to information presented in both emotional and neutral encoding contexts. Moreover, the use of intentional encoding conditions might have enhanced the goal-relevance of the words irrespective of whether they were studied in an emotional or neutral context.

An alternative account relates to the arousal properties of the stimuli used as distractors. Whereas in the studies mentioned above negative background stimuli were more arousing than neutral background stimuli (Macri et al., 2018; Ventura-Bort et al., 2017; Xie & Zhang, 2017), in the current study both negative, positive, and neutral backgrounds were controlled for arousal (see Supplementary Table S1). Furthermore, prior studies indicated that the presentation of arousing stimuli contiguously or concomitantly with non-arousing stimuli might not disrupt or benefit feature binding in the case of non-arousing stimuli (Mather et al., 2009; Mather & Nesmith, 2008). Similarly, as the words used in the current study were neutral, their associations with the details of the encoding task (self-referential vs. common) might not have been particularly affected by the simultaneous presentation of arousing background stimuli. Taken together, controlled levels of arousal and effortful encoding conditions may have resulted in a similar prioritization of item and source details for negative, positive, and neutral encoding contexts.

Another critical aspect to consider is the time elapsed between study and test as prior studies indicated that optimal effects of emotion on memory are obtained when longer study-test intervals are used (Yonelinas & Ritchey, 2015), supporting the operation of consolidation processes (Hamann, 2001). As this factor may account for the lack of emotion effects on item memory studies (e.g., Mitchell et al., 2006; Sharot & Yonelinas, 2008; Wang, 2018), it is plausible that emotion-related effects on source memory are observed if longer study-test intervals are considered. Notwithstanding, most of the studies that explored the effect of emotional encoding contexts on source memory also used short study-test intervals (e.g., Macri et al., 2018; Xie & Zhang, 2017; Subramaniam et al., 2016) and reported significant effects of emotional relative to neutral conditions. The only exception was the study of Ventura-Bort et al. (2017), which used a one-week interval, showing that memory for the location of objects was at chance-level. Hence, the presence of emotional information during encoding in this case did not ensure that certain elements of the encoding episode resisted forgetting. Collectively, these studies highlight the need to further investigate the role of study-test time in the relationship between source memory and emotion.

Considering that a deep analysis of each word was required during encoding (Craik & Lockhart, 1972; Craik & Tulving, 1975), it is also possible that the cognitive demands imposed by the self-reference/common judgment task moderated the influence of emotional contexts. Effortful tasks were found to modulate the response to emotional information in previous studies (e.g., Kellermann et al., 2012; Van Dillen & Koole, 2007). Furthermore, the encoding tasks allowed participants to have a more consistent encoding strategy across emotional and neutral distractors. Although this is a plausible explanation for the lack of valence effects, it cannot be tested here and should be examined in future studies.

Even though the arousal-biased competition theory (Mather & Sutherland, 2011) accommodates the null findings reported here, an additional analysis based on the individual valence ratings provided by the participants in Experiment 2 partially supported our initial hypothesis concerning the effects of negative contexts. Specifically, this analysis revealed that words presented in a negative context were associated with a worse performance compared to those presented in a positive context. We initially hypothesized a difference between negative and neutral contexts, particularly considering behavioral indices of interference during encoding, i.e., longer response times in the negative compared to neutral block (Blair et al., 2007; Erthal et al., 2005; Mitchell et al., 2007; Nielen et al., 2009). Nevertheless, a difference was found between negative and positive contexts, which partially agrees with the study of Subramaniam et al. (2016) showing a benefit in reality monitoring performance when a positive mood was induced. Indeed, Experiment 2 examined the possibility that interference effects were driven by temporary affect changes prompted by the exposure to emotional pictures. Specifically, negative affect has been associated with the occurrence of irrelevant thoughts and with the narrowing of attention to specific features (e.g., an object such as a gun presented in a visually complex background), which in turn can interfere with cognitive processes required by the tasks at hand (Fredrickson & Branigan, 2005; Kensinger, 2009; Sakaki et al., 2011). In its turn, positive affect promotes broader attention and heuristic processing (also enhancing cognitive flexibility and working memory), which may facilitate task-relevant performance (e.g., Ashby, Isen, & Turken, 1999; Fredrickson & Branigan, 2005). Since memory for negative information seems to include more internal details (e.g., thoughts; feelings) from the encoding episode when compared to positive information (see Mickley & Kensinger, 2009), a stronger conflict might have occurred between the internal details spontaneously prompted by the negative pictures and the cognitive operations required by the neutral words. On the contrary, positive mood seems to promote a wider attentional scope and better cognitive flexibility during conflict resolution, which may have accounted for the advantage observed in internal source memory performance. However, caution is needed when interpreting this result, since it is only supported by an additional analysis with fewer trials. Moreover, no changes in negative or positive affect were detected in self-report measures, and only the slower response times verified during the negative encoding block might be indicative of temporary changes in affect (Pereira et al., 2006). Therefore, the lack of a more conclusive valence effect on source memory might also be related to the fact that possible emotional interference effects experienced during the encoding phase were not detrimental, giving the participants the opportunity to manage their cognitive resources and to ensure a stable memory performance.

Limitations and future research

First, as no manipulation check was conducted in terms of pictures' arousal, it is possible that participants' ratings differed from the normative ones (e.g., García-Pacios, Río, Villalobos, Ruiz-Vargas, & Maestú, 2015). As such, it is not possible to rule out potential effects of individual differences in arousal ratings on the current results. Future studies should also consider the possibility of collecting ratings for relevant variables prior to the experimental session in order to select a pool of stimuli that comply with both experimental requirements and individual differences. Such idiosyncratic selection would also accommodate sex differences in the processing of emotional stimuli (e.g., García-García et al., 2016; Stevens & Hamann, 2012), which are manifested in affective ratings (e.g., Soares et al., 2015). Indeed, since the experiments described here were mainly composed of female participants, this precludes the generalization of results.

