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Abstract

This paper explored the differential sensitivity young and older adults exhibit to the local context of items entering memory. We examined trial-to-trial performance during an item directed forgetting task for positive, negative, and neutral (or baseline) words each cued as either to-be-remembered (TBR) or to-be-forgotten (TBF). This allowed us to focus on how variations in emotional valence (independent of arousal) and instruction (TBR vs. TBF) of the previous item (trial *n-1*) impacted memory for the current item (trial *n*) during encoding. Different from research showing impairing effects of emotional arousal, both age groups showed a memorial boost for stimuli when preceded by items high in positive or negative valence relative to those preceded by neutral items. This advantage was particularly prominent for neutral trial *n* items that followed emotional items suggesting that, regardless of age, neutral memories may be strengthened by a local context that is high in valence. A trending age difference also emerged with older adults showing greater sensitivity when encoding instruction changed between trial *n-1* and *n*. Results are discussed in light of age-related theories of cognitive and emotional processing, highlighting the need to consider the dynamic, moment-to-moment fluctuations of these systems.

Keywords: local context; emotional memory; valence; directed forgetting; aging

Word count: 5,827

Introduction

Our understanding of the world is intimately shaped by its immediate temporal surroundings (e.g., Hommel, 2004). As such, our memories can be heavily influenced by contextual factors such that the processing of a current stimulus becomes contingent on events that have just happened and, in some cases, are still to come. Such *local context* effects have been demonstrated across a variety of domains including the sequential judgment of abstract visual (Hillstrom, 2000) and auditory (Mondor & Leboe, 2008) stimuli, buildings (Tousignant & Bodner, 2014) and Olympic Gymnasts (Damisch, Mussweiler & Plessner, 2006). Considerable research has also suggested that a local context high in emotional arousal can influence how surrounding information is encoded in memory (e.g., Knight & Mather, 2009; MacKay et al., 2004; Most, Chun, Widders, & Zald, 2005; Strange, Hurlemann, & Dolan, 2003; for a review see Mather, 2007). Following from this literature, this paper sought to further investigate the impact of an emotionally laden context on memory, taking a specific focus on the influence of valence (i.e., the degree of pleasantness) as opposed to arousal (i.e., the degree of agitation). A second goal was to determine how a context that varies in priority for later memory (i.e., to-be-forgotten vs. to-be-remembered) impacts subsequent memory performance. Finally, we explore how these effects vary as a function of aging, an important question to address considering often reported age differences in emotional information processing (e.g., the age-related positivity effect; Reed & Carstensen, 2012).

Local Context Effects and Emotion

A vast literature suggests that emotionally arousing information gains priority status in memory relative to neutral information by influencing attention and encoding processes (Labar & Cabeza, 2006). As a result, stimuli high in emotional arousal are more likely than non-emotional stimuli to dominate attention (e.g., Yang, Zald, & Blake, 2007) and to be better remembered (Kensinger, 2004). A further intriguing observation is that the influence of emotion can extend to memory for surrounding stimuli. This idea has received great attention in applied memory literature, particularly in the context of eyewitness memory. For instance, *the weapon focus effect* is characterized by instances in which memory for the peripheral details of an event (e.g., the identity of a suspect in a crime) suffers upon exposure to a salient or highly arousing object, such as a weapon (for a meta-analysis see Fawcett, Russell, Peace, & Christie, 2013). This often reported finding is thought to be rooted in the attention-capturing effect of the weapon or highly salient object, which subsequently impairs memory for the less-pertinent coinciding aspects of the event.

Additional research has also shown that emotion does not only impact attention for stimuli in close spatial proximity, but can also exert an influence on stimuli occurring both forward and backward in time (e.g., Knight & Mather, 2009; MacKay et al., 2004; Most et al., 2005; Strange, Hurlemann, & Dolan, 2003). For instance, when an emotionally arousing item is presented within a stream of stimuli, it can impair the ability to detect a neutral target that occurs immediately after (i.e., *emotion-induced blindness*; Most et al., 2005), as well as impair recall for neutral items following the presentation of a taboo word (i.e., *anterograde emotional impairment;* MacKay et al., 2004). In addition to these anterograde effects, MacKay and colleagues demonstrate *retrograde* effects of emotion with impaired recall of items presented *prior* to an emotional stimulus. Despite evidence in favour of memory impairment for stimuli within close proximity of emotion, retrograde memory *enhancement* has also been observed, in which non-emotional stimuli receive a benefit when sufficient consolidation time is allowed (i.e., memory is tested after a week delay; Anderson, Wais, & Gabrieli, 2006) or when non-emotional items receive greater attentional weight (Knight & Mather, 2009). Together, these results suggest that a temporal context high in emotional arousal can impact the encoding resources available for processing nearby stimuli and whether memory is enhanced or impaired may depend on the amount of time elapsed from the arousing stimulus or if sufficient attention is allocated to the non-emotional item (Knight & Mather, 2009).

