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Instruction to forget lead to emotional devaluation

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Abstract

Objective: The aim of this study was to investigate if the interaction between emotion and memory is bidirectional. Specifically we tested if intentional forgetting of words and faces would lead to their subsequent emotional devaluation. **Method:** In three experiments we combined an item-method directed forgetting paradigm with an emotional evaluation task. In addition, to test the general response bias hypothesis, we manipulated the forget instruction so that participants would associate a positive encoding affect with this condition. **Results:** We found that intentionally forgotten words and faces were subsequently emotionally devaluated as compared with the to-be-remembered words and faces. Furthermore, this effect was replicated for words when we associated a positive instruction with the forget condition, which supports that the devaluation was memory specific. **Conclusion**: These findings suggest that the Distractor Devaluation effect previously reported in the attention field can be generalized to memory. This is one the first studies to show an influence of memory processes, namely forgetting, on emotion.

Instruction to forget lead to emotional devaluation

Emotional processing is the central evaluation mechanism of the human brain. At any given time, emotional processing conveys worthwhile information to identify whether an object is a threat or a benefit to our current and future goals (Cornelius, 1996; Ortony, Chlore & Collins, 1998). Thus the emotional system is able to guide goal-directed behaviour by implementing information about the affective value of objects in the environment. To accomplish this, there must be cooperation between the attentional and emotional systems. For instance, it has been shown that the processing of stimuli initially evaluated as threatening is prioritized by the orienting attentional system (Armony & Dolan, 2002; Vuilleumier & Schwartz, 2001). Emotional processing also serves goal-directed behaviour by reinforcing the neural signal of task-relevant information and decreasing the signal of distracting information (Desimone, 1998).

However, only recently it has been demonstrated that the interaction between emotion and attention is bidirectional, and that selective attention may influence emotional processing as well. Raymond, Fenske and Tavassoli (2003) were the first to demonstrate this effect by combining a simple 2-item visual localization task with an emotional evaluation task (Raymond et al., 2003). In the localization task, 2 abstract patterns depicting either squares or circles were briefly presented bilaterally to a central fixation cross, and participants were asked to identify the location (i.e., left or right) of the target pattern. In the evaluation task, participants were asked to evaluate for cheeriness or dreariness target and distractor patterns previously presented in the localization task. The results showed a robust effect of prior attention state on the subsequent evaluations of the stimuli. Specifically, stimuli that served as distractors in the localization task were later rated more negatively than the target patterns, and novel baseline patterns. This effect was termed the distractor devaluation effect (DD effect; Raymond et al., 2003). In a later study, the authors proposed the devaluation-by-inhibition hypothesis to explain this phenomenon (Raymond, Fenske&Westoby, 2005). That is, they argued that when a target object is selected, competing distractors are actively inhibited to reduce interference with the task-relevant response. Emotional devaluation would be a side effect of active inhibition, similar to the reduced perceptual saliency following active suppression of irrelevant stimuli in a visual selection task (Moran &Desimone, 1985). Further, Raymond and colleagues suggested that an inhibitory tag is assigned to the distractor's representation (Kessler & Tipper, 2004). Thus when this stimulus is re-encountered later on, the inhibitory trace is reinstated and renders it less emotionally significant. In this way, visual attention and emotion coordinate their function to prioritize goal-directed behavior.

Interestingly, similar selective mechanisms haven been suggested in the memory field to explain 'motivated forgetting' (see Anderson &Hanslmayr, 2014, for a review). For instance, it has been proposed that the later recognition/recall of the desired information in paradigms such as Think-No Think (Anderson & Green, 2001; Anderson et al., 2004), Directed Forgetting (Bjork, 1989; Fawcet & Taylor, 2008; Ludowig et al., 2010) and Retrieval-practice paradigm (Anderson, Bjork, & Bjork, 1994; Anderson & Spellman, 1995; Anderson, 2003; Bajo, Gómez Ariza, Fernández, & Marful, 2006) is achieved by active inhibition of the unwanted, intrusive, information (Anderson & Spellman, 1995; Anderson & Green, 2001; Bjork, 1970, but see Sahakyan& Kelley, 2002, for a non-inhibitory explanation).