Second, the type of recognition test here might have facilitated both item and source memory recognition as immediate study-test conditions were used. Furthermore, the retrieval phase of prior studies appeared to be more challenging as participants were required to do free-recall in the case of item memory (e.g., Erk et al., 2003), or to remember precise details such as the exact color and location in the case of source memory (e.g., Macri et al., 2018; Xie & Zhang, 2017).

As a final remark, the experimental design of emotional interference studies has been quite variable. While some studies present the interfering information before the critical item (Erk et al., 2003; Xie & Zhang, 2017), others present both types of stimuli concomitantly (Guo et al., 2018; Macri et al., 2018; Pierguidi et al., 2016; Ventura-Bort et al., 2017). Future studies should test whether these approaches lead to different effects and explore the role of factors such as exposure time, number, and type of interfering stimuli.

Conclusion

To the best of our knowledge, this is the first study to demonstrate that the encoding of critical neutral words in emotional (vs. neutral) contexts did not significantly affect behavioral performance in an internal source memory task. Notwithstanding, participants recognized more words that were encoded in the self-referential (vs. common) condition. This effect confirms a memory advantage of self-referential encoding, not only in the case of item memory but also of source memory attributions (Durbin et al., 2017; Leshikar & Duarte, 2014; Pereira et al., 2019; Serbun et al., 2011). The lack of a valence effect in the current study (in which stimuli were controlled for arousal) raises the question of whether memory changes associated with emotional interference during encoding might become more evident when negative stimuli are highly arousing. Nonetheless, the null effect does not imply that the presentation of negative or positive distractors fails to modulate encoding and recognition processes, as in previous studies null behavioral findings were accompanied with differences in electrophysiological brain responses (Ventura-Bort et al., 2017). Furthermore, when individual valence ratings were considered in source memory analysis of Experiment 2, a valence effect emerged. In this context, future studies should consider not only orthogonal manipulations of valence and arousal to better disentangle the effects of each affective dimension, but they should also include more fine-grained trial-by-trial measures of emotional-related modulations (e.g., electrophysiological brain responses and self-reported measures of affect) that better capture individual responses to emotional information. Furthermore, more studies are needed to probe if the null findings reported here are replicated when testing different internal source memory features in similar experimental conditions. Likewise, other external source memory and reality-monitoring features could be further tested. The current findings open a new avenue for future research shedding light on how emotional information, even when irrelevant to the current task goals, influences different episodic memory features.

Acknowledgements This work was supported by a PhD Fellowship (PD/BD/105964/2014), awarded to DRP, funded by the Portuguese Foundation for Science and Technology (FCT) through national funds and co-funded by the European Social Fund (ESF) through the Operational Programme for Human Capital (POCH). It was also supported by a research grant (PTDC/MHC-PCN/0101/2014) funded by FCT and awarded to APP. The study was conducted at the Psychology Research Centre (PSI/01662), University of Minho, supported by FCT and the Portuguese Ministry of Science, Technology and Higher Education (UID/PSI/01662/2019) through national funds (PIDDAC) and co-funded by FEDER through COMPETE2020 under the PT2020 Partnership Agreement (POCI-01-0145-FEDER-007653). The authors would like to acknowledge all the participants for their valuable contribution to the current study.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

References

Anderson, A. K., Wais, P. E., & Gabrieli, J. D. E. (2006). Emotion enhances remembrance of neutral events past. *Proceedings of the National Academy of Sciences of the United States of America, 103*(5), 1599–1604. https://doi.org/10.1073/pnas.0506308103.

Ashby, F. G., Isen, A. M., & Turken, A. U. (1999). A neuropsychological theory of positive affect and its influence on cognition. *Psychological Review, 106*(3), 529–550. https://doi.org/10.1037/0033-295X.106.3.529.

Baeken, C., De Raedt, R., Van Schuerbeek, P., De Mey, J., Bossuyt, A., & Luypaert, R. (2012). The influence of emotional priming on the neural substrates of memory: A prospective fMRI study using portrait art stimuli. *NeuroImage, 61*(4), 876–883. https://doi.org/10.1016/j.neuroimage.2012.03.043.

Bar-Haim, Y., Lamy, D., Pergamin, L., Bakermans-Kranenburg, M. J., & van IJzendoorn, M. H. (2007). Threat-related attentional bias in anxious and nonanxious individuals: A meta-analytic study. *Psychological Bulletin, 133*(1), 1–24. https://doi.org/10.1037/0033-2909.133.1.1.

Beck, A. T., Steer, R., & Brown, G. (1996). *Beck Depression Inventory-II Manual*. New York: The Psychological Corporation.

Bisby, J. A., & Burgess, N. (2013). Negative affect impairs associative memory but not item memory. *Learning & Memory, 21*(1), 760–766. https://doi.org/10.1101/lm.032409.113.

Bisby, J. A., & Burgess, N. (2017). Differential effects of negative emotion on memory for items and associations, and their relationship to intrusive imagery. *Current Opinion in Behavioral Sciences, 17*, 124–132. https://doi.org/10.1016/j.cobeha.2017.07.012.

Bisby, J. A., Horner, A. J., Hørlyck, L. D., & Burgess, N. (2016). Opposing effects of negative emotion on amygdalar and hippocampal memory for items and associations. *Social Cognitive and Affective Neuroscience, 11*(6), 981–990. https://doi.org/10.1093/scan/nsw028.

Blair, K. S., Smith, B. W., Mitchell, D. G. V., Morton, J., Vythilingam, M., Pessoa, L., et al. (2007). Modulation of emotion by cognition and cognition by emotion. *NeuroImage, 35*(1), 430–440. https://doi.org/10.1016/j.neuroimage.2006.11.048.

