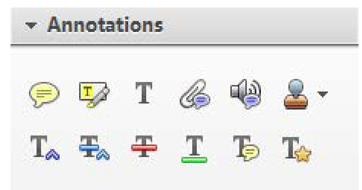
Smart Proof System Instructions

It is recommended that you read all instructions below; even if you are familiar with online review practices.

Using the Smart Proof system, proof reviewers can easily review the PDF proof, annotate corrections, respond to queries directly from the locally saved PDF proof, all of which are automatically submitted directly to **our database** without having to upload the annotated PDF.

- ✓ **Login into Smart Proof** anywhere you are connected to the internet.
- ✓ **Review the proof** on the following pages and mark corrections, changes, and query responses using the **Annotation Tools**.

  Note: Editing done by replacing the text on this PDF is not permitted with this application.



- ✓ **Save your proof corrections** by clicking the "Publish Comments" button.

  Corrections don't have to be marked in one sitting. You can publish comments and log back in at a later time to add and publish more comments before you click the "Complete Proof Review" button below.

Publish Comments

- ✓ **Complete your review** after all corrections have been published to the server by clicking the "Complete Proof Review" button below.

Before completing your review.....

Did you reply to all author queries found in your proof?

Did you click the "Publish Comments" button to save all your corrections? Any unpublished comments will be lost.

Note: Once you click "Complete Proof Review" you will not be able to add or publish additional corrections.

Complete Proof Review

Adding Comments and Notes to Your PDF

To facilitate electronic transmittal of corrections, we encourage authors to utilize the comment/annotations features in Adobe Acrobat. The PDF provided has been *comment enabled,* which allows you to utilize the comment and annotation features even if using only the free Adobe Acrobat reader (see note below regarding acceptable versions). Adobe Acrobat's Help menu provides additional details on the tools. When you open your PDF, the annotation tools are clearly shown on the tool bar (although icons may differ slightly among versions from what is shown below).

For purposes of correcting the PDF proof of your journal article, the important features to know are the following:

- To **insert text,** place your cursor at a point in text and select the Insert Text tool ( ) from the menu bar. Type your additional text in the pop-up box.
- To **replace text,** highlight the text to be changed, select the Replace Text tool ( ) from the menu bar, and type the new text in the pop-up box. Do this instead of deleting and then reinserting.
- To **delete text,** highlight the text to be deleted and press the Delete button on the keyboard.
- Use the **Sticky Note tool** ( ) to describe changes that need to be made (e.g., changes in bold, italics, or capitalization use; altering or replacing a figure) or to answer a question or approve a change from the editor. To use this feature, click on the Sticky Note tool in the menu bar and then click on a point in the PDF where you would like to make a comment. Then type your comment in the pop-up box.
- Use the **Callout tool** ( ) to point directly to changes that need to be made. Try to put the callout box in an area of white space so that you do not obscure the text.
- Use the **Highlight and Add Note to Text tool** ( ) to indicate font problems, bad breaks, and other textual inconsistencies. Select text to be changed, choose this tool, and type your comment in the pop-up box. One note can describe many changes.
- To view a list of changes to the proof or to see a more comprehensive set of annotation tools, select **Comment** from the menu bar.

As with hand-annotated proof corrections, the important points are to communicate changes clearly and thoroughly, to answer all queries and questions, and to provide complete information to allow us to make the necessary changes to your article so it is ready for publication. Do not use tools that incorporate changes to the text in such a way that no indication of a change is visible. Such changes will not be incorporated into the final proof.

To utilize the comments features on this PDF you will need Adobe Reader version 7 or higher. This program is freely available and can be downloaded from http://get.adobe.com/reader/

J_ID: ART NO: 10.1037/xlm0001020 Date: 6-February-21 Page: 1 Total Pages: 15 4/Color Figure(s) ARTTYPE="ResearchArticle"

AMERICAN PSYCHOLOGICAL ASSOCIATION

Journal of Experimental Psychology: Learning, Memory, and Cognition

ISSN: 0278-7393

https://doi.org/10.1037/xlm0001020

The Attentional Boost Effect Enhances the Item-Specific, but Not the Relational, Encoding of Verbal Material: Evidence From Multiple Recall Tests With Related and Unrelated Lists

AQ:

AQ: au

Pietro Spataro[1], Neil W. Mulligan[2], Vincenzo Cestari[3], Alessandro Santirocchi[3], Daniele Saraulli[4], and Clelia Rossi-Arnaud[3]

AQ: 2

[1] Department of Economy, Universitas Mercatorum
[2] Department of Psychology and Neuroscience, University of North Carolina, Chapel Hill
[3] Department of Psychology, Sapienza University
[4] Department of Law, Economics, Politics and Modern Language, LUMSA University

In the Attentional Boost Effect (ABE), words or images encoded with to-be-detected target squares are later recognized better than words or images encoded with to-be-ignored distractor squares. The present study sought to determine whether the ABE enhanced the encoding of the item-specific and relational properties of the studied words by using the multiple recall paradigm. Previous evidence indicates that manipulations fostering item-specific encoding increased the number of item gains, whereas manipulations fostering relational encoding decreased item losses. Across three experiments, participants were presented with lists of semantically related or unrelated words paired with target (red) or distractor (green) squares, under the instructions to remember all the words and press the spacebar when the square was red. Immediately after the study phase, they were involved in four consecutive recall attempts. In all cases, the classical ABE was replicated, in that participants recalled more target- than distractor-paired words. Most importantly, the analyses converged in showing that item gains were significantly greater for target- than for distractor-paired words when participants studied lists of related words (but not when they studied unrelated lists); in contrast, item losses did not differ between the two types of words, irrespective of the nature of the studied list. Taken together, these data suggest that the ABE enhanced the encoding of item-specific information but had no effect on the encoding of relational information.

Keywords: attentional boost effect, item gains and losses, item-specific vs. relational encoding, multiple free recall

The term *Attentional Boost Effect* (ABE) refers to a phenomenon whereby images or words encoded at the same time as unrelated to-be-detected targets are later recognized better than images or words encoded at the same time as to-be-ignored distractors (Lin et al., 2010; Swallow & Jiang, 2010; see Swallow & Jiang, 2013, for a review). In the initial demonstration of the ABE (Swallow & Jiang, 2010), participants repeatedly encoded a long sequence of scenes each presented with a small central square that could be either white (the target stimulus) or black (the distractor stimulus). They were instructed to pay attention to the scenes and simultaneously press the spacebar whenever a white square appeared on the screen (no action was required in response to the black squares). The results of an immediate four-choice recognition task showed that memory for the target-paired scenes was significantly better than memory for the distractor-paired scenes. This advantage has been replicated and extended to verbal materials by Spataro et al. (2013) and by Mulligan et al. (2014). In these studies, participants encoded a series of words each presented with a small circle immediately below the word that was either red (the target stimulus) or green (the distractor stimulus). The instructions were to read aloud the words and press the spacebar whenever a red circle was detected. When memory for the words was later examined in a yes/no recognition task, the results confirmed the ABE, because the words encoded with target circles were recognized significantly better than the words encoded with distractor circles. Subsequent studies have demonstrated that the ABE with verbal material is a robust phenomenon that occurs in a wide range of experimental contexts and applies to different memory tests (including free recall, cued recall and perceptual implicit tasks: Mulligan et al., 2014; Mulligan & Spataro, 2015; Spataro et al., 2017) and different materials (including emotional words and images: Rossi-Arnaud et al., 2018).

From a theoretical point of view, the ABE is relevant because it contradicts previous findings concerning the relation between

Pietro Spataro https://orcid.org/0000-0003-3204-4449
Clelia Rossi-Arnaud https://orcid.org/0000-0001-5006-6583
Correspondence concerning this article should be addressed to Pietro Spataro, Department of Economy, Mercatorum University, Piazza Mattei 10, 00186, Rome, Italy. Email: pietro.spataro@uniroma1.it

AQ: 3

ID: navin.prajapati Time: 17:36 I Path: //mbnas01.cadmus.com/home$/45417$/AP-XLMJ210017

attention and memory. In fact, studies comparing full-attention (FA) and divided-attention (DA) conditions have typically reported lower memory accuracy in the latter condition (e.g., Craik et al., 1996; see Mulligan, 2008; for a review). This cannot be considered a surprising result because performing a secondary task draws attention resources away from the encoding of the primary-task stimuli and therefore reduces their later recognition. The paradigm used to demonstrate the ABE represents a typical DA condition in which participants are requested to perform two simultaneous tasks—encoding the words (or the images) and detecting the target squares (or circles). Because previous evidence indicates that target detection requires more attention resources than distractor rejection (Duncan, 1980; Dux & Marois, 2009), the straightforward prediction would be that the recognition performance for target-paired words in the DA condition should be less accurate than the performance in the FA condition—in which participants are told to ignore the squares and focus all their attention on encoding the words. The ABE represents a surprising exception to this expected pattern because the recognition of target-paired stimuli in the DA condition either equals the level reached in the FA condition (producing a relative memory facilitation: Mulligan et al., 2014; Spataro et al., 2013, 2015; Swallow & Jiang, 2010) or exceeds it (producing an absolute memory facilitation: Mulligan & Spataro, 2015; Prull, 2019; Spataro et al., 2013). Given its unusual nature, examining the conditions under which the effect can be shown and its boundary conditions represents an important issue.

Previous studies have ruled out a number of potential explanations of the ABE, including those based on perceptual distinctiveness, attentional cuing, reinforcement learning, perceptual grouping, and oddball processing (Swallow & Jiang, 2013). For example, the scenes and the squares must be presented at the same time for the effect to occur: target squares presented 100 ms before or 100 ms after the scenes did not facilitate later recognition (Swallow & Jiang, 2011). Other results showed that the ABE does not reflect the processing of rare, infrequent events: in fact, a significant memory enhancement was obtained even when the target and the distractor squares appeared with the same frequency (Swallow & Jiang, 2012; but see Au & Cheung, 2020, for a different conclusion with verbal materials). Based on this evidence, Swallow and Jiang (2013) proposed an integrative theoretical framework of the ABE, referred to as the dual-task interaction model. Briefly, this account assumes that, on each trial during the encoding phase, the word (or the scene) and the square compete for a limited amount of perceptual resources; in addition, participants are requested to coordinate two simultaneous tasks (encoding the scenes and detecting the target squares), which leads to additional interference. However, the categorization of the square as a target requiring a response triggers a set of processes known as temporal selective attention. Hypothetically instantiated by a transient increase in the release of norepinephrine from the locus coeruleus (Nieuwenhuis et al., 2005; Yebra et al., 2019), temporal selective attention operates by temporarily enhancing the amount of perceptual resources devoted to the elaboration of the stimuli that are presented at the same time as the target squares (Sisk & Jiang, 2020). In addition, the detection of a regularly presented target resets and entrains neuronal activity across different cerebral regions, leading to an additional increase in the efficiency of stimulus processing (Lakatos et al., 2008).