Hence, in this study we wondered if the same emotional devaluation effect that arises during attentional selection is also elicited when selecting memory representations. That is, we wondered whether the emotion-memory interaction would be bidirectional in a similar way to the attention-emotion interaction. Specifically we wanted to investigate if memory processes, such as those involved in intentional forgetting, influence subsequent emotional evaluations. To our knowledge only one study has investigated emotional devaluation as an aftereffect of memory selection (Janczyk, &Wühr, 2012)[1]. This study employed the retrieval-practice paradigm (e.g., Anderson, Bjork, & Bjork, 1994) that typically shows that repeated retrieval of a desired target lead to later forgetting (inhibition) of intrusive related representations; this effect has been called retrieval-induced forgetting. In their study, Janczyk and Wühr did not find an emotional devaluation of the intrusive, forgotten, representations. That is, unpracticed items from practiced categories (Rp-) were not emotionally devaluated in comparison with practiced items (Rp+) and items from unpracticed categories (Nrp). The authors concluded that distractor devaluation by attentional selection is not generalized to memory selection.

In the present study, we employed the item method directed forgetting (DF) paradigm (Woodward & Bjork, 1971) to investigate emotional devaluation by selection in a memory task. In this paradigm participants are presented with single items and instructed to remember (TBR condition) or forget (TBF condition) each item. Numerous studies have shown that TBF items have worse recall/recognition than TBR items; this effect has been termed the directed forgetting effect. Thus, the selection of the required targets (TBR items) involves the forgetting of the non-desired competitors (TBF items). This effect has been explained by differential rehearsal/learning of these TBF items (Bjork, 1989) and by active suppression of these items (Geiselman, Bjork & Fishman, 1983; Fawcet & Taylor, 2008; Ludowig et al., 2010; also see Anderson and

[1]During the review process we came across a study in press by De Vito, Ferrey and Fenske (2014) that reported emotional devaluation of items rejected in a Think/No Think paradigm.

Hanslmayr, 2014, for a recent review). A difference between this paradigm and the Retrieval Induced Forgetting paradigm, employed by Janzyk and Wühr, is that in the latter the TBF items are not explicitly presented and forgetting is incidental; whereas in the former the suppression of the explicitly presented intrusive information is intentional, and so this paradigm mirrors more closely the suppression of distractors in attentional tasks. We also decided to employ the item-method instead of the list method, because it has been proposed that in the list method forgetting is directed to a broader context, and thus inhibition may be implemented at the representation of the temporal context and not at individual items (Anderson and Hanslmayr, 2014). In the item-method, forgetting, and consequently inhibition, would be instead directed to individual items as in selective attention paradigms.

Consequently, since the DF effect is a byproduct of memory selection, based on the attentional distractor devaluation effect (Raymond, Fenske&Westoby, 2005), we expect that the TBF items will be emotionally devaluated in comparison with the TBR items.

Experiments 1a and 1b: The effect of Memory Instruction on subsequent emotional evaluations of faces and words

The aim of Experiments1a and 1b was to explore whether the memory instruction of forget would lead to emotional devaluation of these items. In Experiment 1a we replicated the DF paradigm with words used by Alonso and Diez (2000), and in Experiment 1b we replicated the DF paradigm with faces used by Metzer (2011). We combined these tasks with an emotional evaluation task. That is, participants were asked to evaluate emotionally the word/face using a likert-scale from 1 (very unpleasant) to 7 (very pleasant) immediately after the offset of memory instruction. We expected to replicate the DF effect with words and faces. That is, recognition accuracy is expected to be impaired for words/faces followed by a forget instruction as compared to words/faces followed by a remember instruction. If the memory instruction has an effect of emotional evaluations, we expect the TBF words/faces to be evaluated as less pleasant than the TBR words/faces.