Bocanegra, B. R., & Zeelenberg, R. (2009). Dissociating emotion-induced blindness and hypervision. *Emotion, 9*(6), 865–873. https://doi.org/10.1037/a0017749.

Bowen, H. J., & Kensinger, E. A. (2017). Recapitulation of emotional source context during memory retrieval. *Cortex, 91*, 142–156. https://doi.org/10.1016/j.cortex.2016.11.004.

Bradley, M. M., & Lang, P. J. (1999). *Affective Norms for English Words (ANEW): Instruction manual and affective ratings*. Gainesville, FL: Center for Research in Psychophysiology, University of Florida.

Bradley, M. M., Cuthbert, B. N., & Lang, P. J. (1996). Picture media and emotion: Effects of a sustained affective context. *Psychophysiology, 33*(6), 662–670. https://doi.org/10.1111/j.1469-8986.1996.tb02362.x.

Bradley, M. M., Sabatinelli, D., Lang, P. J., Fitzsimmons, J. R., King, W., & Desai, P. (2003). Activation of the visual cortex in motivated attention. *Behavioral Neuroscience, 117*(2), 369–380. https://doi.org/10.1037/0735-7044.117.2.369.

Bridge, D. J., Chiao, J. Y., & Paller, K. A. (2010). Emotional context at learning systematically biases memory for facial information. *Memory & Cognition, 38*(2), 125–133. https://doi.org/10.3758/MC.38.2.125.

Brierley, B., Medford, N., Shaw, P., & David, A. S. (2007). Emotional memory for words: Separating content and context. *Cognition*