While recognizing the utility of the dual-task interaction model, later studies by Mulligan and Spataro (2015) and Spataro et al. (2017) suggested that the ABE might be alternatively understood in the context of the well-known and similar distinctions between item-specific and relational processing (Hunt & McDaniel, 1993; Mulligan, 2006, 2012), item and associative memory (e.g., Gronlund & Ratcliff, 1989; Murdock, 1993), and initial interpretative encoding versus elaborative encoding (Masson & MacLeod, 1992). According to Hunt and Einstein (1981), item-specific processing refers to the elaboration of features that are unique to a given stimulus, whereas relational processing refers to the elaboration of features that are shared between different stimuli. During the retrieval phase, these two processes are supposed to interact to produce a sequence of increasingly finer discriminations in which relational information delimits a class of potential responses and item-specific information allows the selection of a specific response (Hunt & Seta, 1984; Mulligan, 1999). Starting from these assumptions, Spataro et al. (2017) compared the effects of the ABE manipulation on category cued recall (an explicit memory task based on item-specific processing) and category exemplar generation (an implicit memory task based on relational processing). In the category cued recall task, participants were asked to retrieve exemplars that belonged to a given category and had also appeared during the study phase, whereas in the exemplar generation task they were simply asked to produce the first exemplars of a given category that came to mind. Because the discriminations involved in category cued recall were finer than those involved in category exemplar generation, it followed that the role of item-specific processing should have been more prominent in the former than in the latter task (Mulligan, 2006, 2012; Weldon & Coyote, 1996). In line with the idea that the ABE enhances the encoding of item-specific information, Spataro et al. (2017) found that the exemplars encoded with target squares were recalled significantly better than the exemplars encoded with distractor squares in the category cued recall task. In contrast, repetition priming in the category exemplar generation task did not differ between target- and distractor-paired exemplars, suggesting that the ABE did not affect the elaboration of relational information.

The item-specific/relational framework of the ABE nicely accounts for the results reported by Spataro et al. (2017); most importantly, it produces additional predictions that have not been previously tested. In fact, the central implication of this view is that the ABE should have null, or even negative, effects on tasks that are heavily based on relational processing. The validity of this prediction is currently unclear, since previous studies investigated different forms of relational memory (see Chiu et al., 2013) by using slightly different methodologies and materials (images vs. words). An earlier study by Mulligan et al. (2016) found that the detection of target squares did not enhance the recall of the contextual features of the studied words, whether defined in terms of visual details (fonts and colors), study modality (visual or auditory), or list membership. In these experiments, the term *contextual memory* was used to refer to the encoding of the associations between features of the study words (e.g., between word identity and modality) or between the study words and their broader spatiotemporal context (in the list discrimination task). In this respect, the results reported by Spataro et al. (2017), showing the absence of significant ABE effects on category exemplar generation, can be seen as extending the conclusions of Mulligan et al. (2016) to the encoding of the associations between word identity and their semantic category. In both cases, these are associations among the features of background stimuli—that is, associations that do not involve the monitored items. On the other hand, Turker and Swallow (2019) have recently shown that target detection can enhance a different type of relational memory, here defined as the encoding of arbitrary or incidental associations between the constituent elements of an event (e.g., Cohen & Eichenbaum, 1993), or put more simply, as the encoding of the associations between the background stimuli and features of the monitored items. Participants encoded briefly presented scenes and simultaneously pressed a button if a second unrelated item (a central geometrical shape or a face) was a target color (Experiments 1 and 2) or a target gender (Experiment 3) rather than a distractor color or gender. Besides varying in terms of color or gender, target and distractor stimuli also varied for features that were irrelevant for the detection task (type of shape, location, or facial identity). The key finding was that participants reported both the relevant and the irrelevant features of the items that appeared with target-paired scenes better than the features of the items that appeared with distractor-paired scenes. To account for these data, Turker and Swallow (2019) extended the dual-task interaction model by proposing that the release of norepinephrine from the locus coeruleus might increase long-term potentiation in the dentate gyrus of the hippocampus, a structure which has a critical role in the encoding of arbitrary relations between different stimuli occurring at the same moment in time (Sara, 2009; see Yebra et al., 2019; for evidence that action-evoked memory enhancement is mediated by a LC–parahippocampal gyrus circuit).

AQ: 5

Considering these theoretical distinctions, the present study was aimed at examining in more detail the question of whether target detection could enhance the encoding of the associations between word identity and semantic category. Thus, the way in which we used the term *relational memory* was more in line with the meaning suggested by Mulligan et al. (2016) and Spataro et al. (2017). To this purpose, we adopted the multiple free-recall test paradigm —an alternative method for measuring item-specific and relational influences in free recall (Klein et al., 1989; Mulligan, 2000; 2002). The basic procedure required participants to encode a list of words, half paired with a target square and half paired with a distractor square. At the end of the study list, they attempted to retrieve as many words as possible in four successive free-recall tests. This paradigm usually leads to an increase in the number of items recalled on later tests, a phenomenon called *hypermnesia* (Payne, 1987). In particular, item gains are defined as the number of items recalled on later tests that were not reported in earlier tests, whereas item losses are defined as the number of items lost on later tests that were successfully retrieved in earlier attempts. Previous studies demonstrated that (a) manipulations fostering item-specific processing increase the number of item gains, and (b) manipulations fostering relational processing reduce the number of item losses (Burns, 1993; Klein et al., 1989; McDaniel et al., 1998; Olofsson, 1997). Regarding the first point, there is general agreement on the notion that item-specific processing involves a richer encoding of the items' attributes, which in turn enhances the probability of the studied stimuli to be retrieved in the multiple recall paradigm. In fact, assuming that the successful recall of an item depends on the recovery of a minimum number of attributes, it logically follows that the probability of sampling that number over multiple attempts will be higher for stimuli with many encoded attributes than for stimuli with few encoded attributes (McDaniel et al., 1998). Regarding the second point, the assumption is that, when the encoded items are semantically related to one another, relational information is used to guide retrieval and to generate potential responses, resulting in the development of stable retrieval strategies that are repeatedly applied over successive recall attempts (Hunt & McDaniel, 1993; McDaniel et al., 1998; Mulligan, 2000). The consequence is that participants exhibit a strong tendency to generate the same stimuli, which in turn should reduce item losses from one recall trial to the next.

Evidence that item-specific information primarily increases the number of item gains, whereas relational informational primarily decreases the number of item losses, has been provided by Klein et al. (1989). The work of these authors started from previous data demonstrating that the type of processing engaged in by participants during the study phase depends on both the nature of the encoding task and the relatedness of the presented words (Einstein & Hunt, 1980; Hunt & Einstein, 1981). The assumption is that participants studying a list of highly related words spontaneously notice and encode semantic relations. In this condition, a task focusing on relational processing provides information redundant with that already made available by the list structure; in contrast, a task emphasizing item-specific processing provides novel information that is not automatically suggested by the list structure. On the other hand, when participants encode a list of apparently unrelated words, they are more likely to focus on the unique, item-specific information associated with each word. In this case, a task emphasizing item-specific processing provides redundant information, whereas a task emphasizing relational processing suggests novel information not already noticed by participants. These assumptions led Klein et al. (1989) to hypothesize that, if item gains and losses reflect the processing of different types of information, then they should be differentially affected by item-specific and relational tasks. Specifically, the prediction is that, when relational information is already provided by the use of lists of highly related words, then item-specific tasks should be more likely to increase the production of item gains, compared with relational tasks; at the same time, item-specific and relational tasks should result in the same number of item losses, because the information provided by relational tasks would be redundant with that already suggest by the related list structure. Conversely, when participants study lists of unrelated words, then item-specific and relational tasks should produce the same number of item gains, because the information provided by the item-specific task will be redundant with that spontaneously processed by participants; at the same time, relational tasks should result in a lower number of item losses, compared with item-specific tasks. This was exactly the pattern reported by Klein et al. (1989) when comparing pleasantness rating (an item-specific task) and category sorting (a relational task). They found that pleasantness rating produced higher overall recall than category sorting in the related list condition, whereas category sorting produced higher recall than pleasantness rating in the unrelated list condition. Most importantly, they showed that, in the related list condition, pleasantness rating produced higher item gains than did category sorting, whereas the two types of tasks produced the same number of item losses. In contrast, in the unrelated list condition, category sorting produced lower item losses than did pleasantness rating, whereas the two tasks did not differ in terms of item gains.

AQ: 6

In the case of the ABE, the predictions following from the use of the multiple free-recall paradigm are clear. If target detection facilitates both item-specific and relational encoding, then we should find a pattern of results whereby (a) the number of item gains should be higher for target- than for distractor-paired words with related lists (but not with unrelated lists), and (b) the number of item losses should be lower for target- than for distractor-paired words with unrelated lists (but not with related lists). On the other hand, if target detection facilitates item-specific processing but has no effect on relational processing, as suggested by the item-specific/relational account of the ABE (Mulligan & Spataro, 2015; Spataro et al., 2017), then we should find a pattern of results in which (a) the number of item gains should be higher for target- than for distractor-paired words with related lists (but not with unrelated lists), and (b) the number of item losses should be equal for target- and distractor-paired words with both related and unrelated lists.

Experiment 1

Experiment 1 used the standard version of the multiple free-recall paradigm, which involved a single encoding phase and four successive free-recall tests. Previous studies showed that, under these conditions, hypermnesia was typically stronger with images than with words (Belmore, 1981; Mulligan, 2000; Olofsson, 1997; Payne, 1986). In facts, results of several studies indicate that, when it comes to the use of verbal materials, the probability to find a significant hypermnestic recall is higher if words are presented multiple times or are encoded under instructions encouraging semantic elaboration or imagistic processing (see Payne, 1987, for a review). Nevertheless, we judged it appropriate to begin our investigation with a basic methodology and also to determine the replicability of the ABE in free recall (to date, significant effects in this memory task have been only reported by Mulligan et al., 2014). Importantly, both Experiments 1 and 2 used lists of related words (i.e., lists of words organized by category). As explained above, participants studying this type of lists should spontaneously notice and encode relational information. By consequence, manipulations affecting primarily the processing of item-specific information should produce a significant increase in the production of item gains (Klein et al., 1989). If the ABE operates in this way (as suggested by Spataro et al., 2017), then the prediction is that item gains should be higher for target- than for distractor-paired words.