Although informative, the majority of this research has primarily concerned the effects of emotional arousal while ignoring the influence of valence on local context effects in memory. The dissociation of these factors, however, is important to consider as emotion is often conceptualized as a two dimensional construct (Russell, 1980). On one dimension, emotion varies along a continuum of arousal in which the degree of activation ranges from calming to agitating or exciting. The other dimension, valence, refers to how negative or positive an event is (Kensinger, 2004; Recio, Conrad, Hansen, & Jacobs, 2014). Each dimension impacts how emotional events are remembered but in distinct ways. Arousal is responsible for inducing the automatic physiological response that occurs during a highly emotional event (e.g., a perpetrator with a gun) and the neurochemical reaction associated with this response narrows attention in such a way that only the most pertinent information is processed (Mather, 2015). In other words, highly arousing stimuli “win the competition” for attention at the cost of less-salient, non-arousing information (Lee, Itti, & Mather, 2012; Mather & Sutherland, 2011). This is supported by research showing that the impairing effect of arousal on nearby items can be reduced when physiological arousal is dampened via pharmacological blockage of the β-adrenergic system (Strange et al., 2003). Valence, on the other hand, does not evoke a state of physiological activation but rather deals with whether information is deemed “good” or “bad” as it enters memory. Relative to the automaticity of arousal-based effects, the processing of valence appears to rely on more top-down controlled processes (e.g., self-generated encoding processes) rooted in activation of the pre-frontal cortex (e.g., Kensinger & Corkin, 2004; Kensinger & Schacter, 2006). When mental resources are taxed during encoding (e.g., by dividing attention) valence-based memory effects can be washed out, suggesting controlled resources are indeed required to enhance memory for valence (e.g., Kensinger & Corkin, 2004). Moreover, whether more positive or negative memories are retrieved may depend on top-down goals or motivations at the time of encoding or retrieval (e.g., to enhance positive and dampen negative feelings; Mather, 2015).

Taken together, the evidence supports distinct contributions of valence and arousal in emotional memory formation (Kensinger & Corkin, 2004). Thus, in the context of the current study, the impact of valence on processing of stimuli in close proximity would likely diverge from the reported impact of arousal. For example, if controlled processes are evoked during the encoding of valence, these processes may "spill over" to the following stimulus, enhancing subsequent memory traces. Accordingly, the first aim of this paper addresses an important gap in the literature: determining the local context effects of valence in memory, independent of arousal, by examining how memory for an item (hereafter referred to as trial *n*) is affected by the valence of the preceding trial (hereafter referred to as trial *n-1*) during encoding. By intermixing positive, negative and neutral items, this allowed us to assess remote connections between the local context effects of valence experienced at encoding on the eventual recognition of these items.

Emotional Local Context Effects and Aging

A second factor that has received little attention in the literature on local context effects of emotion on memory is how such mechanisms change as a result of normal aging, despite well-reported differences in the processing of emotional stimuli between young and older adults

(Hedden & Gabrieli, 2004). Research has suggested that emotion – particularly information high in valence – has motivational significance to older adults (Reed & Carstensen, 2012). The socioemotional selectivity theory posits that reduced time horizons lead to an increased emphasis on emotionally relevant goals in later life (Carstensen, 1995), impacting what information older adults attend to and remember. As a result, a bias toward positive information or a reduced preference for negative information is often observed in older relative to young adults, an effect termed the *age-related positivity effect* (Mather, 2015; Reed & Carstensen, 2012). How valence impacts older adults' memory for information in close temporal proximity, however, has yet to be determined. Considering that older adults show a preference for positive valence while avoiding negative valence (e.g., Isaacowitz, Wadlinger, Goren, & Wilson, 2006), it is reasonable to expect that differences would arise in older adults' memory for an item when the preceding context is positive rather than negative. For instance, relative to young adults, a positive word may facilitate processing and memory for the subsequent item in older adults. Similarly, since older adults prefer to withdraw attentional resources from negative information, this may hinder the encoding of an item following a negative word.

Local Context Effects and Stimulus Priority

Our third and final aim was to further examine how age differences in local context effects are impacted by variation in stimulus priority (i.e., to-be-remembered, TBR vs. to-be-forgotten, TBF) and the cognitive operations required to process these items. An experimental paradigm well suited to address this question in the context of emotional memory is the item directed forgetting task (Bjork, 1970) in which participants study a series of items each cued as either TBR or TBF. As such, TBR items are high priority for later memory performance whereas TBF items are considered low priority. Unbeknownst to participants is that memory will later be tested for all stimuli *regardless* of whether it was associated with a TBR or TBF cue. When subsequently comparing memory across cue-types, participants typically show the *directed forgetting effect* characterized by increased memory for TBR than TBF items. This effect is seen in participants of an older age but at a reduced magnitude, compared to young adults (e.g., Gallant & Yang, 2014; Titz & Verhaeghen, 2010).

Different cognitive operations have been proposed to account for engaging in remembering of TBR items and intentional forgetting of TBF items. Some theories argue that the high priority TBR items are selectively rehearsed in order to strengthen their trace in memory while low priority TBF items are dropped from such rehearsal processes (Basden & Basden, 1996). Other theories suggest that "forgetting" of TBF items is facilitated by an attentional inhibition mechanism that diminishes processing of these items (Fawcett & Taylor, 2008; Gallant & Dyson, 2016; Wylie, Fawcett, & Taylor, 2008). Whether the cognitive operations elicited by these cues would impact memory of items in close temporal proximity and how this differs across age groups has yet to be explored. For example, if an item has high priority for later memory (i.e., TBR) and requires engagement of selective rehearsal mechanisms, how will memory for a subsequent low priority TBF item be affected or vice versa? One possibility is that repeating the same cognitive operation across consecutive trials (e.g., TBR followed by TBR) would lead to a reduction in the uniqueness of the encoding event and consequently, poorer memory for the TBR item at trial *n*. A second option is that *switching* cognitive operations across consecutive trials (e.g., TBF followed by TBR) reflects a form of task switching, in which one must disengage from inhibiting a TBF item in order to engage in selective rehearsal of a TBR item. Given that the efficiency of switching between mental sets or operations tends to decline with age (Verhaeghen, 2011), older adults may experience difficulty switching from cue to cue across trials relative to young adults. As such, the cue presented at trial *n-1* may have a greater influence on older adults' memory for trial *n* than younger adults'. By intermixing TBR and TBF trials during initial encoding, this allowed us to assess the impact of local context effects of varying cognitive operations experienced at encoding on eventual recognition.