and Emotion, 21(3), 495–521. https://doi.org/10.1080/02699930600684963.
Calvo, M. G., & Lang, P. J. (2004). Gaze patterns when looking at emotional pictures: Motivationally biased attention. *Motivation and Emotion, 28*(3), 221–243. https://doi.org/10.1023/B:MOEM.0000040153.26156.ed.
Carretié, L., Hinojosa, J. A., Martín-Loeches, M., Mercado, F., & Tapia, M. (2004). Automatic attention to emotional stimuli: Neural correlates. *Human Brain Mapping, 22*(4), 290–299. https://doi.org/10.1002/hbm.20037.
Cedrus Corporation. (2015). Superlab (Version 5.0) [Computer software].
Coelho, R., Martins, A., & Barros, H. (2002). Clinical profiles relating gender and depressive symptoms among adolescents ascertained by the Beck Depressive Inventory II. *European Psychiatry, 17*(4), 222–226. https://doi.org/10.1016/S0924-9338(02)00663-6.
Cook, G. I., Hicks, J. L., & Marsh, R. L. (2007). Source monitoring is not always enhanced for valenced material. *Memory & Cognition, 35*(2), 222–230. https://doi.org/10.3758/BF03193443.
Craik, F. I. M., & Lockhart, R. S. (1972). Levels of processing: A framework for memory research. *Journal of Verbal Learning and Verbal Behavior, 11*(6), 671–684. https://doi.org/10.1016/S0022-5371(72)80001-X.
Craik, F. I. M., & Tulving, E. (1975). Depth of processing and the retention of words in episodic memory. *Journal of Experimental Psychology: General, 104*(3), 268–294. https://doi.org/10.1037/0096-3445.104.3.268.
Cui, L., Shi, G., He, F., Zhang, Q., Oei, T. P. S., & Guo, C. (2016). Electrophysiological correlates of emotional source memory in high-trait-anxiety individuals. *Frontiers in Psychology, 7*, 1039. https://doi.org/10.3389/fpsyg.2016.01039.
Culcea, I. C., & Freitas, A. L. (2017). Subjective importance as a cue for self-reference. *Personality and Social Psychology Bulletin, 43*(8), 1100–1111. https://doi.org/10.1177/0146167217705111.
Denkova, E., Wong, G., Dolcos, S., Sung, K., Wang, L., Coupland, N., et al. (2010). The impact of anxiety-inducing distraction on cognitive performance: A combined brain imaging and personality investigation. *PLoS ONE, 5*(11), e14150. https://doi.org/10.1371/journal.pone.0014150.
Doerksen, S., & Shimamura, A. P. (2001). Source memory enhancement for emotional words. *Emotion, 1*(1), 5–11. https://doi.org/10.1037/1528-3542.1.1.5.
Dolcos, F., & Cabeza, R. (2002). Event-related potentials of emotional memory: Encoding pleasant, unpleasant, and neutral pictures. *Cognitive, Affective and Behavioral Neuroscience, 2*(3), 252–263. https://doi.org/10.3758/CABN.2.3.252.
Dolcos, F., Iordan, A. D., & Dolcos, S. (2011). Neural correlates of emotion-cognition interactions: A review of evidence from brain imaging investigations. *Journal of Cognitive Psychology, 23*(6), 669–694. https://doi.org/10.1080/20445911.2011.594433.
Dulas, M. R., & Duarte, A. (2014). Aging affects the interaction between attentional control and source memory: An fMRI study. *Journal of Cognitive Neuroscience, 26*(12), 2653–2669. https://doi.org/10.1162/jocn_a_00663.
Durbin, K. A., Mitchell, K. J., & Johnson, M. K. (2017). Source memory that encoding was self-referential: The influence of stimulus characteristics. *Memory, 25*(9), 1191–1200. https://doi.org/10.1080/09658211.2017.1282517.
Ellis, H. C., Thomas, R. L., & Rodriguez, I. A. (1984). Emotional mood states and memory: Elaborative encoding, semantics processing, and cognitive effort. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 10*(3), 470–482. https://doi.org/10.1037/0278-7393.10.3.470.
Erk, S., Kiefer, M., Grothe, J., Wunderlich, A. P., Spitzer, M., & Walter, H. (2003). Emotional context modulates subsequent memory effect. *NeuroImage, 18*(2), 439–447. https://doi.org/10.1016/S1053-8119(02)00015-0.
Erk, S., Martin, S., & Walter, H. (2005). Emotional context during encoding of neutral items modulates brain activation not only during encoding but also during recognition. *NeuroImage, 26*(3), 829–838. https://doi.org/10.1016/j.neuroimage.2005.02.045.
Erthal, F. S., Oliveira, L., Mocaiber, I., Pereira, M. G., Machado-Pinheiro, W., Volchan, E., et al. (2005). Load-dependent modulation of affective picture processing. *Cognitive, Affective and Behavioral Neuroscience, 5*(4), 388–395. https://doi.org/10.3758/CABN.5.4.388.
Fan, W., Zhong, Y., Li, J., Yang, Z., Zhan, Y., Cai, R., et al. (2016). Negative emotion weakens the degree of self-reference effect: Evidence from ERPs. *Frontiers in Psychology, 7*, 1408. https://doi.org/10.3389/fpsyg.2016.01408.
Faul, F., Erdfelder, E., Lang, A., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods, 39*(2), 175–191. https://doi.org/10.3758/BF03193146.
Fenker, D. B., Schott, B. H., Richardson-Klavehn, A., Heinze, H. J., & Düzel, E. (2005). Recapitulating emotional context: Activity of amygdala, hippocampus and fusiform cortex during recollection and familiarity. *European Journal of Neuroscience, 21*(7), 1993–1999. https://doi.org/10.1111/j.1460-9568.2005.04033.x.
Ferguson, S. A., Hastroudi, S., & Johnson, M. K. (1992). Age differences in using source-relevant cues. *Psychology and Aging, 7*(3), 443–452. https://doi.org/10.1037/0882-7974.7.3.443.
Ferré, P., Comesaña, M., & Guasch, M. (2019). Emotional content and source memory for language: Impairment in an incidental encoding task. *Frontiers in Psychology, 10*, 65. https://doi.org/10.3389/fpsyg.2019.00065.
Figueira, J. S. B., Oliveira, L., Pereira, M. G., Pacheco, L. B., Lobo, I., Motta-Ribeiro, G. C., et al. (2017). An unpleasant emotional state reduces working memory capacity: Electrophysiological evidence. *Social Cognitive and Affective Neuroscience, 12*(6), 984–992. https://doi.org/10.1093/scan/nsx030.
Fossati, P., Hevenor, S. J., Lepage, M., Graham, S. J., Grady, C., Keightley, M. L., et al. (2004). Distributed self in episodic memory: Neural correlates of successful retrieval of self-encoded positive and negative personality traits. *NeuroImage, 22*(4), 1596–1604. https://doi.org/10.1016/j.neuroimage.2004.03.034.
Fredrickson, B. L., & Branigan, C. (2005). Positive emotions broaden the scope of attention and thought-action repertoires. *Cognition and Emotion, 19*(3), 313–332. https://doi.org/10.1080/02699930441000238.
Galinha, I. C., & Pais-Ribeiro, J. (2005). Contribuição para o estudo da versão portuguesa da Positive and Negative Affect Schedule (PANAS): II – Estudo psicométrico. *Análise Psicológica, 2*, 219–227.
García-García, I., Kube, J., Gaebler, M., Horstmann, A., Villringer, A., & Neumann, J. (2016). Neural processing of negative emotional stimuli and the influence of age, sex and task-related characteristics. *Neuroscience and Biobehavioral Reviews, 68*, 773–793. https://doi.org/10.1016/j.neubiorev.2016.04.020.
García-Pacios, J., Río, D. D., Villalobos, D., Ruiz-Vargas, J. M., & Maestú, F. (2015). Emotional interference-based forgetting in short-term memory. Cognitive inhibition of pleasant but not unpleasant biologically relevant distractors. *Frontiers in Psychology, 6*, 582. https://doi.org/10.3389/fpsyg.2015.00582.
Gärtner, M., & Bajbouj, M. (2014). Encoding-related EEG oscillations during memory formation are modulated by mood state. *Social Cognitive and Affective Neuroscience, 9*(12), 1934–1941. https://doi.org/10.1093/scan/nst184.
Gingerich, A. C., & Dodson, C. S. (2013). Sad mood reduces inadvertent plagiarism: Effects of affective state on source monitoring in

cryptomnesia. *Motivation and Emotion, 37*(2), 355–371. https://doi.org/10.1007/s11031-012-9309-2.

Graf, P., & Yu, M. (2015). Valenced cues and contexts have different effects on event-based prospective memory. *PLoS ONE, 10*(2), e0116953. https://doi.org/10.1371/journal.pone.0116953.

Güntekin, B., & Tülay, E. (2014). Event related beta and gamma oscillatory responses during perception of affective pictures. *Brain Research, 1577*, 45–56. https://doi.org/10.1016/j.brainres.2014.06.029.

Guo, X., Li, Y., Zhang, Q., Cui, L., & Wei, P. (2018). Weakening of recognition memory caused by task-irrelevant emotional encoding context can be modulated by individuals' inhibitory control. *Personality and Individual Differences, 134*, 201–209. https://doi.org/10.1016/j.paid.2018.06.012.

Hamami, A., Serbun, S. J., & Gutchess, A. H. (2011). Self-referencing enhances memory specificity with age. *Psychology and Aging, 26*(3), 636–646. https://doi.org/10.1038/jid.2014.371.

Hamann, S. (2001). Cognitive and neural mechanisms of emotional memory. *Trends in Cognitive Sciences, 5*(9), 394–400. https://doi.org/10.1016/S1364-6613(00)01707-1.