Method

Participants

Thirty-six undergraduate and graduate students of the School of Medicine and Psychology of the University "La Sapienza" of Rome volunteered to participate in Experiment 1. They were 27 females and nine males (age: $M = 25.25$, $SD = 3.78$).

Mulligan et al. (2014; Exp. 5) reported that the effect size associated with the ABE manipulation in a free recall task was $\eta^2 = .20$ (corresponding to $f = .50$) in a repeated-measures ANOVA. Using the software GPower3 (Faul et al., 2007), we determined that, with $N = 36$, $\alpha = 0.05$ and a low correlation among repeated measures ($r = .20$), the post hoc power to detect an ABE effect similar or greater than that observed by Mulligan et al. (2014) was .99 (test family: F tests; Statistical test: ANOVA repeated-measures, within-factors).

Materials

Four exemplars of eight different categories (trees, vegetables, diseases, professions, flowers, fruits, fishes, and birds) were selected from the database provided by Boccardi and Cappa (1997). The resulting eight sets of exemplars were equated as closely as possible in terms of taxonomic frequency (i.e., the mean number of participants producing each exemplar; range: 37.5–79.0), written frequency (range: 5.7–35.2, as estimated from the CoLFIS vocabulary: http://linguistica.sns.it/CoLFIS/Home_eng.htm), and length in letters (range: 6.2–8.5). The selected items did not include the five most common exemplars of each category. In addition, four abstract words were selected from the Lexvar database (https://www.istc.cnr.it/en/grouppage/lexvar) to be used as buffer items at the beginning (two) and at the end (wo) of each study list.

AQ: 7

Procedure

Participants were tested individually. The experiment consisted of a study phase and four free-recall memory tests. In the study phase, participants were told to read aloud and try to remember each word while simultaneously monitoring the color of a small squares placed immediately below the word. The study list consisted of 36 exemplars: two primacy buffers, 32 critical exemplars, and two recency buffers. Of the 32 critical exemplars, 16 were paired with a target (red) square, whereas the other 16 were paired with a distractor (green) square—thus, the target-to-distractor ratio was 1:1 (Swallow & Jiang, 2012). The buffer items were always associated with distractor squares. The study procedures were modeled after Spataro et al. (2013) and Mulligan et al. (2014; Exp. 4–5). On each trial, one word (Times New Roman, 44 points) and one square (green or red, 1 cm in diameter) appeared simultaneously at the center of the screen for 300 ms, with a vertical distance of 1 cm between them, after which only the word remained visible for an additional 1,200 ms (there was no interitem interval between two successive words). With the exception of the buffer items, the study list was composed of eight blocks of four words belonging to the same category. This means that all the words from a given category were presented in the same block, and the categorical organization of the list was easily apparent to participants. Within each block (and therefore within each category), two exemplars were associated with red (target) squares, whereas the other two exemplars were associated with green (distractor) squares. The assignment of the four words of each block to the target and distractor conditions was counterbalanced across participants, leading to the construction of six different encoding lists (i.e., if we call the four words of the block A, B, C, and D, then the target-associated words could be AB, AC, AD, BC, BD, and CD). Six participants were presented with each encoding list. In addition, the order of presentation of the trials within each block was semirandomized, with the constraint that, across the eight blocks, target-paired words appeared in each position (first, second, third, and fourth) two times.

Immediately after the presentation of the study list, participants were engaged in a free recall task in which they were asked to spontaneously recall as many exemplars as possible from the study list (note that the exemplars could be retrieved in any order, as the

J_ID: ART NO: 10.1037/xlm0001020 Date: 6-February-21 Page: 5 Total Pages: 15 4/Color Figure(s) ARTTYPE="ResearchArticle"

instructions did not emphasize the necessity to follow the order of presentation). The test lasted 5 min, and participants wrote their responses on an appropriate response sheet. This procedure was repeated three more times, leading to a total of four free-recall tests (there was no interval between successive tests: Mulligan, 2000). Before each recall attempt, the participants were reminded that the aim of the task was to recall as many words as possible, including those that were reported on prior tests. They were also encouraged to use the entire time and to try to recall additional items even if they feel they cannot recall any more words.

Results and Discussion

Encoding Phase

The mean proportion of target squares correctly detected was very high, M = .99 (SD = .02). False alarms (i.e., incorrect press responses to distractor squares) were rare, M = .04 (SD = .03). The mean response time (RT) for correct target detection was 668.7 ms (SD = 177.6 ms).

Test Phase: Recall Performance

F1 Figure 1 illustrates the mean proportions of words correctly retrieved in the four free-recall tests, as a function of whether they were presented together with a target or a distractor square during the encoding phase. These proportions were analyzed with a 2 × 4 completely repeated ANOVA, considering Trial Type (target- vs. distractor-paired words) and Recall Test (first, second, third and fourth) as within-subject factors. The results revealed a significant main effect of Trial Type, $F(1, 35) = 31.74$, $p < .001$, $\eta^2 = .48$, indicating that target-paired words (M = .47) were recalled significantly better than distractor-paired words (M = .30). Thus, we successfully replicated the ABE reported by Mulligan et al. (2014). The main effect of Recall Test did not reach the standard significance level, $F(3, 105) = 2.35$, $p = .076$, $\eta^2 = .06$. Lastly, the two-way interaction between Trial Type and Recall Test was not significant, $F(3, 105) = .24$, $p = .86$, $\eta^2 = .01$.

AQ: 8

Test Phase: Gains and Losses

The mean number of item gains and item losses are reported in Table 1. To recap, item gains for test i were computed as the number of words recalled on test i but not on test $i - 1$. Item losses for test i were computed as the number of words recalled on test $i - 1$, but not on test i (Mulligan, 2002). They were analyzed with two 2 × 3 completely repeated ANOVAs, considering Trial Type (target- vs. distractor-paired words) and Recall Test (second, third and fourth) as within-subject factors. By default, the number of item gains and losses could not be computed for the first recall test, because there was no previous reference point. T1

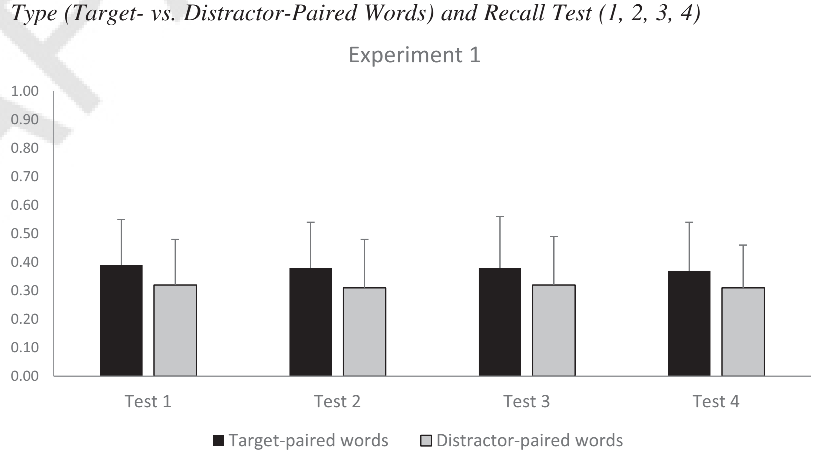
For item gains, the ANOVA showed a significant main effect of Trial Type, $F(1, 35) = 6.38$, $p = .016$, $\eta^2 = .15$, indicating that item gains were higher for target-paired words (M = .50) than for distractor-paired words (M = .32). The main effect of Recall Test and the two-way interaction between Trial Type and Recall Test were not significant, $F(2, 70) = .80$, $p = .45$, $\eta^2 = .02$, and $F(2, 70) = .79$, $p = .46$, $\eta^2 = .02$, respectively.

For item losses, the same ANOVA found a significant main effect of Recall Test, $F(2, 70) = 7.43$, $p = .001$, $\eta^2 = .18$. The post hoc comparisons (using the Bonferroni correction) demonstrated a significant decrease in item losses between the second and the fourth tests (M = .63 vs. M = .13, $p = .004$) and a marginal decrease between the second and the third tests (M = .63 vs. M = .25, $p = .068$; no difference emerged between the third and the fourth tests: $p = .61$). The main effect of Trial Type showed a marginal tendency toward the significance level, $F(1, 35) = 3.51$, $p = .069$, $\eta^2 = .09$, indicating that item losses tended to be higher for target-paired words (M = .41) than for distractor-paired words (M = .26). Finally, the two-way interaction between Trial Type and Recall Test was not significant, $F(2, 70) = 1.40$, $p = .25$, $\eta^2 = .04$.

Finally, the raw frequencies of intrusions reported by participants were fairly low: M = .44 in the first test, M = .77 in the second test, M = .94 in the third test, and M = 1.25 in the fourth test. The linear trend was significant, $F(1, 35) = 21.96$, $p < .001$, $\eta^2 = .39$, suggesting that intrusions increased across successive tests.

Figure 1

Mean Proportions of Words Recalled in Experiment 1, as a Function of Trial Type (Target- vs. Distractor-Paired Words) and Recall Test (1, 2, 3, 4)



Note. Error bars represent standard deviations.

AQ: 12

Table 1
Mean Number of Item Gains and Losses in Experiment 1, as a Function of Trial Type (Target- vs. Distractor-Paired Words) and Recall Test (1–2, 2–3, 3–4)

	Between tests		
Encoding condition	1−2	2−3	3−4
Item gains			
Target-paired words	0.53 (0.69)	0.56 (0.87)	0.42 (0.69)
Distractor-paired words	0.44 (0.77)	0.22 (0.48)	0.28 (0.45)
Item losses			
Target-paired words	0.78 (1.02)	0.31 (0.57)	0.14 (0.42)
Distractor-paired words	0.47 (0.84)	0.19 (0.53)	0.11 (0.39)

Note. Standard deviations are reported in parentheses.