Current Study

To reiterate, this paper examines age differences in local context effects in memory associated with emotional valence (independent of arousal) and the priority of stimuli as indicated by TBR and TBF encoding instructions. To address these questions, we conducted a novel analysis of data from a prior experiment (Gallant & Yang, 2014) in which young and older adults completed an item directed forgetting task for positive, negative, and neutral words matched on arousal. In this experiment, we adopted the task used by Thompson, Fawcett, and Taylor (2011) which included a source monitoring recognition procedure. Relative to the typical old/new recognition test, this source monitoring task allowed measurement of both item and source recognition by asking participants to assign a TBR, TBF, or New source to each item. Through combination of TBR and TBF responses, we were able to derive an aggregate of 'old' responses (i.e., indicating an item had been previously studied), while examining TBR and TBF responses separately provided a measure of source recognition for each item (i.e., whether it was TBR or TBF). Given that aging seems to impact source memory to a greater degree than item memory (Spaniol, 2015), the greatest impact of aging on *overall* performance in this analysis should be localized to the source recognition data. Across item and source recognition, individual memories for trial *n* items were assessed based on the relationship between the trial *n-1* and *n* item, specifically depending on its valence and encoding instruction. Consistent with the age-related positivity bias, it was predicted that a positive trial *n-1* would have a greater influence on memory for trial *n* in older relative to young adults. Since older adults' attention tends to be captured by positive information, a positive trial *n-1* may thus facilitate encoding for the subsequent trial, resulting in greater memory for that item, relative to instances where trial *n-1* had been negative or neutral.

Age was further expected to interact with the status of the memorial cue (i.e., TBR or TBF) between trial *n-1* and trial *n*, with older adults showing greater sensitivity to cues that switch across trials. For example, if trial *n-1* cue was TBR and trial *n* cue was TBF, then older adults' ability to "switch" from remembering to forgetting processes may be impaired, resulting in reduced forgetting of a TBF-cued trial *n* item (indexed by greater recognition of that item). As young adults show less evidence of difficulty with task switching, their memory may be less affected by the cue switching across trials.

Methods

Participants

These methods have been previously described in Gallant and Yang (2014). Participants included 36 young adults between the ages of 18 and 28 (M = 20.22, SD = 3.12; 7 males) and 36 older adults between the ages of 65 and 85 (M = 71.53, SD = 5.44; 11 males) from Toronto, Ontario, Canada. This sample size provided sufficient power (.94) to detect a within-between interaction of a small effect size (.15 at α = .05). The younger sample consisted of undergraduate students recruited from Introductory Psychology courses at Ryerson University who were compensated with a bonus course credit. Older adults were recruited from a senior research participant pool at Ryerson University and were compensated with $10 CAD.

Participants were invited to participate if they had no prior or current neurological abnormalities (e.g., mild cognitive impairment, stroke), were not taking medication known to affect mental functioning, and learned English prior to age six (to ensure English language proficiency as verbal stimuli were used). Participants' data were excluded on the basis of criteria established a-priori including: (1) scores over 26 on the Beck Anxiety Inventory (BAI; Beck, Epstein, Brown, & Steer, 1988) as anxiety symptoms have shown to influence emotional biases in attention; (2) scores lower than 20 on the Shipley Institute of Living Vocabulary Test, suggesting poor English vocabulary (Shipley, 1946); and (3) scores above six on the Short Blessed Test (SBT; Katzman et al., 1983), suggesting cognitive impairment. Based on these criteria, three young adults were excluded due to scores less than 20 on the Shipley and eight for scoring over 26 on the BAI, suggesting presence of anxiety symptoms. In addition to these measures, the Digit Symbol Substitution Test (DSST; Wechsler, 1981) as a measure of processing speed, the Positive and Negative Affective Schedule (PANAS; Watson, Clark, & Tellegen, 1988) as a mood measure, and a background information questionnaire were administered. The data from these measures are presented in Table 1. Young and older adults differed on several of the characteristics such that older adults had higher years of education, higher positive affect, lower negative affect, lower processing speed, lower anxiety scores, and higher vocabulary. These age differences are consistent with those generally reported in the literature (e.g., Truong & Yang, 2014; Verhaeghen, 2003).

Place Table 1 about here

Materials

The experiment was programmed using E-Prime version 2.0 software and presented on a 17 inch laptop at a viewing distance of roughly 60 cm. Stimuli were shown in the centre of the screen using black lowercase Courier New size-18 font on a white background.

Stimuli

Stimuli were chosen from the Affective Norms for English Words database (ANEW; Bradley & Lang, 1999) and included 120 words with equal representation of positive, negative, and neutral items. Words were selected based on their valence and arousal ratings each ranging from 1 (negative, low arousal) to 9 (positive, high arousal). To isolate the effects of valence, words were matched on word length, word frequency and mean arousal but differed significantly on mean valence (see Table 2).

Place Table 2 about here

Using these stimuli, two sets of 60 words were formed to be counterbalanced as ‘old’ and ‘new’ lists across participants. Each of these lists was further divided into two sub-sets of 30 words such that when the set was ‘old’, each of the sub-sets was counterbalanced as words receiving either a TBR or TBF cue. List divisions always contained equal representation from each valence category matched on arousal, word frequency and word length.

Procedure

Upon arrival, informed consent was collected and an introduction to the experiment was provided. Participants were asked to study a series of words for a later recognition task, but to remember those followed by an ‘RRRR’ cue and forget those followed by an ‘FFFF’ cue. After the instructions, three practice trials were provided prior to commencing encoding.