Method

Participants

Sixteen female Spanish undergraduate students with a mean age of 18.38 years (SD = 0.78) and 23 undergraduate college students (10 females) with a mean age of 25.08 years (SD = 6.55) from the Universities of Granada and Jaén and the University of Sheffield International Faculty participated in Experiments 1a and 1b, respectively.

Materials and stimuli

The experiments were designed and presented electronically using E-Prime 2.0 software (Psychology Software Tools, Pittsburgh, PA). They ran on 2 View-Sonic 17-in monitors controlled by 200-mHz Pentium processors. The viewing distance was approximately 70cm from the monitor, and all stimuli appeared on a solid white background. Instruction texts were displayed in black 12- and 18-point Courier New Font. Alphanumeric stimuli (i.e., +, -) were displayed in black 45-point Courier New font.

In Experiment 1a, the stimuli consisted of 216 words selected from a Spanish standardized data base (Algarabel, 1996). All the words were neutral (had scores between 3 and 5 in a scale from 1 to 7; for more details see Algarabel, 1996). From the 216 words, 10 words were employed for the practice block, 6 were used as fillers, and 200 were included in the Experimental list. The 200 words were further divided into two sets of 100 words each (list A and B), which were matched on frequency (Alameda y Cuetos, 1995), concreteness, and length (Algarabel, 1996; see Table 1).

In Experiment 1b, the stimuli were 36 greyscale frontal views of the head and shoulder of young males that appeared on a simple grey background. Twenty-four of them were used as test stimuli and the remaining were the practice stimuli. All stimuli were selected from the greyscale FERET database of facial images (Phillips, Moon, Rizvi & Rauss, 2000; Phillips, Wechsler, Huang & Rauss, 1998). Face stimuli were corrected for luminosity, contrast, and size.

Procedure

Experiment 1a with words

Participants were tested individually in a dimly lit room. The experiment consisted of two phases; a study and recognition phase.

In the study phase, half of the participants viewed list A, and the remaining half viewed list B. For each list, half of the words were followed by the instruction remember (RRRR), and the other half was followed by the instruction forget (FFFF).The three first and last items of the list were fillers. In addition, in half of the items of the study phase, participants were asked to indicate how pleasant on a scale from 1 (very unpleasant) to 7 (very pleasant) they find each word right after the instruction to remember or forget disappeared from the screen. Because only half of the items were evaluated, participants could not anticipate if they were going to be asked to emotionally evaluate a certain item. Thus, each trial in the study phase consisted of: a fixation point (+) during 1 second, followed by a word that stayed on the screen for 1 second. This was then followed by a blank screen for 1 second. After that the evaluation instruction appeared for 1 second. Finally the pleasantness evaluation scale remained on the screen until response or for 4 seconds.

In the second phase, participants were asked to do a recognition task. The 200 words from the Experimental list (100 studied, 100 new) were presented randomly along with 4 fillers words that appeared at the beginning of the task. Each trial consisted of the presentation of a fixation point (1 second) followed by the word (300 msec) and a screen with the instruction “respond”. This screen remained until response.

Experiment 1b with faces

The procedure was adapted from Metzger (2011; Experiment 1) with a few additional changes to make it comparable to Experiment 1a. As in Experiment 1a, participants were tested individually and the experiment consisted of two phases; a study and recognition phase.

In the study phase 12 neutral male faces were presented on the centre of the screen. Each trial in this phase begun with a fixation cross at the centre of the screen for 2 sec. Then a face appeared on the screen for 2 sec. Half of the faces were then followed by a remember (+) instructions, whereas the other half was followed by a forget (-) instruction. The memory cue remained on screen for 3 sec. Participants were instructed to remember faces that were followed by a remember cue and forget those that were followed by a forget cue. In addition, in half of the items of the study phase, participants were asked to indicate how pleasant on a scale from 1 (very unpleasant) to 7 (very pleasant) they found each face right after the instruction to remember or forget disappeared from the screen. Because only half of the items were evaluated, participants could not anticipate if they were going to be asked to emotionally evaluate a certain item.