Additional Analyses

Because the main effect of Trial Type did not reach the standard significance level for item losses, we performed two additional analyses. The first analysis evaluates a more general implication of the item-specific/relational account of the ABE, which combines gains and losses. Specifically, this framework predicts that the ABE should increase both item gains (due to enhanced item-specific encoding) and item losses (due to disrupted relational encoding). This means that recall for target-paired words should be more volatile than recall for distractor-paired words. Simply summing item gains and item losses for target- and distractor-paired words provides a measure that can be used to index overall volatility across the four recall attempts (Mulligan, 2000). These scores were submitted to a 2 (Trial Type) × 3 (Recall Test) completely repeated ANOVA that revealed significant main effect of both Trial Type, $F(1, 35) = 6.06$, $p = .019$, $\eta^2 = .15$, and Recall Test, $F(2, 70) = 9.15$, $p < .001$, $\eta^2 = .21$. As expected, recall volatility was greater for target-paired words ($M = .91$) than for distractor-paired words ($M = .57$); in addition, volatility decreased from the first to the second recall ($M = 1.11$ vs. $M = .64$, $p = .017$) and from the first to the third recall ($M = 1.11$ vs. $M = .47$, $p = .001$). The two-way interaction between Trial Type and Recall Test was not significant, $F(2, 34) = .45$, $p = .64$, $\eta^2 = .03$.

The second analysis addresses an artifactual explanation of the present results—namely, the idea that the target condition produced more gains and losses simply because it led to higher overall recall. As outlined by Olofsson (1997) and Mulligan (2000), this hypothesis applies to item losses but not to item gains. Item losses could be more frequent in the encoding condition that produces higher recall simply because there are more items to be forgotten in the next recall attempt. However, the same reason leads to the expectation that item gains should be less frequent in the condition with higher recall, because there remain fewer nonrecalled words to be produced in the next recall. To determine whether our results were dependent on the differences in initial recall, statistical analyses were repeated by computing proportional item losses. Following Mulligan (2000), proportional scores were measured by taking the number of losses in the $n + 1$ test and dividing it by the total number of words recalled in the n test (this was done separately for target- and distractor-paired words). A 2 (Trial Type) × 3 (Recall Test) completely repeated ANOVA found only a significant effect of Recall Test, $F(2, 70) = 9.03$, $p < .001$, $\eta^2 = .21$, confirming that item losses decreased between the first ($M = .09$) and the second recall ($M = .03$, $p = .034$) and between the first and the third recall ($M = .02$, $p = .002$). Neither the main effect of Trial Type nor the two-way interaction between Trial Type and Recall Test reached the significance level, $F(1, 35) = .29$, $p = .59$, $\eta^2 = .01$, and $F(2, 70) = .21$, $p = .81$, $\eta^2 = .01$, respectively. Thus, even after taking into account the initial recall level, there was no evidence that the ABE increased the production of item losses.[1] Fn1

In summary, Experiment 1 yielded several interesting results. First, the analysis of the overall recall replicated previous findings showing that a robust ABE occurs in the free recall of categorized lists (Mulligan et al., 2014; Spataro et al., 2017). Most importantly, the analysis of item gains and losses over four consecutive sessions demonstrated that the advantage for target-paired words was significant in the case of item gains and marginally significant or nonsignificant in the case of item losses (depending on whether the analyses were performed on absolute scores or on proportional scores). As illustrated above, when participants study related lists, manipulations that enhance the efficiency of item-specific encoding processes are expected to increase the number of item gains (Burns, 1993; Klein et al., 1989; McDaniel et al., 1998; Olofsson, 1997); in this respect, our results confirm that the ABE behaves like many other manipulations that are known to enhance the elaboration of the features of individual items (such as the generation effect, the bizarre-imagery effect, the effect of orthographic distinctiveness, the enactment effect and the perceptual interference effect: Engelkamp & Dehn, 2000; Hunt & Elliot, 1980; McDaniel & Einstein, 1986; Mulligan, 2002). On the other hand, we did not expect the ABE to decrease the number of item losses, because, in the case of related study lists, manipulations affecting relational processing provide information that is redundant with that conveyed by list structure (Einstein & Hunt, 1980; Klein et al., 1989). Our results confirmed this prediction by showing that the absolute number of item losses tended to be higher (rather than lower) for target- than for distractor-paired words. Although this evidence has been sometimes taken to reflect a disruption of relational processing (Mulligan, 2000; Olofsson, 1997), our conclusions must necessarily be more cautious because the advantage of target-paired words did not reach the standard significance level and was eliminated when we analyzed proportional loss scores. Thus, for now, Experiment 1 suggests that target detection did not enhance

[1] As noted above, the issue of the initial recall levels is less problematic for item gains, because the prediction, clearly contradicted by the present results, is that the number of item gains should be lower (rather than greater) for the condition with higher initial recall. In contrast, we found that the absolute number of item gains was greater for target- than for distractor-paired words, despite the fact that the target condition was associated with higher levels of initial recall. We nevertheless computed proportional gain scores, by taking the raw number of item gains in the $n + 1$ recall test and dividing it by the number of nonrecalled items in the n test (Mulligan, 2000). Not surprisingly, a 2 (Trial Type) × 3 (Recall Test) completely repeated ANOVA confirmed the results obtained in the original analysis by showing a significant main effect of Trial Type, $F(1, 35) = 11.60$, $p = 0.002$, $\eta^2 = 0.25$: proportional gain scores were again higher for target-paired ($M = 0.07$) than for distractor-paired words ($M = 0.03$). The main effect of Recall Test and the two-way interaction between Trial Type and Recall Test were not significant, $F(2, 70) = 0.48$, $p = 0.62$, $\eta^2 = 0.01$, and $F(2, 70) = 0.63$, $p = 0.54$, $\eta^2 = 0.02$, respectively.

J_ID: ART NO: 10.1037/xlm0001020 Date: 6-February-21 Page: 7 Total Pages: 15 4/Color Figure(s) ARTTYPE="ResearchArticle"

the processing of the semantic relations between the studied words.

Two additional points should be noted. First, as anticipated, there was no evidence of hypermnesia in the overall recall performance. This result was expected, because the to-be-remembered words were presented only once at encoding and the instructions did not encourage semantic or imaginal processing (see Payne, 1987, for a review). Second, item losses showed a significant decline across the four tests, confirming that participants used increasingly stable retrieval strategies (likely based on the categorical structure of the studied list) that minimized forgetting (Hunt & McDaniel, 1993; McDaniel et al., 1998; Mulligan, 2000).

Experiment 2

Despite being intriguing, the conclusions of Experiment 1 cannot be considered conclusive, especially because the absolute number of item gains and losses was somewhat low. Following Mulligan (2000; Exp. 2), Experiment 2 was designed to increase the number of item gains and losses by (a) presenting the encoding list twice and (b) providing participants with instructions that encouraged the elaboration of the semantic meaning of the studied words. Previous evidence indicates that the combination of these two modifications should increase the numbers of item gains and losses (Belmore, 1981; Olofsson, 1997; Payne, 1986, 1987), allowing for a more conclusive test of the item-specific/relational account of verbal ABE.

Method

Participants

Eighteen undergraduate and graduate students of the School of Medicine and Psychology of the University "La Sapienza" of Rome volunteered to participate in Experiment 2. They were 11 males and seven females (age: $M = 24.2$, $SD = 3.5$).

In Experiment 1, the effect size associated with the ABE manipulation (i.e., corresponding to the main effect of Trial Type) was $\eta^2 = .48$ (corresponding to $f = .96$) in a repeated-measures ANOVA. Using the software GPower3 (Faul et al., 2007), we determined that, with $N = 18$, $\alpha = 0.05$, and a low correlation among repeated measures ($r = .20$), the post hoc power to detect an ABE effect similar or greater than that observed in Experiment 1 exceeded .99 (test family: *F* tests; Statistical test: ANOVA repeated-measures, within-factors).

Materials

The materials of Experiment 2 were the same 36 words selected and used in Experiment 1 (32 critical words plus four fillers).

Procedure

Experiment 2 followed the same procedure as Experiment 1, with two relevant exceptions during the encoding phase. First, participants were told that the study list would be presented twice. Second, they were told that a good strategy to memorize the words was to think about the meaning of each word as it was presented, for example by forming a mental image (see Mulligan, 2000; Exp. 2). The latter instruction was administered at the beginning of the experiment (i.e., before the presentation of the first list) and repeated during the break between the two presentations. The to-be-recalled words were presented in the same order and appeared in the same Trial Type (target or distractor) within the two lists. The test phase included four subsequent recall attempts and was identical to Experiment 1.

Results and Discussion

Encoding Phase

The mean proportions of target squares correctly detected were $M = .98$ ($SD = .03$) in the first presentation and .99 ($SD = .01$) in the second presentation. Participants made few false alarms (i.e., incorrect responses to distractor-paired words): $M = .04$ ($SD = .03$) in the first presentation and .03 ($SD = .02$) in the second presentation. The mean RTs for correct target detection were 462.8 ($SD =$ 196.3 ms) and 419.1 ($SD = 172.8$ ms), respectively.