During encoding 60 words were presented, half cued as RRRR and half as FFFF. Trials proceeded in a pseudo-randomized sequence such that words from each valence or cue condition did not occur more than three times in a row. Each trial began with a fixation cross presented at the centre of the screen for 1 s, replaced by a word for 3 s. Following the word, an inter-stimulus interval (ISI) was presented as a blank screen for 1.5 s before proceeding to the memory cue for 1 s. The trial ended with another ISI for .5 s, before proceeding to the next trial.

Prior to the recognition task, the Digit Symptom Substitution Task (DSST) was administered for two minutes as a distractor task. During recognition, 60 new and 60 old words were presented in the same pseudo-random fashion as encoding. Participants were instructed to attribute a source to a word by indicating whether the word was one they were supposed to remember, one they were supposed to forget, or new by pressing corresponding keys on the keyboard (i.e., the ‘z’, ‘.’, and spacebar, respectively labeled as ‘R’, ‘F’, or ‘New’; Thompson et al., 2011). Each trial began with a fixation cross for 1 s followed by a word that stayed in the centre of the screen until the participant responded. Although the task was self-paced, participants were instructed to respond as quickly and accurately as possible. Each response was followed by an ISI of .5 s before proceeding to the next trial.

Following recognition, the BAI, PANAS, SBT (older adults only), and a background questionnaire were administered.

Statistical Analysis

To determine the effects of trial *n-1* valence on recognition of the subsequent item at trial *n*, we examined correct recognition, which was considered an ‘old’ response to a TBR or TBF word. To calculate this, the procedures of Thompson et al. (2011) were followed by combining ‘R’ and ‘F’ responses to obtain an index of ‘old’ recognition as our dependent variable. Next, we calculated the number of all valence category combinations across consecutive trials (e.g., positive *n-1* followed by positive *n*, positive *n-1* followed by neutral *n*, etc.) during encoding and determined whether trial *n* in each pair was correctly recognized as old. Proportion scores were then generated for all nine valence category combinations from the total possible number of observations. To determine the effects of trial *n-1*and *n* memory cue on the eventual recognition of trial *n*, we similarly calculated the proportion of correct recognition for trial *n* positions for all possible cue combinations (e.g., TBR *n-1* followed by TBR *n,* TBF *n-1* followed by TBR *n,* etc.) during encoding. The same procedure was applied to the source recognition data, except that accuracy to detect the correct source of each item (i.e., as TBR or TBF) was used as the dependent variable. It is important to note chance performance differed for both item and source recognition. In item recognition, chance performance was 50%, as response options were either old or new. In contrast, chance performance for source recognition was 33% as response options included TBR, TBF, or New.

To determine local context effects of valence, ANOVAs were conducted on the between-participants factor of age (young, older) and within-participant factors of trial *n-1* item valence (positive, negative, neutral) and trial *n* item valence (positive, negative, neutral) across item and source recognition. To analyze the impact of cue, the between-participant factor of age (older, younger) and the within-participant factors of trial *n-1* memory cue (TBR, TBF) and trial *n* memory cue (TBR, TBF) were again entered into ANOVAs for item and source recognition, respectively. Results were interpreted in terms of statistical significance ($\alpha = .05$) and effect size using partial eta squared (η^2_p) with a scale of .02, .13, and .26 reflecting small, medium, and large effect sizes respectively (Cohen, 1988). When required, significant effects and interactions were unpacked via follow-up *t*-tests using Bonferroni corrections for multiple comparisons. Summary statistics from the ANOVAs are presented in Tables 4-7.

Results

Results are organized according to valence and cue effects. The means and standard deviations for item and source recognition of each of the trial *n*-1 and trial *n* combinations are presented in Table 3.

Place Table 3 about here

Stimulus Valence *n-1* Effects

Item recognition. The analysis revealed a main effect of trial *n* valence ($p < .001$) explained by greater recognition of emotional (positive $M = .78$, $SD = .16$; negative, $M = .71$, $SD = .15$) relative to neutral items ($M = .68$, $SD = .17$; $ps < .01$); positive items were also better recognized than negative items ($p = .013$). A second main effect of trial *n-1* valence ($p = .001$) showed that recognition (regardless of trial *n* valence) was lower when the preceding item was neutral ($M = .69$, *SD* .16) relative to positive ($M = .76$, *SD* .17) or negative ($M = .76$, *SD* .16; $ps < .01$). These two variables also interacted in the analysis ($p = .002$) such that recognition of neutral items was particularly poor when the preceding item (trial *n-1*) was neutral but not positive or negative ($ps < .01$; see Figure 1 and Table 3 for means). The interaction also revealed that recognition of negative items was not impacted by the valence of trial *n-1*; however, positive items were better recognized when preceded by negative rather than neutral items ($p = .03$). There were no main effects or interactions involving age group ($ps > .307$; see table 4 for summary statistics of the ANOVA).

Place Table 4 and Figure 1 about here

Source recognition. Different from the item recognition analysis, the ANOVA showed a main effect of age ($p = .030$), confirming overall poorer source recognition in older ($M = .46$, $SD = .10$) relative to younger adults ($M = .53$, $SD = .15$; Figure 2a). A second main effect of *n-1* valence (p = .015) revealed lower source recognition of trial *n* items that followed a neutral (M = .45, SD = .15) relative to negative item (M = .51, SD = .16). This was qualified by an interaction that showed a trend toward significance between trial *n-1* valence and trial *n* valence (p = .090), which showed that recognition of neutral trial *n* items suffered when they followed a neutral item (M = .39, SD = .29) relative to a negative (M = .53, SD = .22) or positive (M = .52, SD = .29) item (Figure 2b). All other main effects and interactions were non-significant (ps > .249; see able 5 for summary statistics of the ANOVA).