In the recognition phase, 24 male faces (12 studied and 12 new faces) were presented randomly. In each trial a blank screen was first presented for 2 sec, followed by a face for 500 msec. Finally, a screen with the instruction “respond” was presented until response.

Results

Experiment 1a: Words

Recognition Memory task

The results showed significantly worse mean recognition accuracy for the TBF items ($M = .60$, $SD = .13$) than for the TBR items ($M = .78$, $SD = .09$), $t(15) = 7.566$, $p < .0001$, $d = 1.89$. Since half of the items were previously evaluated during the study phase, we submitted item evaluation status (evaluated, non-evaluated) to a repeated measure ANOVA (evaluation status: evaluated, non-evaluated x type of item: TBR, TBF). Results indicated a lower level of recognition for TBF ($M = .60$, $SD = .15$) when compared to TBR items ($M = .78$, $SD = .11$), $F(1,15) = 56.87$, $p < .0001$, $\eta^2_p = 0.80$). Neither the main effect of evaluation status $F(1,15) = 3.8$, $p = .07$, $\eta^2_p = .21$) nor the interaction evaluation status x type of item reached statistical significance $F(1,15) = 0.16$, $p = .67$, $\eta^2_p = .01$). Thus, the same pattern of data has been obtained when evaluated and non-evaluated items were analyzed collapsed or separately, in consequence, further analyses were carried out only on collapsed data.

Word Evaluation task

There was also a significant difference between the mean evaluation ratings for the TBF condition ($M = 4.53$, $SD = 0.78$) and TBR condition ($M = 4.78$, $SD = 0.78$), $t(15)$

= 3.284, $p = .005$, $d = 0.82$. That is, we found an emotional devaluation of items that were instructed to be forgotten[2].

Experiment 1b: Faces

Recognition Memory task

One participant was not included in the analyses because recognition accuracy rates were below .33 in all conditions. Results showed a significant difference between the mean recognition accuracy for the TBF items ($M = .68$, $SD = .29$) and the TBR items ($M= .80$, $SD= .17$) items, $t(21) = -2.21$, $p = .038$, $d = .46$. As we mention in footnote 3, because of the need to include a limited number of faces to replicate the directed forgetting effect, we did not have sufficient trials per cell to conduct further analyses taking into account the evaluation factor as we did for Experiment 1a.

Face Evaluation task

There was also a significant difference between the mean evaluation ratings for the TBF items ($M = 3.38$, $SD = 1.01$) and the TBR items ($M = 3.72$, $SD = 1.05$) conditions on the emotional evaluation scores, $t(21) = -2.71$, $p = .013$, $d = .57$. That is, TBF items were evaluated as less pleasant than TBR items (see Figure 1).

>Insert Figure 1 about here<

Discussion

The results from Experiments 1a and 1b showed significant emotional devaluation effects for TBF items (words and faces) when participants were asked to evaluate the

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[2] A power analysis conducted on the devaluation effect revealed that an n of 15 was needed to obtain statistical power at .85 level (Cohen, 1988). Thus, we replicated Experiment 1a with 16 participants and found a significant DF effect; recognition was significantly worse for the TBF items [$M = .61$, $SD = 10$] than for the TBR items [$M=.73$, $SD = .10$, $t(15) = 3.8$, $p =.001$, $d = 0.97$]. Most important, we also replicated the emotional devaluation of items that were instructed to be forgotten. That is, items in the TBF condition were evaluated as less pleasant, [$M=4.39$, $SD = .71$] than in the TBR condition [$M=4.48$, $SD = .73$, $t(15) = 2.17$, $p =.046$, $d = 0.54$].

items right after the memory instruction. To our knowledge this is the first study to show an emotional devaluation effect in a memory task similar to the one reported first by Raymond et al (2003).