Test Phase: recall Performance

Figure 2 illustrates the mean proportions of words correctly retrieved in the four free-recall tests, as a function of whether they were presented together with a target or a distractor square during the encoding phase. These proportions were analyzed with a 2 × 4 completely repeated ANOVA, considering Trial Type (target- vs. distractor-paired words) and Recall Test (first, second, third and fourth) as within-subject factors. The results revealed a significant main effect of Trial Type, $F(1, 17) = 18.64$, $p < .001$, $\eta^2 = .52$, indicating that target-paired words ($M = .49$) were recalled significantly better than distractor-paired words ($M = .32$). Thus, a significant ABE was obtained in Experiment 2. The main effect of Recall Test was also significant, $F(3, 51) = 17.07$, $p < .001$, $\eta^2 =$ .50. The post hoc comparisons (with the Bonferroni correction) demonstrated significant increases in the recall proportions (a) between the first and the third tests ($M = .37$ vs. M = .42, $p =$ .002), (b) between the first and the fourth tests ($M = .37$ vs. $M =$ .45, $p < .001$), and (c) between the second and the fourth tests ($M = .39$ vs. M = .45, $p = .002$); the increase in recall between the third and the fourth tests was marginally significant ($M = .42$ vs. $M = .45$, $p = .075$). Thus, a robust hypermnesia was obtained in Experiment 2, suggesting that our manipulations were effective. Lastly, the two-way interaction between Trial Type and Recall Test was not significant, $F(3, 51) = 1.89$, $p = .14$, $\eta^2 = .10$. F2

Test Phase: Gains and Losses

The mean number of item gains and losses in Experiment 2 are reported in Table 2. They were analyzed with two 2 × 3 completely repeated ANOVAs, considering Trial Type (target- vs. distractor-paired words) and Recall Test (second, third and fourth) as within-subject factors. By default, the number of item gains and losses could not be computed for the first recall test, because there was no previous reference point. T2

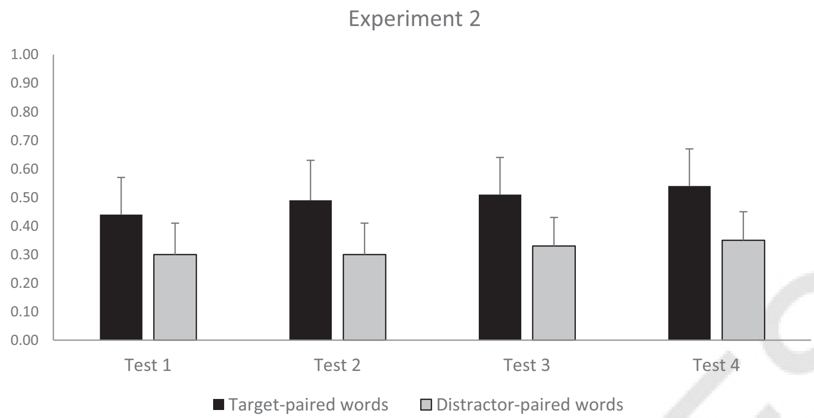
For item gains, the ANOVA showed a significant main effect of Trial Type, $F(1, 17) = 18.78$, $p < .001$, $\eta^2 = .53$, indicating that item gains were higher for target-paired words ($M = 2.29$) than for distractor-paired words ($M = 1.76$). The main effect of Recall Test and the two-way interaction between Trial Type and Recall Test were not significant, $F(2, 34) = .17$, $p = .84$, $\eta^2 = .01$ and $F(2, 34) =$ .98, $p = .38$, $\eta^2 = .06$, respectively.

ID: navin.prajapati Time: 17:36 I Path: //mbnas01.cadmus.com/home$/45417$/AP-XLMJ210017

J_ID: ART NO: 10.1037/xlm0001020 Date: 6-February-21 Page: 8 Total Pages: 15 4/Color Figure(s) ARTTYPE="ResearchArticle"

Figure 2

Mean Proportions of Words Recalled in Experiment 2, as a Function of Trial Type (Target- vs. Distractor-Paired Words) and Recall Test (1, 2, 3, 4)



Note. Error bars represent standard deviations.

For item losses, the same ANOVA found a significant main effect of Trial Type, $F(1, 17) = 5.67$, $p = .029$, $\eta^2 = .25$, indicating that item losses were higher for target-paired words ($M = 1.70$) than for distractor-paired words ($M = 1.48$). The main effect of Recall Test and the two-way interaction between Trial Type and Recall Test were not significant, $F(2, 34) = .71$, $p = .49$, $\eta^2 = .04$, and $F(2, 34) = .58$, $p = .56$, $\eta^2 = .03$, respectively.

Finally, the raw frequencies of intrusions were low: $M = .05$ in the first test, $M = .20$ in the second test, $M = .40$ in the third test, and $M = .60$ in the fourth test. The linear trend was again significant, $F(1, 19) = 9.81$, $p = .005$, $\eta^2 = .34$, suggesting that intrusions increased across successive tests.

Additional Analyses

We again examined the overall volatility of the recall performance by summing item gains and item losses were summed across the four recall attempts, separately for target- and distractor-paired words (Mulligan, 2000). A 2 (Trial Type) × 3 (Recall Test) completely repeated ANOVA confirmed the significant main effect of Trial Type, $F(1, 17) = 18.12$, $p = .001$, $\eta^2 = .52$, indicating that recall volatility was greater for target-paired words ($M = 2.00$) than for distractor-paired words ($M = 1.24$). The main effect of Recall Test and the two-way interaction between Trial Type and Recall Test were not significant, $F(2, 34) = .45$, $p = .64$, $\eta^2 = .03$ and $F(2, 34) = .72$, $p = .49$, $\eta^2 = .04$, respectively.

To assess the impact of differences in the initial recall level, we again computed proportional loss scores, by taking the absolute number of item losses in the $n + 1$ test and dividing it by the total number of words recalled in the n test (Mulligan, 2000). A 2 (Trial Type) × 3 (Recall Test) completely repeated ANOVA was applied to these scores but failed to reveal significant effects, all $Fs < 1.73$, $p > .19$. In particular, proportional loss scores were almost equal for target- and distractor-paired words ($M = .08$ vs. $M = .09$), $F(1, 17) = .003$, $p = .95$, $\eta^2 = .00$. This finding confirms that the ABE failed to increase item losses, even when differences in initial recall levels were taken into account.[2] Fn2

In summary, Experiment 2 confirmed and strengthened the findings reported in Experiment 1. First, item gains were significantly higher for target- than for distractor-paired words. Second, items losses either did not differ between target- and distractor-paired words (when measured in terms of proportional scores) or were higher for target-paired words (when measured in terms of absolute scores). According to previous evidence (Burns, 1993; Hunt & McDaniel, 1993; Klein et al., 1989; McDaniel et al., 1998; Mulligan, 2000; 2002; Olofsson, 1997), these results indicate that the ABE-related manipulation enhanced the efficiency of item-specific processing but had no effect on the efficiency of relational processing. In addition, the analysis of the overall recall performance showed that the modifications introduced in Experiment 2 (i.e., the encoding list was presented twice and participants were encouraged to elaborate on the meaning of each word) were conducive to a significant hypermnesia. As importantly, these modifications

Table 2

Mean Number of Item Gains and Losses in Experiment 2, as a Function of Trial Type (Target- vs. Distractor-Paired Words) and Recall Test (1–2, 2–3, 3–4)

	Between tests		
Encoding condition	1–2	2–3	3–4
Item gains			
Target-paired words	2.55 (1.19)	2.17 (1.09)	2.16 (1.08)
Distractor-paired words	1.66 (0.97)	1.83 (1.04)	1.77 (0.54)
Item losses			
Target-paired words	1.72 (0.82)	1.83 (0.92)	1.55 (0.70)
Distractor-paired words	1.61 (0.84)	1.54 (0.51)	1.38 (0.69)

Note. Standard deviations are reported in parentheses.

[2] As in Experiment 1, a 2 (Trial Type) × 3 (Recall Test) completely repeated ANOVA was also performed on proportional gain scores. As expected, this analysis replicated the significant main effect of Trial Type, $F(1, 17) = 24.07$, $p < 0.001$, $\eta^2 = 0.59$, showing that proportional gain scores were higher for target-paired ($M = 0.17$) than for distractor-paired ($M = 0.07$) words. The main effect of Recall Test and the two-way interaction between Trial Type and Recall Test were not significant, $F(2, 34) = 0.01$, $p = 0.98$, $\eta^2 = 0.001$, and $F(2, 34) = 0.39$, $p = 0.68$, $\eta^2 = 0.02$, respectively.

ID: navin.prajapati Time: 17:36 I Path: //mbnas01.cadmus.com/home$/45417$/AP-XLMJ210017

J_ID: ART NO: 10.1037/xlm0001020 Date: 6-February-21 Page: 9 Total Pages: 15 4/Color Figure(s) ARTTYPE="ResearchArticle"

succeeded in substantially increasing item gains and losses (more than doubling them relative to Experiment 1) allowing for even more decisive tests of the competing hypotheses. The only minor difference between the experiments is that the decrease in item losses across successive tests that was obtained in Experiment 1 did not emerge in Experiment 2. This was likely because the repeated presentation of the encoding list, coupled with its easily apparent categorical organization, were so effective in stabilizing the retrieval strategies that participants had no room to further enhance their performance across multiple tests (put in other words, retrieval strategies were already stabilized at the time of the first recall).

Experiment 3

Experiments 1 and 2 established that, in the case of related lists, the ABE was effective in increasing the production of item gains, thus suggesting that target detection benefited the encoding of item-specific information. On the other hand, there was no evidence that the ABE could reduce the number of item losses. This is partly because the use of related lists made it likely that participants noticed and encoded semantic information: In these conditions, any manipulation supposed to increase relational encoding would provide information partially redundant with that conveyed by list structure. Experiment 3 provided an additional test of the effects of the ABE on relational processing by using a list of unrelated words. In this context, predictions were as follow: First, we did not expect the ABE to increase item gains, because with unrelated lists the information provided by manipulations affecting item-specific encoding should be redundant with that spontaneously processed by participants (Einstein & Hunt, 1980; Hunt & Einstein, 1981; Klein et al., 1989). In contrast, if the ABE enhanced relational encoding, then we expected that target detection should be particularly effective in producing a decrease in the number of item losses.

Method

Participants

Fifty-two students from Sapienza University, Lumsa University, and Mercatorum University (all based in Rome) volunteered to participate in Experiment 3. They were 36 females and 16 males (age: M = 24.4, SD = 6.6). Six additional participants were excluded from statistical analyses either because they failed to identify more than 50% of the targets (almost always in the first presentation: four participants) or because they wrote no words during one or more recall attempts (two participants; see below).

Materials

Thirty-two unrelated words, from five to eight letters in length, were selected from the LexVar database (https://www.istc.cnr.it/en/grouppage/lexvar). They had a medium-high frequency of use (M = 45.78, range: 4–106) and a high imageability (M = 6.15, on a 7-point Likert scale). In addition, fourteen words were selected from the same database to be used as practice items (10) or buffer items at the beginning (two) and at the end (two) of each study list.

Procedure

Owing to the restrictions imposed by the current (Covid-19) health emergency, Experiment 3 was carried out remotely. Stimuli were delivered, and the participants' responses recorded, online, through a classic 3-tier Web application. Participants were recruited by e-mail and accessed the experiment as a web page, via an URL and a Web browser, with no additional requirements (e.g., downloading and installing software on their devices was not necessary). Experimental parameters (i.e., presentation times and the visual characteristic of the stimuli) were the same as in previous experiments; to prevent participants from running the experiment on undersized screens, the use of the software on tablets and smartphones was forbidden. No personal data, other than those reported here (i.e., age, gender, and education), were collected. The software allows to describe the experiment in a subset of the JavaScript language, entered in an online editor. It is based on common open- source tools, such as the Django framework, jQuery, and PegJS, and can be hosted by any provider; here, the Python Anywhere free service was chosen for its ease of use. Any other technical detail is available upon request.