Place Table 5 and Figure 2 about here

Memory Cue *n-1* Effects.

Item recognition. Consistent with the directed forgetting effect, a main effect of trial *n* cue showed higher recognition of TBR relative (M = .83, SD = .10) to TBF items (M = .67, SD = .17; p < .001). Trial *n* cue also interacted with age group (p = .002), explained by increased forgetting performance (i.e., lower recognition of TBF items) in younger (M = .62, SD = .17) as compared to older adults (M = .72, SD = .15; p = .020, Figure 3); there was no difference in recognition of TBR items across young (M = .83, SD = .09) and older adults (M = .81, SD = .11; p = .333). No other main effects or interactions were observed (see Table 6 for summary statistics of the ANOVA).

Place Table 6 and Figure 3 about here

Source recognition. Similar to the first source recognition analysis, a main effect of age (p = .040) confirmed overall poorer performance in older (M = .46, SD = .09) relative to young adults (M = .54, SD = .12, see Figure 4). A main effect of cue (p < .001) revealed poorer source recognition performance of TBF (M = .44, SD = 17) relative to TBR items (M = .56, SD = .14).

The three-way interaction showed a trend toward significance (p = .092), suggesting that the impact of trial *n-1* cue on the source recognition of trial *n* varied across age groups. Specifically, older but not young adults showed greater source recognition of TBF items when preceded by a TBR (M = .44, SD = .15) relative to a TBF item (M = .38, SD = .20; see Table 7 for summary statistics of the ANOVA).

Place Table 7 and Figure 4 about here

Discussion

The information we encounter on a daily basis varies not only in the degree of excitement but also pleasantness. As such, it is important to understand how these varying dimensions of emotional intensity can influence memory representations. According to existing research, if we are approached by an individual brandishing a knife or gun, our attention will be so captured by the highly arousing weapon that we will likely fail to encode the peripheral details of the event (Fawcett et al., 2013). Moreover, arousal's influence can extend to relatively benign information occurring in close temporal proximity (e.g., MacKay et al., 2004). Diverging from this research, the current study focused on the impact of valence on memory for nearby information. Specifically, we examined age differences in how the local context of an item at encoding affects both item and source recognition in memory, both in terms of the valence and encoding instruction associated with the preceding (trial *n-1*) stimulus. To address this goal, across age groups, we used an item directed forgetting task modified to include a source attribution procedure to determine how memory for trial *n* items would vary as a function of the valence (i.e., positive, negative, or neutral) and stimulus priority (i.e., whether it was TBR or TBF) of trial *n-1*. As arousal and valence have shown to be processed by distinct cognitive and neural mechanisms, we expected that the local context effects of valence would diverge from the previously reported effects of arousal. Moreover, with the documented age differences in emotional information processing (i.e., the positivity effect; Mather & Carstensen, 2005; Reed & Carstensen, 2012) and age-related declines in task-switching ability (Verhaeghen, 2011), we also expected to see between-group differences as a result of both manipulations (i.e., valence and encoding instruction). Finally, we expected to see the greatest impact of age on overall performance in the source recognition data, given age-related declines in source memory (Spaniol, 2015). Our hypotheses, however, were only partially supported.

First, when examining item recognition, we identified a novel finding of age-independent volatility of neutral stimuli, contingent on the valence of trial *n-1*. Specifically, recognition of neutral trial *n* items suffered when preceded by neutral stimuli but not when preceded by a positive or negative stimulus. This finding is in stark contrast to prior evidence of emotional disruption in memory for trial *n* neutral items that have an emotionally arousing local context (e.g., Knight & Mather, 2009; MacKay et al., 2004; Most et al., 2005; Strange et al., 2003) and also the often reported weapon focus effect. It is likely that we did not observe impairing local context effects of valence on memory as valence does not induce a state of physiological arousal in the same manner that stimuli high in arousal do (Strange, 2003). In contrast, the stimuli utilized in the current experiment had relatively low arousal ratings, falling in the range of 3.0 to 5.8 on a scale of 1 (low arousal) to 9 (high arousal), and varied along the valence continuum across conditions. Different from arousal, the activation of controlled encoding processes are thought to support and strengthen the subsequent representation of valence in memory (Kensinger & Corkin, 2004; Mather, 2015). In the current experiment, it is evident that items high in valence were indeed encoded to a greater degree given that recognition of these two conditions was greater than that of neutral. As such, in instances where a neutral item followed those items high in valence, it is plausible that the controlled processes used to encode the positive and negative items presented at trial *n-1* carried over to the subsequent neutral trial *n* item, enhancing its strength in memory as well. A similar pattern of results was observed for the source recognition data although at a trending level as the interaction failed to reach our threshold for statistical significance. This may suggest that the benefit of a local context high in valence on memory of neutral stimuli is greatest for item memory as opposed to more specific source memory representations (item $\eta^2_p = .06$ vs. source $\eta^2_p = .02$).