We believe that a similar mechanism can explain both the distractor devaluation effect typically found in selective attention paradigms, and the emotional devaluation for intentionally forgotten items found in the present study; this mechanism is active inhibition. Raymond et al. (2005) proposed the devaluation-by-inhibition hypothesis to explain the emotional devaluation of stimuli that were encountered previously as distractors in an attentional selection task. They proposed that when a target object is selected, competing distractors are actively inhibited to reduce interference with the task-relevant response. Emotional devaluation would be a side effect of active inhibition, similar to the reduced perceptual saliency following active suppression of irrelevant stimuli in a visual selection task (Moran & Desimone, 1985). This hypothesis has received substantial support from electrophysiological studies (Kiss, Goolsby, Raymond, Shapiro, Silvert, Nobre, et al., 2007).

With regard to directed forgetting, there has been a debate about the mechanisms underlying this effect, and whether the same processes are involved in the list and the item methods. Some authors have claimed that the worse recall/recognition of items followed by a forget instruction relative to a remember instruction (namely the item method) is best explained in terms of selective rehearsal (MacLeod et al., 2003). According to this account, after the forget instruction, items are simply dropped from maintenance rehearsal. Intentional forgetting would then be the outcome of natural/passive decay of the memory trace. On the other hand, there is now substantial and converging evidence from behavioural and neuroimaging studies that suggests that intentional forgetting is not a passive process, but it involves the active suppression of the irrelevant information (Fawcet & Taylor, 2008, Wyley, Foxe & Taylor, 2008; Ludowig et al., 2010; see also Anderson and Hanslmayr, 2014, for a recent review). For instance, Fawcet and Taylor, introduced a secondary task after instructions to remember or forget. Contrary to the selective rehearsal account of DF, which would predict a greater cognitive load for the remember condition, they found slower response times in the secondary task after the forget instruction. This finding suggests that forgetting is more effortful than remembering. Similarly Wylie et al. (2008) found that intentional forgetting in an item-method directed forgetting paradigm differentially activated a neural network involving the superior/middle frontal gyrus and inferior frontal gyrus. This network has been typically associated with cognitive control and inhibition. Further, when the authors analysed the areas activated for the key interaction intention by outcome, they found that the right insula, the left-sided inferior parietal and the thalamus were activated only when the implementation of a forget or remember intention was successful. This finding similarly suggests that attentional resources may be necessary to successfully implement an intention to forget. Finally, Ludowig et al. (2010) found that neural activity in the mediotemporal lobe (MTL), measured with intracranial event-related potentials, did not support the rehearsal account but was in agreement with the active-suppression model. That is, the authors found a significantly decreased MTL-P300 component for TBR cues that actually resulted in later forgetting. All together, these findings suggest that a prefrontal-temporal lobe network is recruited to actively disrupt encoding of the TBF items in the item-method.

However an alternative explanation may be that the emotional devaluation in the ‘forget’ condition is the result of task-demands and not of memory processes or attentional control processes interacting with memory. That is, the instructions ‘forget’ and 'remember' ('OOOO' and 'AAAA' for the words and '+' and '-' for the faces) could have led to a negative and positive affect encoding, respectively, since 'forget'' items could be perceived as undesirable. This interpretation would be in agreement with the Evaluative coding account proposed by Dittrich and Klauer (2012). Thus, the 'forget' instruction could have resulted in a general response bias and consequently participants may have given overall lower scores for those items.

To test this alternative hypothesis we manipulated the 'forget' instruction in Experiment 3, so that a positive affect encoding would be associated with this condition.

Experiment 2: Positive Forgetting and emotional devaluation.

In Experiment 2, we replicated Experiment 1a with words (since we observed a similar pattern for faces and words[3]), and modified the instructions for the TBF condition so that a positive affect encoding would be associated to this condition. In the instruction we emphasized the positive value of forgetting as an adaptive mechanism that improves performance. In addition, we included two questions at the end of the experiment to have self-report measures of the affect state associated with the memory instruction. If the emotional effect of intentional forgetting found in Experiment 1a was due to a negative affective encoding associated with the forget instruction, then TBF items should not be emotionally devaluated when the forget instruction is associated with a positive affective state. Furthermore, participants that state explicitly that they did not associated a negative and a positive value to the forget and remember cue, respectively, should not evaluate differently TBF items relative to TBR items.