Apart from this difference, Experiment 3 used the same procedure of Experiment 2. Thus, the study list of 36 words (32 critical words, of which 16 were paired with target squares and 16 with distractor squares, plus two initial and two final buffer items) was presented twice. In addition, participants were instructed to think about the meaning of each word as it was presented, for example by forming a mental image (Mulligan, 2000; Exp. 2). A practice phase including ten words (five target-paired words) was performed before the first presentation to familiarize participants with the task. Note that the assignment of the critical words to the target and distractor conditions was randomized anew for each participant by the software. During the test phase, participants had 5 minutes to type the words they remembered into a blank space. After the end of the first recall attempt, a new blank space appeared on the screen and participants engaged in the second recall attempt (this procedure was repeated four times).

Results and Discussion

Encoding Phase

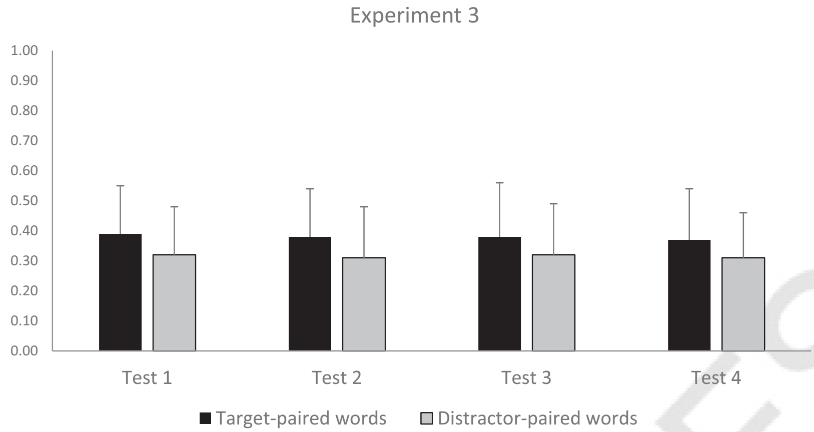
The mean proportions of target squares correctly detected were high, M = .98 (SD = .03) in the first presentation and .99 (SD = .02) in the second presentation. Participants made relatively few false alarms (i.e., incorrect responses to distractor-paired words): M = .05 (SD = .10) in the first presentation and M = .02 (SD = .04) in the second presentation. Lastly, the mean RTs for correct target detection in the first and second presentations were 595.2 ms (SD = 159.5 ms) and 554.6 ms (SD = 142.8 ms), respectively.

Test Phase: Recall Performance

Figure 3 illustrates the mean proportions of target-paired and distractor-paired words correctly retrieved in the four free-recall tests. These proportions were analyzed with a 2 × 4 completely repeated ANOVA, considering Trial Type (target- vs. distractor-paired words) and Recall Test (first, second, third and fourth) as within-subject factors. The results revealed a significant main effect of Trial Type, $F(1, 51) = 10.51$, $p = .002$, $\eta^2 = .17$, F3

Figure 3

Mean Proportions of Words Recalled in Experiment 3, as a Function of Trial Type (Target- vs. Distractor-Paired Words) and Recall Test (1, 2, 3, 4)



Note. Error bars represent standard deviations.

indicating that target-paired words (M = .48) were recalled significantly better than distractor-paired words (M = .42). Thus, the standard ABE was replicated in Experiment 3. The main effect of Recall Test was also significant, $F(3, 153) = 2.80$, $p = .042$, $\eta^2 = .05$; surprisingly, the post hoc comparisons (with the Bonferroni correction) showed a small but significant decrease in the recall performance from the first (M = .46) to the second (M = .44) recall attempt. Finally, the two-way interaction between Trial Type and Recall Test was not significant, $F(3, 153) = .93$, $p = .42$, $\eta^2 = .02$.

Test Phase: Gains and Losses

The mean number of item gains and losses in Experiment 3 are
T3 reported in Table 3. They were analyzed with two 2 × 3 completely repeated ANOVAs, considering Trial Type (target- vs. distractor-paired words) and Recall Test (second, third and fourth) as within-subject factors.

For item gains, neither the main effects of Trial Type, $F(1, 51) = .05$, $p = .82$, $\eta^2 = .00$, and Recall Test, $F(2, 102) = 2.13$, $p = .12$, $\eta^2 = .04$, nor the two-way interaction between Trial Type and Recall Test were significant, $F(2, 102) = .28$, $p = .75$, $\eta^2 = .01$.

For item losses, the ANOVA found a significant main effect of Recall Test, $F(2, 102) = 7.75$, $p = .001$, $\eta^2 = .13$: the post hoc comparisons (with the Bonferroni correction) indicated that item losses decreased from the first (M = 1.76) to the second (M = 1.38, $p = .003$) and third recall attempts (M = 1.40, $p = .001$). The main effect of Trial Type did not reach the significance level, $F(1, 51) = 3.09$, $p = .084$, $\eta^2 = .06$, although an inspection of the means indicated that losses were numerically higher for target-paired (M = 1.57) than for distractor-paired (M = 1.46) words. Lastly, the two-way interaction between Trial Type and Recall Test was not significant, $F(2, 102) = .15$, $p = .86$, $\eta^2 = .00$.

Finally, the raw frequencies of intrusions reported by participants were: M = .42 in the first test, M = .81 in the second test, M = 1.06 in the third test, and M = 1.31 in the fourth test. The linear trend was significant, $F(3, 153) = 17.96$, $p < .001$, $\eta^2 = .26$, suggesting that intrusions increased across successive tests.

Additional Analyses

The overall volatility of the recall performance was examined by summing item gains and losses across the four recall attempts, separately for target- and distractor-paired words (Mulligan, 2000). A 2 (Trial Type) × 3 (Recall Test) completely repeated ANOVA showed a significant main effect of Recall Test, $F(2, 102) = 6.90$, $p = .002$, $\eta^2 = .12$: the post hoc comparisons, with the Bonferroni correction, indicated that the overall volatility decreased from the first (M = 2.24) to the second (M = 1.87, $p = .049$) and third (M = 1.73, $p = .001$) recall attempts. The main effect of Trial Type and the two-way interaction between Trial Type and Recall Test were not significant, $F(1, 51) = 1.48$, $p = .22$, $\eta^2 = .03$ and $F(2, 102) = .11$, $p = .89$, $\eta^2 = .00$, respectively.

Proportional loss scores, computed by dividing the absolute number of item losses in the $n + 1$ test by the total number of words recalled in the n test (Mulligan, 2000), were also examined with a 2 (Trial Type) × 3 (Recall Test) completely repeated ANOVA. This analysis revealed a significant main effect of Recall Test, $F(2, 102) = 8.06$, $p = .001$, $\eta^2 = .14$: the post hoc comparisons, with the Bonferroni correction, confirmed that proportional loss scores decreased from the first (M = .13) to the second (M = .07, $p = .007$) and third (M = .06, $p = .002$) recall attempts. The

Table 3

Mean Number of Item Gains and Losses in Experiment 3, as a Function of Trial Type (Target- vs. Distractor-Paired Words) and Recall Test (1–2, 2–3, 3–4)

	Between tests		
Encoding condition	1–2	2–3	3–4
Item gains			
Target-paired words	1.46 (0.77)	1.48 (0.80)	1.37 (0.68)
Distractor-paired words	1.48 (0.75)	1.50 (0.91)	1.29 (0.49)
Item losses			
Target-paired words	1.81 (0.86)	1.46 (0.93)	1.44 (0.87)
Distractor-paired words	1.73 (0.91)	1.31 (0.89)	1.37 (0.86)

Note. Standard deviations are reported in parentheses.

main effect of Trial Type and the two-way interaction between Trial Type and Recall Test were not significant, $F(1, 51) = .99$, $p = .32$, $\eta^2 = .02$ and $F(2, 102) = 1.32$, $p = .27$, $\eta^2 = .03$, respectively.

To summarize, in line with our predictions, Experiment 3 indicated that the ABE did not increase item gains when participants studied lists of unrelated words, likely because the item-specific elaboration induced by target detection provided information that was redundant with that spontaneously processed by participants (Einstein & Hunt, 1980; Klein et al., 1989). Most importantly, the ABE failed to reduce item losses (if anything, there was a numerical trend for absolute losses to be higher for target- than for distractor-paired words). This finding constitutes a strong evidence against the idea that target detection enhanced relation processing, because the conditions of Experiment 3 were ideal to observe such a reduction – remember that, working in similar conditions, Klein et al. (1989), showed that category soring, a standard relational manipulation, was effective in decreasing item losses.

Although of secondary interest, hypermnesia was not observed in Experiment 3. This was somewhat unexpected, given the use of two encoding manipulations known to be conducive to this effect and the results obtained in Experiment 2 (Mulligan, 2000). The difference might be attributable to the fact that participants studied unrelated (rather than related) lists during the encoding phase; alternatively, the use of an online research environment might have rendered it less likely to observe hypermnesia. Whatever the correct explanation, the important point for the present purposes is that is that the item-specific/relational analysis of gains and losses does not rely on observing hypermnesia.

General Discussion

The present study used a multiple recall test paradigm to investigate the effects of the ABE-related manipulation on item-specific versus relational encoding (Hunt & Einstein, 1981; Hunt & McDaniel, 1993; Mulligan, 2006, 2012). Our interest was specifically focused on the analysis of item gains (the number of words recalled on test i but not on test $i - 1$) and item losses (the number of words recalled on test $i - 1$, but not on test i). Previous studies established that manipulations fostering item-specific processing typically enhance the number of item gains when participants study lists of related words (but not when they study unrelated lists); in contrast, manipulations fostering relational processing typically decrease the number of item losses when participants study lists of unrelated words (but not when they study related lists; Burns, 1993; Klein et al., 1989; McDaniel et al., 1998; Olofsson, 1997). Starting from these assumptions, we performed two experiments in which participants encoded lists of related (Experiment 1 and 2) or unrelated (Experiment 3) words associated with either red (target) or green (distractor) squares, under the instructions to remember the words and press the spacebar whenever a red square appeared below the words. After the study phase, they were requested to retrieve all the words they remembered in four successive recall tests. The results converged in showing that (a) item gains were significantly higher for target-paired than for distractor-paired words in the related list conditions (but not in the unrelated condition), and (b) item losses were either higher for target-paired than for distractor-paired words (when using raw scores) or did not differ between the two conditions (when using proportional scores), irrespective of the nature of the encoded lists.