Han, M., Mao, X., Kartvelishvili, N., Li, W., & Guo, C. (2018). Unitization mitigates interference by intrinsic negative emotion in familiarity and recollection of associative memory: Electrophysiological evidence. *Cognitive, Affective, & Behavioral Neuroscience, 18*(6), 1259–1268. https://doi.org/10.3758/s13415-018-0636-y.

Iordan, A. D., Dolcos, S., Denkova, E., & Dolcos, F. (2013). Sex differences in the response to emotional distraction: An event-related fMRI investigation. *Cognitive, Affective, & Behavioral Neuroscience, 13*(1), 116–134. https://doi.org/10.3758/s13415-012-0134-6.

Iordan, A. D., Dolcos, S., & Dolcos, F. (2013). Neural signatures of the response to emotional distraction: A review of evidence from brain imaging investigations. *Frontiers in Human Neuroscience, 7*, 200. https://doi.org/10.3389/fnhum.2013.00200.

Jaeger, A., & Rugg, M. D. (2012). Implicit effects of emotional contexts: An ERP study. *Cognitive, Affective and Behavioral Neuroscience, 12*(4), 748–760. https://doi.org/10.3758/s13415-012-0110-1.

Jaeger, A., Johnson, J. D., Corona, M., & Rugg, M. D. (2009). ERP correlates of the incidental retrieval of emotional information: Effects of study-test delay. *Brain Research, 1269*, 105–113. https://doi.org/10.1016/j.brainres.2009.02.082.

JASP Team. (2018). JASP (Version 0.9.0.1) [Computer software].

Johnson, M. K., & Raye, C. L. (1981). Reality monitoring. *Psychological Review, 88*(1), 67–85. https://doi.org/10.1037/0033-295X.88.1.67.

Johnson, M. K., Hashtroudi, S., & Lindsay, D. S. (1993). Source monitoring. *Psychological Bulletin, 114*(1), 3–28. https://doi.org/10.1037/0033-2909.114.1.3.

Kellermann, T. S., Sternkopf, M. A., Schneider, F., Habel, U., Turetsky, B. I., Zilles, K., et al. (2012). Modulating the processing of emotional stimuli by cognitive demand. *Social Cognitive and Affective Neuroscience, 7*(3), 263–273. https://doi.org/10.1093/scan/nsq104.

Kendall, P. C., Hollon, S. D., Beck, A. T., Hammen, C. L., & Ingram, R. E. (1987). Issues and recommendations regarding use of the Beck Depression Inventory. *Cognitive Therapy and Research, 11*(3), 289–299. https://doi.org/10.1007/BF01186280.

Kensinger, E. A. (2004). Remembering emotional experiences: The contribution of valence and arousal. *Reviews in the Neurosciences, 15*(4), 241–253. https://doi.org/10.1515/REVNEURO.2004.15.4.241.

Kensinger, E. A. (2009). Remembering the details: Effects of emotion. *Emotion Review, 1*(2), 99–113. https://doi.org/10.1177/1754073908100432.

Kensinger, E. A., & Corkin, S. (2003). Memory enhancement for emotional words: Are emotional words more vividly remembered than neutral words? *Memory & Cognition, 31*(8), 1169–1180. https://doi.org/10.3758/BF03195800.

Kensinger, E. A., & Corkin, S. (2004). Two routes to emotional memory: Distinct neural processes for valence and arousal. *Proceedings of the National Academy of Sciences of the United States of America, 101*(9), 3310–3315. https://doi.org/10.1073/pnas.0306408101.

Kensinger, E. A., & Schacter, D. L. (2006). Amygdala activity is associated with the successful encoding of item, but not source, information for positive and negative stimuli. *Journal of Neuroscience, 26*(9), 2564–2570. https://doi.org/10.1523/JNEUROSCI.5241-05.2006.

Kensinger, E. A., Gutchess, A. H., & Schacter, D. L. (2007). Effects of aging and encoding instructions on emotion-induced memory trade-offs. *Psychology and Aging, 22*(4), 781–795. https://doi.org/10.1037/0882-7974.22.4.781.

Koenig, S., & Mecklinger, A. (2008). Electrophysiological correlates of encoding and retrieving emotional events. *Emotion, 8*(2), 162–173. https://doi.org/10.1037/1528-3542.8.2.162.

Kohn, N., Falkenberg, I., Kellermann, T., Eickhoff, S. B., Gur, R. C., & Habel, U. (2014). Neural correlates of effective and ineffective mood induction. *Social Cognitive and Affective Neuroscience, 9*(6), 864–872. https://doi.org/10.1093/scan/nst055.

Koster, E. H. W., De Raedt, R., Goeleven, E., Franck, E., & Crombez, G. (2005). Mood-congruent attentional bias in dysphoria: Maintained attention to and impaired disengagement from negative information. *Emotion, 5*(4), 446–455. https://doi.org/10.1037/1528-3542.5.4.446.

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1990). Emotion, attention, and the startle reflex. *Psychological Review, 97*(3), 377–395. https://doi.org/10.1037/0033-295X.97.3.377.

Lang, P. J., Greenwald, M. K., Bradley, M. M., & Hamm, A. O. (1993). Looking at pictures: Affective, facial, visceral, and behavioral reactions. *Psychophysiology, 30*(3), 261–273. https://doi.org/10.1111/j.1469-8986.1993.tb03352.x.

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1997). International Affective Picture System (IAPS): Technical manual and affective ratings. Gainesville, FL: University of Florida, NIMH Center for the Study of Emotion and Attention.

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1998). Emotion, motivation, and anxiety: Brain mechanisms and psychophysiology. *Biological Psychiatry, 44*(12), 1248–1263. https://doi.org/10.1016/S0006-3223(98)00275-3.