[3] We conducted this further manipulation only for the Experiment with words due to the difficulty of replicating the directed forgetting effect with a greater number of (12) faces. We realized ad-hoc to Experiment 1b, that this relatively small set of stimuli constrained potential further trials analyses.

Method

Participants

Twenty-four undergraduate students (20 females; Mean age = 19.23, SD=1.75) from the University of Jaen volunteered to participate in the study. The participants received course credit for their participation.

Stimuli and Procedure

We replicated Experiment 1a with the only addition of a new slide with the following positive instruction for the TBF condition, and a set of questions at the end of the experiment:

“Please consider that forgetting unnecessary information (that is, the words that are followed by the forget instruction "OOOO") will allow you to perform better on the task. This is because forgetting is an adaptive mechanism that facilitates learning and cognitive functioning overall, when people must recall a great amount of information”.

At the end of the experiment participants were asked to give a ‘yes/no’ response to the following statements: “When I saw the instruction forget (OOOO), I evaluated the word as more negative without thinking about its meaning, and just because I associated the instruction forget with something negative”, and “When I saw the instruction remember (AAAA), I evaluated the word as more positive without thinking about its meaning, and just because I associated the instruction remember with something positive”.

Results

Recognition Memory task

There was a significant difference between the mean recognition accuracy for the TBF items ($M = .53$, $SD = .21$) and the TBR items ($M = .66$, $SD = .23$), $t(23) = 4.669$, $p < .001$, $d = .95$.

Word Evaluation task

There was also a significant difference between the mean evaluation ratings for the TBF condition (M =4.17, SD = 0.53) and the TBR condition (M = 4.71, SD = 0.70), $t(23) = 3.284$, $p < .001$, $d = 1.01$.That is, we found a devaluation of items that were positively instructed to be forgotten.

In addition, we found significant emotional devaluation effects when we analysed the data only for those participants who responded NO to the final questions. That is "When I saw the instruction forget (OOOO), I evaluated the word as more negative without thinking about its meaning" (Q1; N=10 participants), $TBR_{mean} = 4.88$ (SD = .56) vs $TBF_{mean} = 4.21$ (SD = .44), $t(9) = 3.699$, $p = .005$, $d = 1.17$; and "When I saw the instruction remember (AAAA), I evaluated the word as more positive without thinking about its meaning, and just because I associated the instruction 'remember' with something positive" (Q2; N = 12 participants), $TBR_{mean} = 4.89$ (SD = .70) vs $TBF_{mean} = 4.18$ (SD = .57), $t(12) =4.375$, $p = .001$, $d = 1.26$.

Discussion

In Experiment 2, we include a novel manipulation to associate a positive affect state with the instruction forget. To our knowledge this is the first study to replicate the DF effect with a positive forget instruction. A look at the descriptive data also suggests that the DF effect seems to be unaffected by this manipulation (Experiment 1a: .78 (TBR) vs .60 (TBF), and Experiment 2: .66 vs .53). This finding may fit well with motivated forgetting in natural environments, where forgetting may work as a positive adaptive mechanism that allows us to regulate negative affect, but also helps us to maintain a positive self-image (Anderson &Hanslmayr, 2014). In this sense, forgetting does not necessarily have to be associated with a negative connotation. In this

Experiment, forgetting was associated with the positive outcome of improved performance.