The present findings are consistent with the conclusions previously reached by Spataro et al. (2017). Briefly, these authors found that the ABE enhanced the number of exemplars retrieved in the category-cued recall task, an explicit memory test which is thought to rely primarily on item-specific encoding processes; in contrast, it had no effect on repetition priming in the category exemplar generation task, an implicit memory test which is thought to rely primarily on relational encoding processes (Mulligan, 2006; 2012). Based on these results, Spataro et al. (2017) suggested that the ABE might behave like many other manipulations that are known to produce a tradeoff between item-specific and relational processes—for example, the enactment effect (Engelkamp & Seiler, 2003; Engelkamp et al., 2004), the generation effect (Mulligan, 2001), or the perceptual interference effect (Mulligan, 2000, 2002). The fact that the ABE increased the number of item gains when using related study lists is consistent with the idea that the detection of target squares benefited the encoding of the item-specific properties of the associated words, because in this condition participants are assumed to spontaneously encode the semantic structure of the studied list: As a consequence, any manipulation fostering item-specific processing provides novel information, which is likely to enhance memory performance (Einstein & Hunt, 1980; Hunt & Einstein, 1981; Klein et al., 1989). On the other hand, the finding that the ABE did not reduce the number of item losses appears to be inconsistent with the suggestion that target detection should also enhance the encoding of the relational properties of background words (Broitman & Swallow, 2020; Turker & Swallow, 2019). This is particularly true in the unrelated list condition, in which participants are expected to focus their attention on the item-specific properties of the studied words; in this case, any manipulation fostering relational encoding should enhance the development of stable retrieval strategies and consequently reduce the number of item losses (Klein et al., 1989). In contrast, in our experiments the ABE either produced no effect or increased the number of item losses, depending on whether absolute or proportional scores were used; taken together, this evidence suggests that target detection had no positive effect on the relational processing of target-paired words (Engelkamp & Seiler, 2003; Mulligan, 2000, 2002).

AQ: 9

Before taking this conclusion for granted, we should discuss the possibility that our procedure was not sufficiently sensitive to detect a significant reduction in item losses. Although this explanation cannot be definitely ruled out, we believe that the overall pattern of results militates against it, for several reasons. First, we were able to replicate previous studies showing that manipulations expected to influence the processing of item-specific information increased the number of item gains in the related list condition, but not in the unrelated condition (Burns, 1993; Klein et al., 1989; Mulligan, 2000; Olofsson, 1997). Thus, it appears that our paradigm behaved in the same way as the original one, despite the consistent reduction in the encoding times (in the study by Klein et al., 1989; participants had 8 s to study each word). Second, the overall levels of item losses observed in Experiments 2 and 3 ($M = 1.60$ and $M = 1.52$, respectively) were very similar to those reported by Klein et al. (1989; 1.61 for related lists and 1.19 for unrelated lists), implying that we should have similar sensitivity to factors that affect item losses as in earlier research. Third, in the unrelated list conditions of Experiment 3 (i.e., the conditions in which the positive impact of target detection on relational processing should be mostly evident), we found strong evidence for a reduction in item losses across successive recall attempts.

It is therefore unclear why target detection did not lead to a similar reduction, if this manipulation acted by enhancing the encoding of the relational properties of studied words.

The reason why target detection induced better item-processing processing may be that when participants detected the target squares and pressed the spacebar, they focused on the associated words as separate units and encoded them as isolated representations in memory (Olofsson, 1997). Because this type of elaboration results in the encoding of a higher number of items' attributes, target-paired words became highly accessible and had an increased probability to be recalled in later tests if not originally recalled in the first tests (Burns, 1993; Klein et al., 1989; McDaniel et al., 1998). At the same time, the very fact that target-paired words were encoded as isolated representations implies that the elaboration of their interitem properties was necessarily less efficient than that of distractor-paired words (Hunt & McDaniel, 1993; McDaniel et al., 1998; Mulligan, 2000). Two additional points should be noted with respect to the item-specific/relational account of verbal ABE. First, our results and conclusions echo those reached by other authors with respect to different manipulations. Olofsson (1997) and Engelkamp and Seiler (2003) showed that enacting action phrases produced consistently more gains and more losses than learning the phrase verbally and concluded that the enactment effect increased the item-specific processing of action phrases but disrupted their relational encoding. Similarly, Mulligan (2000, 2002) found that interfering with word perception by backward masking enhanced later memory by producing both more item gains (indexing enhanced item-specific processing) and more item losses (indexing disrupted relational processing). These similarities are important as far as they help us to integrate the current research on the ABE within the broader context of the item-specific/relational framework (Hunt & McDaniel, 1993). Second, this account provides a reasonable explanation for a number of null findings that are difficult to reconcile with the dual-task interaction model (Swallow & Jiang, 2013). Spataro et al. (2013), for instance, reported that the ABE increased repetition priming in lexical decision and word-fragment completion, two implicit tasks that are based on the analysis of the perceptual features of the studied words (a form of item-specific processing), whereas it had no positive effects on semantic classification, an implicit task which requires participants to process the commonalities underlying the exemplars of two different categories (a form of relational processing: Mulligan, 2006). Along the same lines, previous research showed that the ABE failed to enhance the recognition of low-frequency words (Mulligan et al., 2014; but see Prull, 2019) and orthographically-distinctive words (i.e., words having rare combinations of letters; Spataro et al., 2015). This type of result can be satisfactorily explained by assuming that low-frequency and orthographically distinctive words were already subject to heightened item-specific processing, making the ABE-related enhancement redundant.

We already mentioned that the present study examined a form of relational memory referring to the associations between features of the background stimuli (in this case word identity and semantic category). In this respect our findings cannot be directly compared with those previously reported by Swallow and Atir (2019) and Turker and Swallow (2019), who instead investigated the associations between background images and features of the monitored items. It is, however, important to examine which factors might underlie the different effects of target detection on the various forms of relational memory. Two relevant differences between the present experiments and those illustrated by Turker and Swallow (2019) concern the materials employed (verbal vs. pictorial stimuli) and the use of single versus multiple presentations during the encoding phase (in the study by Turker and Swallow each scene was presented ten times, whereas we presented words once in Experiment 1 and twice in Experiment 2). As discussed by Turker and Swallow (2019), the way in which people approach the encoding and the memorization of words may not necessarily be equal to that employed with images. Words are often encoded by emphasizing their semantic, abstract meaning and by disregarding the elaboration of their contextual properties. This type of encoding might have a negative impact on the performance in tasks requiring the recall of perceptual features, such as the color in which words are printed (Mulligan et al., 2016). However, in the present study a focus on semantic meaning should have facilitated the processing of the categorical relations between the encoded words and the use of this semantic information to develop stable retrieval strategies. Furthermore, this tendency should have been exacerbated by the categorical organization of the study list and by the instructions provided in Experiments 2 and 3, which requested participants to memorize the words by thinking to their meaning. From this perspective, our results might suggest that the ABE does not enhance the encoding of the contextual properties of the studied words, even when these properties refer to their semantic meaning. Interestingly, previous studies using the multiple recall paradigm showed that pictures produced a larger hypermnesic effect than words and that this was attributable to the production of a greater number of item gains (Erdelyi & Becker, 1974; Payne, 1986). It seems therefore desirable, for future research, to establish whether the present results can be generalized to pictures.

With respect to the number of presentations during the study phase, Broitman and Swallow (2020) have recently shown that the ABE increased recollection estimates (taken to reflect the retrieval of the associations between the study item and the contextual aspects of the environment in which they were encountered; see Yonelinas, 2002) for background scenes encoded two or eight times, but not for scenes encoded once. Although we cannot exclude the possibility that participants might be better able to process the relational properties of the studied items over multiple representations, Experiment 2 showed that the nonsignificant effect of the ABE on item losses persisted, and was possibly stronger, when the words were presented twice. Another aspect discussed by Broitman and Swallow (2020) relates to the encoding time: They indeed found that the recollection estimates of once-presented scenes were enhanced by target detection when the stimuli were presented for 1,000 ms, but not when they were presented for 500 ms, and suggested that the ABE might enhance elaborative or late-stage processes when encoding time is sufficiently long. We believe that this factor is unlikely to have played a major role in the present results, because in both experiments the words were presented for a total of 1,500 ms (note that using longer study times might result in a decrease in the size of the ABE; Mulligan & Spataro, 2015; Spataro et al., 2017).

A recent study by Mulligan et al. (in press) shed additional light on the role of these two factors by showing that participants remembered the color of the squares associated with target-paired words better than the color of the squares associated with distractor-paired words. These experiments are important, because they showed that the results originally reported with images by Swallow and Atir (2019) and Turker and Swallow (2019; with reference to the relevant features of the monitored items) could be replicated by using verbal materials and by presenting the study stimuli only once during the encoding phase. The authors concluded that the key factors explaining the differences between previous studies concerned the nature of the tasks used to assess relational memory and possibly the memorial information on which they are based. As mentioned in the Introduction, by focusing on item losses, we examined the development of stable retrieval strategies that depended on the recognition that different words, presented in different trials, belonged to the same category. In contrast, Turker and Swallow (2019; see also Swallow & Atir, 2019) examined the participants' ability to remember the within-trial associations between a background image and a monitored item having specific properties. It is possible that the ABE enhances the encoding of the associations between features of the monitoring task and background stimuli whereas it fails to benefit associations among the perceptual or conceptual features of background, irrelevant stimuli. In this respect, it is interesting that one defining feature of the ABE, as originally illustrated by Swallow and Jiang (2010), is the necessity of temporal cooccurrence of the stimuli. That is, target detection enhances the encoding of stimuli overlapping in time into a more coherent event (see Swallow & Jiang, 2011; for evidence showing the ABE does not benefit the encoding of images presented 100 ms before or after the target stimuli). In contrast, stimuli whose appearance does not overlap in time are presumably acted upon as separate, isolated items. When viewed in this perspective, another critical difference between the present experiments and those reported by Turker and Swallow (2019) is that we investigated the building of semantic associations between words that are presented across different trials and that therefore do not overlap in time. Future studies should examine in more details the role of this factor, for example by testing whether target detection increases the recall of pairs of words presented at the same moment in time (Naveh-Benjamin et al., 2003).