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (2008). *International Affective Picture System (IAPS): Affective ratings of pictures and instruction manual* (Technical Report No. A-8). Gainesville, FL: University of Florida, NIMH Center for the Study of Emotion and Attention.

Leshikar, E. D., & Duarte, A. (2012). Medial prefrontal cortex supports memory accuracy for self-referenced items. *Social Neuroscience, 7*(2), 126–145. https://doi.org/10.1080/17470919.2011.585242.Medial.

Leshikar, E. D., & Duarte, A. (2014). Medial prefrontal cortex supports source memory for self-referenced materials in young and older adults. *Cognitive, Affective, & Behavioral Neuroscience, 14*(1), 236–252. https://doi.org/10.3758/s13415-013-0198-y.

Leshikar, E. D., Dulas, M. R., & Duarte, A. (2015). Self-referencing enhances recollection in both young and older adults. Neuropsychology, Development, and Cognition. Section B, Aging, Neuropsychology and Cognition, 22(4), 388–412. doi: 10.1080/13825585.2014.957150.

Lv, J. Y., Wang, T., Tu, S., Zheng, F., & Qiu, J. (2011). The effect of different negative emotional context on involuntary attention: An ERP study. *Brain Research Bulletin, 86*(1–2), 106–109. https://doi.org/10.1016/j.brainresbull.2011.06.010.

Mackay, D. G., Shafto, M., Taylor, J. K., Marian, D. E., Abrams, L., & Dyer, J. R. (2004). Relations between emotion, memory, and attention: Evidence from taboo Stroop, lexical decision, and immediate memory tasks. *Memory & Cognition, 32*(3), 474–488. https://doi.org/10.3758/BF03195840.

Macri, A., Pavard, A., & Versace, R. (2018). The beneficial effect of contextual emotion on memory: The role of integration. *Cognition and Emotion, 32*(6), 1355–1361. https://doi.org/10.1080/02699931.2017.1387101.

Marchewka, A., Wypych, M., Michałowski, J. M., Sińczuk, M., Wordecha, M., Jednoróg, K., et al. (2016). What is the effect of basic emotions on directed forgetting? Investigating the role of basic emotions in memory. *Frontiers in Human Neuroscience, 10*, 378. https://doi.org/10.3389/fnhum.2016.00378.

Martínez-Galindo, J. G., & Cansino, S. (2015). Positive and negative emotional contexts unevenly predict episodic memory. *Behavioural Brain Research, 291*, 89–102. https://doi.org/10.1016/j.bbr.2015.05.018.

Martínez-Galindo, J. G., & Cansino, S. (2017). Emotional context during encoding modulates recognition electrophysiological activity. *Experimental Brain Research, 235*(1), 169–179. https://doi.org/10.1007/s00221-016-4780-8.

Martins, A., Coelho, R., Ramos, E., & Barros, H. (2000). Administração do BDI-II a adolescentes portugueses: Resultados preliminares. *Revista Portuguesa Psicossomática, 2*(1), 123–132.

Mather, M., & Nesmith, K. (2008). Arousal-enhanced location memory for pictures. *Journal of Memory and Language, 58*(2), 449–464. https://doi.org/10.1016/j.jml.2007.01.004.

Mather, M., & Sutherland, M. R. (2011). Arousal-biased competition in perception and memory. *Perspectives on Psychological Science, 6*(2), 114–133. https://doi.org/10.1177/1745691611400234.

Mather, M., Gorlick, M. A., & Nesmith, K. (2009). The limits of arousal's memory-impairing effects on nearby information. *American Journal of Psychology, 122*(3), 349–369.

Meinhardt, J., & Pekrun, R. (2003). Attentional resource allocation to emotional events: An ERP study. *Cognition and Emotion, 17*(3), 477–500. https://doi.org/10.1080/02699930244000039.

Mickley, K. R., & Kensinger, E. (2009). Phenomenological characteristics of emotional memories in younger and older adults. *Memory, 17*(5), 528–543. https://doi.org/10.1080/09658210902939363.

Mitchell, K. J., Mather, M., Johnson, M. K., Raye, C. L., & Greene, E. R. (2006). A functional magnetic resonance imaging investigation of short-term source and item memory for negative pictures. *NeuroReport, 17*(14), 1543–1547. https://doi.org/10.1097/01.wnr.0000234743.50442.e5.

Mitchell, D., Nakic, M., Fridberg, D., Kamel, N., Pine, D. S., & Blair, R. (2007). The impact of processing load on emotion. *NeuroImage, 34*(3), 1299–1309. https://doi.org/10.1016/j.neuroimage.2006.10.012.

Mogg, K., Bradley, B. P., Williams, R., & Mathews, A. (1993). Subliminal processing of emotional information in anxiety and depression. *Journal of Abnormal Psychology, 102*(2), 304–311. https://doi.org/10.1037/0021-843X.102.2.304.

Murphy, N. A., & Isaacowitz, D. M. (2008). Preferences for emotional information in older and younger adults: A meta-analysis of memory and attention tasks. *Psychology and Aging, 23*(2), 263–286. https://doi.org/10.1037/0882-7974.23.2.263.

Newsome, R. N., Dulas, M. R., & Duarte, A. (2012). The effects of aging on emotion-induced modulations of source retrieval ERPs: Evidence for valence biases. *Neuropsychologia, 50*(14), 3370–3384. https://doi.org/10.1016/j.neuropsychologia.2012.09.024.

Nielen, M. M. A., Heslenfeld, D. J., Heinen, K., Van Strien, J. W., Witter, M. P., Jonker, C., et al. (2009). Distinct brain systems underlie the processing of valence and arousal of affective pictures. *Brain and Cognition, 71*(3), 387–396. https://doi.org/10.1016/j.bandc.2009.05.007.