Most important, we also replicated the emotional devaluation found in Experiment 1a. That is, participants rated items that were positively instructed to be forgotten as less pleasant than items that were instructed to be remembered. One may argued that our manipulation was not successful in creating a positive affect state at encoding in the forget instruction, and to test this hypothesis we had included two questions at the end of the experiment. Against the predictions of a general response bias explanation, we found that participants who stated that they did not associate a negative value to the word followed by the forget instruction (Q1), and a positive value to the word followed by a remember instruction (Q2), did also rate TBF words as less pleasant than TBR words. Thus, we can safely conclude that the emotional devaluation of TBF words in Experiment 1a and 2, are not the result of a negative encoding associated with the cue forget, which would have biased responses towards negative ratings.

General Discussion

Recent evidence suggests that we consider distracting objects less emotionally significant than target objects because selective attention inhibits the former during voluntary visual search (Fenske, Raymond, Kessler, Westoby & Tipper, 2005; Fenske, Raymond & Kunar, 2004; Goolsby, Shapiro, Silvert, Fragopanagos, Eimer, Nobre et al., 2009; Kiss, Raymond, Westoby, Nobre & Eimer, 2008; Raymond et al., 2003; Raymond, Fenske & Westoby, 2005). The deleterious impact of inhibition on the subsequent emotional evaluations of ignored objects is referred to as the distractor devaluation effect (DD) of visual attention. In the presented study we aimed at investigating if a similar emotional devaluation effect could be observed for intentionally forgotten stimuli. Thus, we combined a directed forgetting paradigm with an emotional evaluation task. Our results showed significant emotional devaluation effects for words and faces that were followed by a forget cue. In addition, we replicated this finding with words when the instruction to forget was associated with a positive affect state at encoding. Our findings also suggest that the emotional devaluation by intentional forgetting is a robust effect, since we replicated it in four separate group of participants (and in two different labs), and with both words and faces (see Figure 1).

Although there is now mounting evidence (see Buchanan & Adolphs, 2002 for a review) for the positive influence of emotions on declarative memory, this is one of the first studies to show an influence of memory processes, namely forgetting, on emotion. Recently, another unpublished study conducted by De Vito et al (2014) has also reported an emotional devaluation of items rejected from long-term visual object memories in a Think/No Think paradigm. Together, these findings suggest that as with attention and emotion, the influences between emotion and memory are bidirectional.

We believe that a similar mechanism can explain both the distractor devaluation effect typically found in selective attention paradigms, and the emotional devaluation for intentionally forgotten items found in the present study; this mechanism is active inhibition. Raymond et al. (2005) proposed the devaluation-by-inhibition hypothesis to explain the emotional devaluation of stimuli that were encountered previously as distractors in an attentional selection task. This hypothesis has received substantial support from electrophysiological studies (Kiss et al., 2007). For instance Kiss et al., (2007) found in an ERP study that the level of distractor devaluation in the emotional rating task covaried with the level of distractor inhibition in the search task. Specifically, higher N2pc amplitudes and therefore efficient distractor inhibition during search were recorded in trials where distractor faces were rated less trustworthy in the rating task. This finding supports a direct link between attentional inhibition and the DD effect, that is, the greater the distractor inhibition during search, the lower the subsequent devaluation of distractors.

With regard to directed forgetting, and as we discussed above, there has been a debate about the mechanisms underlying this effect, and whether the same processes are involved in the list and the item methods. However more recent evidence from both behavioural and neuroimaging studies strongly suggest that intentional forgetting in the item-method is not a passive process (see Anderson & Hanlsmayr, 2014, for a recent review). Rather these findings support that attentional control (inhibition) interacts with encoding processes in episodic memory to discard unwanted information from our memory. This explanation also fits well with the results from Experiment 2. That is, results from Experiment 2 do not seem to support an alternative account in terms of a more general affect or response bias being associated with the memory cues. Dittrich and Klauer (2012) proposed the Evaluative coding account to explain the emotional devaluation of ignored items in selective attention tasks. The authors re-interpreted attentional selection in affective terms, and suggested that attend and ignore behaviours can be re-interpreted as approach vs avoidance behaviours, respectively. Consequently, distractors would be devaluated because of the negative affect encoding associated with rejecting the ignore stimulus, and not as a by-product of inhibition. In a similar vein, one could propose that TBF items in the present study could have been associated with a negative affect at encoding. Also notice that the cues (+ and – for remember and forget respectively) used in the face experiment (Experiment 1b) could have primed negative and positive evaluations, respectively. In Experiment 2, we tested this hypothesis by manipulating the instructions associated with the forget cue ("OOOO") so that it would be associated with a positive affect state. Against the predictions of the Evaluative coding account this manipulation did not affect the emotional devaluation of TBF items. Furthermore, when we analyzed only the data from participants that explicitly stated that they did not associate a negative and positive value to the forget and remember cue, respectively, we still replicated the emotional devaluation of TBF items. And although we had fewer participants in these analyses we still found large effects size (Cohen, 1988). Thus, we believe that the emotional devaluation of TBF found in the present study can best explained as the result of specific processes involved in intentional forgetting.