Interestingly, the facilitative local context effect of valence for memory of neutral items held true across both age groups. This is in contrast to hypotheses concerning how a positive trial *n-1* would influence older adults' performance as well as what would be expected from the perspective of the socioemotional selectivity theory (Carstensen, 1995). That is, given older adults' motivational shift to prioritize positive information, it was predicted that a positive trial *n-1* might capture their attention and enhance processing of the subsequent trial. Yet, despite often reported age-related positivity effects (Reed & Carstensen, 2012; Reed, Chan, & Mikels, 2014) no interaction between age and valence was observed in our local context analysis. This may suggest that older adults' positivity bias does not extend to the processing of items in close temporal proximity. It is also possible that the cue manipulation in the current task constrained older adults' attention, overriding their ability to elaborate on positive information. Consistent with this speculation, a recent meta-analysis has suggested that the age-related positivity effect is largest when older adults' cognitive processing is unconstrained (Reed et al., 2014). In either case, the results imply that the more general valence-based memory enhancement (e.g., Kensinger, 2008; Kensinger & Corkin, 2004) extends to improve memory for relatively benign information that is nearby in time across both young and older adults. Altogether and in light of prior research, these findings reinforce the importance of considering the differential effects of both dimensions of emotion (i.e., valence *and* arousal) on memory.

When examining the influence of stimulus priority or encoding instruction, no local context effects were observed in item recognition. Instead, an expected directed forgetting effect emerged with greater recognition of TBR relative to TBF trial *n* items, the magnitude of which was smaller in older adults. Similarly, source recognition of TBF items was poorer than that of TBR items, likely due to differences in the representation of these low versus high priority items in memory. Different from item recognition, however, a trending local context effect was observed in the older adult group such that source recognition of TBF items was greater if preceded by a TBR item. This finding suggests that the high priority TBR item at trial *n-1* may have facilitated source recognition of subsequent low priority TBF items at trial *n.* Moreover that this interaction was not evident in young adults may suggest that older adults' experienced increased sensitivity to trial-to-trial shifts in stimulus priority and the cognitive operations required at each trial (i.e., to encode them or to prevent encoding). Rather, young adults' performance did not vary according to the encoding instruction presented at trial *n-1*. As discussed previously, these trial-to-trial shifts may represent a form a task switching, such that one type of cognitive operation must be implemented at trial *n-1* and subsequently disengaged to follow the instructions of the next trial. Consistent with documented age-related reductions in task switching (Verhaeghen, 2011), older adults may have had difficulty shifting across trials, and in some instances the operation required for trial *n-1* may have carried over to trial *n*. However, it is important to note that these findings are rooted in a trending interaction and thus should be further considered in future research.

This study is not without limitations. The number of trials across trial *n* and trial *n-1* conditions was not matched (see Table 3). However, both young and older adults were exposed to the same trial orders, so trial structure cannot account for any age-related effects. There were some trial-to-trial combinations that appeared more frequently than others. For instance, as we sought to ensure that words from each valence or cue condition did not occur more than three times in a row, specific valence repetitions across trials were less frequent than valence changes. However, since all types of valence repetition were rare, the rarity of B-B trial combinations in and of itself cannot account for the reduced memory effect we saw for this specific condition. That is, if rare pairs were somehow remembered worse than those presented more frequently, then N-N and P-P trials should have also shown the reduced memory effect, but this was not the case. Removing the constraint regarding the repetition in valence or cue condition in future research will allow for a greater range of observations per cell per individual, and should allow for a more thorough study for the mechanisms that generate this effect. It will additionally be important to extend these findings beyond words and towards stimuli that yield more extreme valence judgments such as pictures.

Despite limitations, this paper adds two novel findings to the literature concerning local context effects in memory. First, different from what has been previously found with arousing local contexts, memory for neutral information can *benefit* from a context high in valence when arousal is controlled. Second, older adults were more affected when the cognitive operation of an item switched from its local context, a finding that may have implications for mechanistic explanations of directed forgetting performance particularly with regards to task switching.

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Figures and Tables

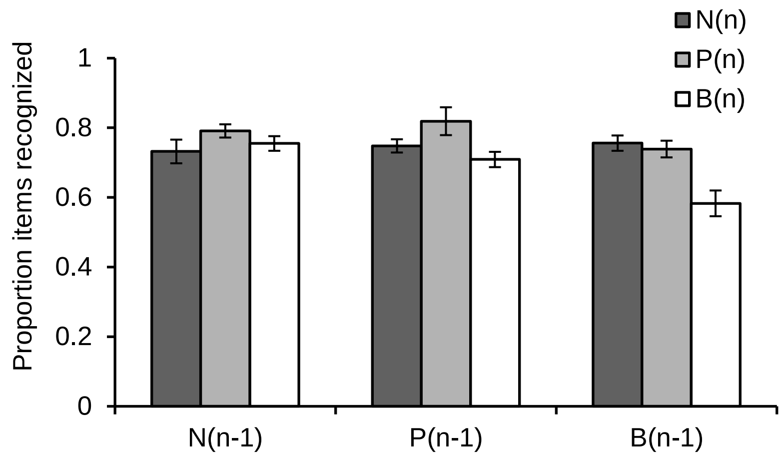

Figure 1. Proportional item recognition performance of trial *n* items as a function of trial *n-1* and trial *n* valence. P = positive, N = negative, B = neutral/baseline; (n) = current trial, (n-1) = prior trial. Error bars represent standard error of the mean.