Pereira, M. G., Volchan, E., Souza, G. G. L., Oliveira, L., Campagnoli, R., Pinheiro, W. M., et al. (2006). Sustained and transient modulation of performance induced by emotional picture viewing. *Emotion, 6*(4), 622–634. https://doi.org/10.1037/1528-3542.6.4.622.

Pereira, D. R., Sampaio, A., & Pinheiro, A. P. (2019). Differential effects of valence and encoding strategy in internal source memory and judgments of source: Exploring the production and the self-reference effect. *Frontiers in Psychology, 10*, 1326. https://doi.org/10.3389/fpsyg.2019.01326.

Pierguidi, L., Righi, S., Gronchi, G., Marzi, T., Caharel, S., Giovannelli, F., et al. (2016). Emotional contexts modulate intentional memory suppression of neutral faces: Insights from ERPs. *International Journal of Psychophysiology, 106*, 1–13. https://doi.org/10.1016/j.ijpsycho.2016.05.008.

Pinheiro, A. P., Del Re, E., Nestor, P. G., McCarley, R. W., Gonçalves, O. F., & Niznikiewicz, M. (2013). Interactions between mood and the structure of semantic memory: Event-related potentials evidence. *Social Cognitive & Affective Neuroscience, 8*(5), 579–594. https://doi.org/10.1093/scan/nss035.

Pinheiro, A. P., Del Re, E., Nestor, P. G., Mezin, J., Rezaii, N., McCarley, R. W., et al. (2015). Abnormal interactions between context, memory structure, and mood in schizophrenia: An ERP investigation. *Psychophysiology, 52*(1), 20–31. https://doi.org/10.1111/psyp.12289.

Pinheiro, A. P., Barros, C., Dias, M., & Niznikiewicz, M. (2017). Does emotion change auditory prediction and deviance detection? *Biological Psychology, 127*, 123–133. https://doi.org/10.1016/j.biopsycho.2017.05.007.

Pratto, F., & John, O. (1991). Automatic vigilance: The attention-grabbing power of negative social information. *Journal of Personality and Social Psychology, 61*(3), 380–391. https://doi.org/10.1037/0022-3514/91/S3.00.

Raye, C. L., & Johnson, M. K. (1980). Reality monitoring vs. discriminating between external sources of memories. *Bulletin of the Psychonomic Society, 15*(6), 405–408. https://doi.org/10.3758/BF03334572.

Ritchey, M., LaBar, K. S., & Cabeza, R. (2011). Level of processing modulates the neural correlates of emotional memory formation. *Journal of Cognitive Neuroscience, 23*(4), 757–771. https://doi.org/10.1162/jocn.2010.21487.

Rogers, T. B., Kuiper, N. A., & Kirker, W. S. (1977). Self-reference and the encoding of personal information. *Journal of Personality and Social Psychology, 35*(9), 677–688. https://doi.org/10.1037/0022-3514.35.9.677.

Sakaki, M., Gorlick, M. A., & Mather, M. (2011). Differential interference effects of negative emotional states on subsequent semantic and perceptual processing. *Emotion, 11*(6), 1263–1278. https://doi.org/10.1037/a0026329.

Santos, S. F., & Silva, D. R. (1997). Adaptação do State-Trait Anxiety Inventory (STAI)—Form Y para a população portuguesa: Primeiros dados. *Revista Portuguesa de Psicologia, 32*, 85–98.

Schmidt, K., Patnaik, P., & Kensinger, E. A. (2011). Emotion's influence on memory for spatial and temporal context. *Cognition and Emotion, 25*(2), 229–243. https://doi.org/10.1080/02699931.2010.483123.

Serbun, S. J., Shih, J. Y., & Gutchess, A. H. (2011). Memory for details with self-referencing. *Memory, 19*(8), 1004–1014. https://doi.org/10.1080/09658211.2011.626429.

Sharot, T., & Yonelinas, A. P. (2008). Differential time-dependent effects of emotion on recollective experience and memory for contextual information. *Cognition, 106*(1), 538–547. https://doi.org/10.1016/j.cognition.2007.03.002.

Silva, D. R., & Campos, R. (1998). Alguns dados normativos do Inventário de Estado Traço de Ansiedade—Forma Y (STAI-Y) de Spielberger, para a população portuguesa. *Revista Portuguesa de Psicologia, 33*, 71–89.

Silva, D. R., & Spielberger, C. D. (2007). *Manual do Inventário de Estado Traço de Ansiedade (STAI)*. New York: Mind Garden Inc.

Smith, A. P. R., Henson, R. N. A., Dolan, R. J., & Rugg, M. D. (2004). fMRI correlates of the episodic retrieval of emotional contexts. *NeuroImage, 22*(2), 868–878. https://doi.org/10.1016/j.neuroimage.2004.01.049.

Smith, A. P. R., Henson, R. N. A., Rugg, M. D., & Dolan, R. J. (2005). Modulation of retrieval processing reflects accuracy of emotional source memory. *Learning & Memory, 12*(5), 472–479. https://doi.org/10.1101/lm.84305.

Smith, J. C., Bradley, M. M., & Lang, P. J. (2005). State anxiety and affective physiology: Effects of sustained exposure to affective pictures. *Biological Psychology, 69*(3), 247–260. https://doi.org/10.1016/j.biopsycho.2004.09.001.

Snodgrass, J. G., & Corwin, J. (1988). Pragmatics of measuring recognition memory: Applications to dementia and amnesia. *Journal of Experimental Psychology: General, 117*(1), 34–50. https://doi.org/10.1037/0096-3445.117.1.34.

Soares, A. P., Comesaña, M., Pinheiro, A. P., Simões, A., & Frade, C. S. (2012). The adaptation of the affective norms for english words (ANEW) for European Portuguese. *Behavior Research Methods, 44*(1), 256–269. https://doi.org/10.3758/s13428-011-0131-7.