Actually, one can clearly establish a parallelism between intentional forgetting and selective attention, since both aim at preventing outdated or irrelevant information from interfering with memory for relevant information and goal-directed behaviour. The present findings suggest that attentional control may interact with memory processes to shape our memories. Thus, the emotional devaluation effect, as an aftereffect of intentional forgetting, observed in the present study could be in fact the result of attentional selection. Our study was not designed to shed light on the mechanisms responsible for the worse recognition of TBF items, and so we cannot conclude on this matter. However, our study does suggest that whatever process is responsible for directed forgetting, it has the same deleterious consequences on subsequent emotional evaluation as attentional selection. We propose that the adaptive value of the emotional devaluation of intentionally forgotten items may be to make these items less available for later retrieval. In this sense, the emotional system may guide the memory system in a similar way that it guides the attentional system.

One limitation of our study is that we did not include a baseline condition in the directed forgetting task (e.g., a word or picture not followed by a memory instruction) to unequivocally conclude that the difference between TBF and TBR items was due to a reduction in the rating for the TBF items and not to an increase of the ratings for the TBR items or both. Although, future studies should consider adding this condition, Experiment 2 appears to rule out an explanation of the data in terms of more general positive/negative response biases.

To conclude, ignoring and forgetting are two crucial processes that our cognitive system has to cope with the great cognitive demands imposed by our complex environment so as to keep our awareness free from irrelevant and undesirable information, and to produce organized and goal-directed behaviour. Our study suggests that the emotional aftereffect of these two processes may be common: emotional devaluation of the ignored or intentionally forgotten information. This aftereffect may function to support our choices, so as to make then even less desirable. Considering the proposed social-affective and marketing implications of the emotional devaluation effect (Duff & Faber, 2011; Fenske et al., 2005; Raymond et al., 2003), we suggest that it is particularly important to examine this effect in other experimental procedures that induce motivated forgetting, and to investigate whether there is a single common mechanisms underlying the emotional devaluations observed in both attention and memory tasks. Such an investigation should reveal crucial information regarding the role of selective attention and memory in shaping social affect and consumer preference in the long run.

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Table 1. Means of frequency (Alameda & Cuetos, 1995), concreteness, andlength (Algarabel, 1996) for Set A and Set B in Experiment 1b.

	Frequency	Concreteness	Length
Set A	95.3	4.51	7.57
Set B	91.6	4.54	7.46

Figure Captions

Figure 1. Mean emotion evaluative ratings for TBR (to-be-remember) and TBF (to-be-forgotten) items in Experiment 1a (E1a; words), Experiment 1b (E1b; faces), Experiment 2 (E2), Experiment 2 for participants who responded No to Question 1(E2Q1) ["When I saw the instruction forget (OOOO), I evaluated the word as more negative without thinking about its meaning, and just because I associated the instruction forget with something negative"] , and in Experiment 2 for participants who responded No to Question 2 (E2Q2) ["When I saw the instruction remember (AAAA), I evaluated the word as more positive without thinking about its meaning, and just because I associated the instruction remember with something positive"].

Figure 1