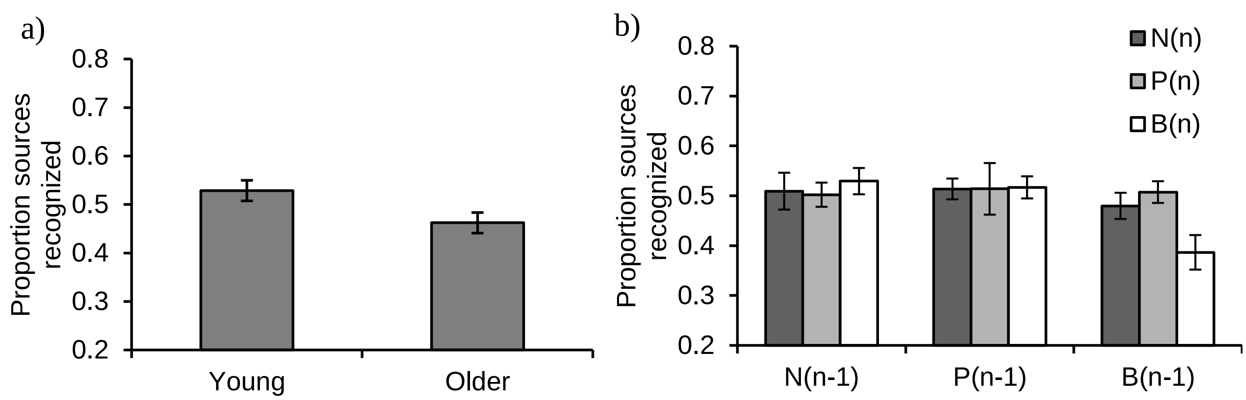

Figure 2. (a) Proportional source recognition performance for trial *n* items as a function of age. (b) Proportional source recognition as a function of trial *n-1* and trial *n* valence. Error bars represent standard error of the means.

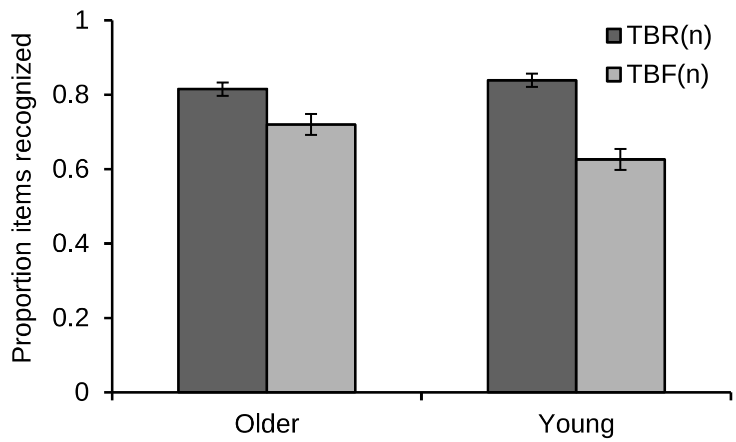

Figure 3. Proportional item recognition of trial *n* items as a function of cue type (TBR or TBF). Error bars represent standard errors of the mean.

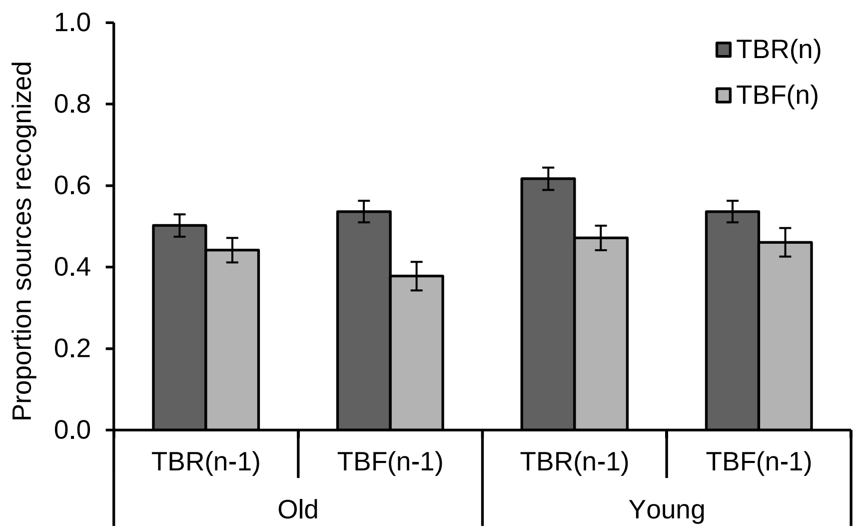

Figure 4. Proportional source recognition across older and younger adults as a function of trial *n-1* and trial *n* cue. TBR = to-be-remembered, TBF = to-be-forgotten; (n) = current trial, (n-1) = prior trial. Error bars represent standard error of the means.

Table 1

Final Sample Characteristics

	Older (n = 36)	Younger (n = 36)	
Characteristic	*M (SD)*	*M (SD)*	*p*-value
Age in years	71.53 (5.44)	20.22 (3.12)	<.001
Years of Education	15.89 (2.11)	13.90 (2.79)	.001
PANAS: Positive Affect	34.89 (8.43)	28.72 (7.84)	.002
PANAS: Negative Affect	11.42 (3.53)	13.50 (4.88)	.041
BAI	3.25 (4.19)	13.08 (6.61)	<.001
Shipley Vocabulary Test	37.25 (1.71)	27.86 (3.56)	<.001
DSST[a]	58.81 (15.76)	86.00 (11.36)	<.001
SBT	0.53 (1.21)	-	-

Note: [a]score reflects number of correct solutions. PANAS = Positive and Negative Affect Schedule; BAI = Beck Anxiety Inventory; DSST = Digit Symbol Substitution Test; SBT = Short Blessed Test.