Soares, A. P., Pinheiro, A. P., Costa, A., Frade, C. S., Comesaña, M., & Pureza, R. (2015). Adaptation of the international affective picture system (IAPS) for European Portuguese. *Behavior Research Methods, 47*(4), 1159–1177. https://doi.org/10.3758/s13428-014-0535-2.

Stevens, J. S., & Hamann, S. (2012). Sex differences in brain activation to emotional stimuli: A meta-analysis of neuroimaging studies. *Neuropsychologia, 50*(7), 1578–1593. https://doi.org/10.1016/j.neuropsychologia.2012.03.011.

Subramaniam, K., Gill, J., Slattery, P., Shastri, A., Mathalon, D. H., Nagarajan, S., et al. (2016). Neural mechanisms of positive mood induced modulation of reality monitoring. *Frontiers in Human Neuroscience, 10*, 581. https://doi.org/10.3389/fnhum.2016.00581.

Subramaniam, K., Ranasinghe, K. G., Mathalon, D., Nagarajan, S., & Vinogradov, S. (2017). Neural mechanisms of mood-induced modulation of reality monitoring in schizophrenia. *Cortex, 91*, 271–286. https://doi.org/10.1016/j.cortex.2017.01.005.

Symons, C. S., & Johnson, B. T. (1997). The self-reference effect in memory: A meta- analysis. *Psychological Bulletin, 121*(3), 371–394. https://doi.org/10.1037/0033-2909.121.3.371.

Takashima, A., van der Ven, F., Kroes, M. C. W., & Fernández, G. (2016). Retrieved emotional context influences hippocampal involvement during recognition of neutral memories. *NeuroImage, 143*, 280–292. https://doi.org/10.1016/j.neuroimage.2016.08.069.

Talmi, D., Anderson, A. K., Riggs, L., Caplan, J. B., & Moscovitch, M. (2008). Immediate memory consequences of the effect of emotion on attention to pictures. *Learning & Memory, 15*(3), 172–182. https://doi.org/10.1101/lm.722908.

Van Dillen, L. F., & Koole, S. L. (2007). Clearing the mind: A working memory model of distraction from negative mood. *Emotion, 7*(4), 715–723. https://doi.org/10.1037/1528-3542.7.4.715.

Ventura-Bort, C., Löw, A., Wendt, J., Dolcos, F., Hamm, A. O., & Weymar, M. (2016). When neutral turns significant: Brain dynamics of rapidly formed associations between neutral stimuli and emotional contexts. *European Journal of Neuroscience, 44*(5), 2176–2183. https://doi.org/10.1111/ejn.13319.

Ventura-Bort, C., Löw, A., Wendt, J., Moltó, J., Poy, R., Dolcos, F., et al. (2016). Binding neutral information to emotional contexts: Brain dynamics of long-term recognition memory. *Cognitive, Affective and Behavioral Neuroscience, 16*(2), 234–247. https://doi.org/10.3758/s13415-015-0385-0.

Ventura-Bort, C., Dolcos, F., Wendt, J., Wirkner, J., Hamm, A. O., & Weymar, M. (2017). Item and source memory for emotional associates is mediated by different retrieval processes. *Neuropsychologia*. https://doi.org/10.1016/j.neuropsychologia.2017.12.015.

Wagenmakers, E.-J., Love, J., Marsman, M., Jamil, T., Ly, A., Verhagen, J., et al. (2018). Bayesian inference for psychology Part II: Example applications with JASP. *Psychonomic Bulletin & Review, 25*(1), 58–78. https://doi.org/10.3758/s13423-017-1323-7.

Wagenmakers, E.-J., Marsman, M., Jamil, T., Ly, A., Verhagen, J., Love, J., et al. (2018). Bayesian inference for psychology Part I: Theoretical advantages and practical ramifications. *Psychonomic Bulletin & Review, 25*(1), 35–57. https://doi.org/10.3758/s13423-017-1343-3.

Wang, B. (2018). Retention interval modulates the effect of negative arousing pictures on recognition memory. *Memory, 26*(8), 1105–1116. https://doi.org/10.1080/09658211.2018.1427763.

Watson, D., Clark, L., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology, 54*(6), 1063–1070. https://doi.org/10.1037/0022-3514.54.6.1063.

Watson, L. A., Dritschel, B., Jentzsch, I., & Obonsawin, M. C. (2008). Changes in the relationship between self-reference and emotional valence as a function of dysphoria. *British Journal of Psychology, 99*(1), 143–152. https://doi.org/10.1348/000712607X248689.

Xie, W., & Zhang, W. (2017). Negative emotion enhances mnemonic precision and subjective feelings of remembering in visual long-term memory. *Cognition, 166*, 73–83. https://doi.org/10.1016/j.cognition.2017.05.025.

Yonelinas, A. P., & Ritchey, M. (2015). The slow forgetting of emotional episodic memories: An emotional binding account. *Trends in Cognitive Sciences, 19*(5), 259–267. https://doi.org/10.1016/j.tics.2015.02.009.

Zhang, Q., Liu, X., An, W., Yang, Y., & Wang, Y. (2015). Recognition memory of neutral words can be impaired by task-irrelevant emotional encoding contexts: Behavioral and electrophysiological evidence. *Frontiers in Human Neuroscience, 9*, 73. https://doi.org/10.3389/fnhum.2015.00073.

Zlomuzica, A., Preusser, F., Totzeck, C., Dere, E., & Margraf, J. (2016). The impact of different emotional states on the memory for what, where and when features of specific events. *Behavioural Brain Research, 298*, 181–187. https://doi.org/10.1016/j.bbr.2015.09.037.