Table 2

Stimuli Characteristics

	Positive (n = 40)		Negative (n = 40)		Neutral (n = 40)	
	M (*SD*)	Range	*M* (*SD*)	Range	*M* (*SD*)	Range
Valence[a]	7.39 (0.40)	6.7-8.1	2.64 (0.61)	1.6-3.6	5.01 (0.55)	4.0-6.0
Arousal[b]	4.38 (0.63)	3.0-5.4	4.45 (0.51)	3.3-5.8	4.20 (0.40)	3.4-5.0
Length[c]	5.97 (0.26)	3.0-9.0	5.70 (0.25)	3.0-10.0	6.02 (0.26)	3.0-9.0
Frequency[d]	49.10 (47.02)	1.0-216.0	49.15 (64.80)	3.0-277.0	51.10 (69.30)	1.0-244.0

Note: Ratings are based on norms from ANEW database (Bradley & Lang, 1999). Across valence categories: [a]Differed on mean valence, *ps* < .001; [b]matched on mean arousal, *ps* > .07; [c]matched on mean word length, *ps* > .30; [d]matched on mean word frequency, *ps* > .88.

Table 3

Average proportion scores and standard deviations for correct item and source recognition as a function of age group and condition

Trial type (*n-1 – n*)		Older		Younger	
		Item	Source	Item	Source
Valence	# Trials	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)
N-N	3	.74 (.28)	.50 (.29)	.72 (.29)	.52 (.33)
P-N	8.5	.76 (.16)	.47 (.17)	.74 (.16)	.55 (.19)
B-N	8.5	.78 (.16)	.40 (.21)	.73 (.20)	.56 (.23)
N-P	8.5	.82 (.15)	.48 (.20)	.76 (.17)	.53 (.22)
P-P	1.5	.81 (.36)	.43 (.47)	.83 (.32)	.60 (.41)
B-P	9	.77 (.18)	.49 (.16)	.71 (.20)	.52 (.21)
N-B	8	.78 (.15)	.53 (.24)	.73 (.21)	.53 (.21)
P-B	9.5	.73 (.21)	.51 (.19)	.87 (.11)	.53 (.19)
B-B	2.5	.60 (.29)	.35 (.27)	.56 (.34)	.43 (.31)
Cue	# Trials				
R-R	8.5	.81 (.16)	.50 (.16)	.87 (.11)	.62 (.17)
F-R	21	.82 (.11)	.54 (.14)	.81 (.13)	.59 (.18)
R-F	21.5	.71 (.16)	.44 (.15)	.61 (.21)	.47 (.21)
F-F	8	.73 (.19)	.38 (.21)	.64 (.22)	.46 (.21)

Note: "# Trials" represents the average number of trials across two counterbalanced conditions. N = Negative, P = Positive, B = Baseline/Neutral. R = Remember, F = forget.

Table 4

Summary of the three-way mixed-model ANOVA assessing the impact of trial n-1 stimulus valence effects during encoding on item recognition of trial n across older and younger adults

Metric	df	*F*	MSE	*p*	η^2_p
Age (A)	1, 70	1.059	.185	.307	.015
Valence *n-1* (V*n-1*)	**2, 140**	**7.662**	**.320**	**.001**	**.099**
Valence n (V*n*)	**2, 140**	**17.500**	**.556**	**<.001**	**.200**
A x V*n-1*	2, 140	.600	.025	.550	.008
A x V*n*	2, 140	.103	.003	.902	.001
V*n-1* x V*n*	**4, 280**	**4.488**	**.191**	**.002**	**.060**
A x V*n-1* x V*n*	4, 280	.326	.014	.860	.005

Note: Statistical significance at $p < .05$ indicated in bold font.

Table 5

Summary of the three-way mixed model ANOVA assessing the impact of trial n-1 stimulus valence effects during encoding on source recognition of trial n across older and younger adults

Metric	df	*F*	MSE	*p*	η^2_p
Age (A)	**1, 70**	**4.908**	**.715**	**.030**	**.066**
Valence *n-1* (V*n-1*)	**2, 140**	**4.363**	**.228**	**.015**	**.059**
Valence n (V*n*)	2, 140	.872	.054	.421	.012
A x V*n-1*	2, 140	1.403	.073	.249	.020
A x V*n*	2, 140	.708	.044	.494	.010
V*n-1* x V*n*	4, 280	2.031	.124	.090	.028
A x V*n-1* x V*n*	4, 280	1.147	.070	.335	.016

Note: Statistical significance at $p < .05$ indicated in bold font.

Table 6

Summary of the three-way mixed model ANOVA assessing the impact of memory cue at trial n-1 on trial n item recognition performance

Metric	df	*F*	MSE	*p*	η^2_p
Age (A)	1, 70	1.670	.089	.200	.023
Cue *n-1* (C*n-1*)	1, 70	.045	.015	.833	.019
Cue n (C*n*)	**1, 70**	**67.361**	**1.704**	**<.001**	**.490**
A x C*n-1*	1, 70	1.327	.015	.253	.019
A x C*n*	**1, 70**	**10.035**	**.254**	**.002**	**.125**
C*n-1* x C*n*	1, 70	2.012	.044	.160	.028
A x C*n-1* x C*n*	1, 70	.734	.016	.394	.010

Note: Statistical significance at $p < .05$ indicated in bold font.

Table 7

Summary of the three-way mixed model ANOVA assessing the impact of memory cue at trial n-1 on trial n source recognition performance

Metric	df	*F*	MSE	*p*	η^2_p
Age (A)	**1, 70**	**7.88**	**.047**	**.006**	**.096**
Cue *n-1* (C*n-1*)	1, 70	1.01	.017	.319	.014
Cue n (C*n*)	**1, 70**	**23.98**	**.047**	**<.001**	**.255**
A x C*n-1*	1, 70	<.01	.017	.958	<.001
A x C*n*	1, 70	.35	.047	.556	.004
C*n-1* x C*n*	1, 70	1.84	.018	.179	.026
A x C*n-1* x C*n*	**1, 70**	2.92	.018	.092	.040

Note: Statistical significance at $p < .05$ indicated in bold font.