In summary, the present study examined the effects of the ABE in the multiple recall paradigm, by specifically focusing on item gains and item losses. The results replicated previous findings showing that the overall recall performance was better for target- than for distractor-paired words (Mulligan et al., 2014); most importantly, we found that the ABE (a) enhanced item gains in the related (but not in the unrelated) condition and (b) failed to decrease item losses in both the related and unrelated conditions. On the basis of previous evidence (Burns, 1993; Engelkamp & Seiler, 2003; Klein et al., 1989; McDaniel et al., 1998; Mulligan, 2000, 2002; Olofsson, 1997), we conclude that target detection increased the item-specific processing of studied words but had no effect on their relational processing.

AQ: 11

References

Au, R. K. C., & Cheung, C.-N. (2020). The role of attention level in the attentional boost effect. *Journal of Cognitive Psychology*. Advance Online Publication. https://doi.org/10.1080/20445911.2020.1736086

Belmore, S. M. (1981). Imagery and semantic elaboration in hypermnesia for words. *Journal of Experimental Psychology: Human Learning and Memory*, *7*(3), 191–203. https://doi.org/10.1037/0278-7393.7.3.191

Broitman, A. W., & Swallow, K. M. (2020). The effects of encoding instruction and opportunity on the recollection of behaviourally relevant events. *Quarterly Journal of Experimental Psychology: Human Experimental Psychology*, *73*(5), 711–725. https://doi.org/10.1177/1747021819893676

Burns, D. J. (1993). Item gains and losses during hypermnesic recall: Implications for the item-specific-relational information distinction. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *19*(1), 163–173. https://doi.org/10.1037/0278-7393.19.1.163

Chiu, Y.-C., Dolcos, F., Gonsalves, B. D., & Cohen, N. J. (2013). On opposing effects of emotion on contextual or relational memory. *Frontiers in Psychology*, *4*, 103https://doi.org/10.3389/fpsyg.2013.00103

Craik, F. I. M., Govoni, R., Naveh-Benjamin, M., & Anderson, N. D. (1996). The effects of divided attention on encoding and retrieval processes in human memory. *Journal of Experimental Psychology: General*, *125*(2), 159–180. https://doi.org/10.1037/0096-3445.125.2.159

Duncan, J. (1980). The locus of interference in the perception of simultaneous stimuli. *Psychological Review*, *87*(3), 272–300. https://doi.org/10.1037/0033-295X.87.3.272

Dux, P. E., & Marois, R. (2009). The attentional blink: A review of data and theory. *Attention, Perception & Psychophysics*, *71*(8), 1683–1700. https://doi.org/10.3758/APP.71.8.1683

Engelkamp, J., & Dehn, D. M. (2000). Item and order information in subject-performed tasks and experimenter-performed tasks. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *26*(3), 671–682. https://doi.org/10.1037/0278-7393.26.3.671

Engelkamp, J., Seiler, K. H., & Zimmer, H. D. (2004). Memory for actions: Item and relational information in categorized lists. *Psychological Research*, *69*(1-2), 1–10. https://doi.org/10.1007/s00426-003-0160-7

Engelkamp, J., & Seiler, K. H. (2003). Gains and losses in action memory. *The Quarterly Journal of Experimental Psychology*, *56*(5), 829–848. https://doi.org/10.1080/02724980244000648

Erdelyi, M. H., & Becker, J. (1974). Hypermnesia for pictures: Incremental memory for pictures but not words in multiple recall trials. *Cognitive Psychology*, *6*(1), 159–171. https://doi.org/10.1016/0010-0285(74)90008-5

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). GPower 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

Gronlund, S. D., & Ratcliff, R. (1989). Time course of item and associative information: Implications for global memory models. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *15*(5), 846–858. https://doi.org/10.1037/0278-7393.15.5.846

Hunt, R. R., & Einstein, G. O. (1981). Relational and item-specific information in memory. *Journal of Verbal Learning and Verbal Behavior*, *20*(5), 497–514. https://doi.org/10.1016/S0022-5371(81)90138-9

Hunt, R. R., & Elliot, J. M. (1980). The role of nonsemantic information in memory: Orthographic distinctiveness effects on retention. *Journal of Experimental Psychology: General*, *109*(1), 49–74. https://doi.org/10.1037/0096-3445.109.1.49

Hunt, R. R., & McDaniel, M. A. (1993). The enigma of organization and distinctiveness. *Journal of Memory and Language*, *32*(4), 421–445. https://doi.org/10.1006/jmla.1993.1023

Hunt, R. R., & Seta, C. E. (1984). Category size effects in recall: The roles of relational and individual item information. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *10*(3), 454–464. https://doi.org/10.1037/0278-7393.10.3.454

Klein, S. B., Loftus, J., Kihlstrom, J. F., & Aseron, R. (1989). Effects of item-specific and relational information on hypermnesic recall. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *15*(6), 1192–1197. https://doi.org/10.1037/0278-7393.15.6.1192

Lakatos, P., Karmos, G., Mehta, A. D., Ulbert, I., & Schroeder, C. E. (2008). Entrainment of neuronal oscillations as a mechanism of attentional selection. *Science*, *320*(5872), 110–113. https://doi.org/10.1126/science.1154735

Lin, J. Y., Pype, A. D., Murray, S. O., Boynton, G. M., & Fahle, M. (2010). Enhanced memory for scenes presented at behaviorally relevant points in time. *PLoS Biology*, *8*(3), 1–6. https://doi.org/10.1371/journal.pbio.1000337

Masson, M. E. J., & MacLeod, C. M. (1992). Reenacting the route to interpretation: Enhanced perceptual identification without prior perception. *Journal of Experimental Psychology: General*, *121*(2), 145–176. https://doi.org/10.1037/0096-3445.121.2.145

McDaniel, M. A., & Einstein, G. O. (1986). Bizarre imagery as an effective memory aid: The importance of distinctiveness. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *12*(1), 54–65. https://doi.org/10.1037/0278-7393.12.1.54

McDaniel, M. A., Moore, B. A., & Whiteman, H. L. (1998). Dynamic changes in hypermnesia across early and late tests: A relational/item-specific account. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *24*(1), 173–185. https://doi.org/10.1037/0278-7393.24.1.173

Mulligan, N. W. (1999). The effects of perceptual interference at encoding on organization and order: Investigating the roles of item-specific and relational information. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *25*(1), 54–69. https://doi.org/10.1037/0278-7393.25.1.54

Mulligan, N. W. (2000). Perceptual interference at encoding enhances item-specific encoding and disrupts relational encoding: Evidence from multiple recall tests. *Memory & Cognition*, *28*(4), 539–546. https://doi.org/10.3758/BF03201244

Mulligan, N. W. (2002). The emergence of item-specific encoding effects in between-subjects designs: Perceptual interference and multiple recall tests. *Psychonomic Bulletin & Review*, *9*(2), 375–382. https://doi.org/10.3758/BF03196296

Mulligan, N. W. (2008). Attention and memory. In H. L. Roediger (Ed.), *Learning and memory: A comprehensive reference* (pp. 7–22). Elsevier.

Mulligan, N. W. (2012). Differentiating between conceptual implicit and explicit memory: A crossed double dissociation between category-exemplar production and category-cued recall. *Psychological Science*, *23*(4), 404–406. https://doi.org/10.1177/0956797611433335

Mulligan, N. W., Smith, S. A., & Spataro, P. (2016). The attentional boost effect and context memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *42*(4), 598–607. https://doi.org/10.1037/xlm0000183

Mulligan, N. W., & Spataro, P. (2015). Divided attention can enhance early-phase memory encoding: The attentional boost effect and study trial duration. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *41*(4), 1223–1228. https://doi.org/10.1037/xlm0000055

Mulligan, N. W., Spataro, P., & Picklesimer, M. (2014). The attentional boost effect with verbal materials. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *40*(4), 1049–1063. https://doi.org/10.1037/a0036163

Mulligan, N. W., Spataro, P., Rossi-Arnaud, C., & Wall, A. R. (in press). The attentional boost effect and source memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition*.

Mulligan, N. W. (2006). Conceptual implicit memory and the item-specific—relational distinction. In R. R. Hunt & J. B. Worthen (Eds.), *Distinctiveness and memory* (pp. 183–209). Oxford University Press. https://doi.org/10.1093/acprof:oso/9780195169669.003.0009

Murdock, B. B. (1993). TODAM2: A model for the storage and retrieval of item, associative, and serial-order information. *Psychological Review*, *100*(2), 183–203. https://doi.org/10.1037/0033-295X.100.2.183

Naveh-Benjamin, M., Guez, J., & Marom, M. (2003). The effects of divided attention at encoding on item and associative memory. *Memory & Cognition*, *31*(7), 1021–1035. https://doi.org/10.3758/bf03196123

Nieuwenhuis, S., Gilzenrat, M. S., Holmes, B. D., & Cohen, J. D. (2005). The role of the locus coeruleus in mediating the attentional blink: A neurocomputational theory. *Journal of Experimental Psychology: General*, *134*(3), 291–307. https://doi.org/10.1037/0096-3445.134.3.291

Olofsson, U. (1997). Win some, lose some: Hypermnesia for actions reflects item-specific processing. *Memory & Cognition*, *25*(6), 797–800. https://doi.org/10.3758/BF03211323

Payne, D. G. (1986). Hypermnesia for pictures and words: Testing the recall level hypothesis. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *12*(1), 16–29. https://doi.org/10.1037/0278-7393.12.1.16

Payne, D. G. (1987). Hypermnesia and reminiscence in recall: A historical and empirical review. *Psychological Bulletin*, *101*(1), 5–27. https://doi.org/10.1037/0033-2909.101.1.5

Prull, M. W. (2019). The attentional boost effect for words in young and older adults. *Psychology and Aging*, *34*(3), 405–417. https://doi.org/10.1037/pag0000337

Rossi-Arnaud, C., Spataro, P., Costanzi, M., Saraulli, D., & Cestari, V. (2018). Divided attention enhances the recognition of emotional stimuli: Evidence from the attentional boost effect. *Memory*, *26*(1), 42–52. https://doi.org/10.1080/09658211.2017.1319489

Sara, S. J. (2009). The locus coeruleus and noradrenergic modulation of cognition. *Nature Reviews Neuroscience*, *10*(3), 211–223. https://doi.org/10.1038/nrn2573

Sisk, C. A., & Jiang, Y. V. (2020). The yellow light: Predictability enhances background processing during behaviorally relevant events. *Journal of Experimental Psychology: Learning, Memory, and Cognition*. Advance Online Publication. https://doi.org/10.1037/xlm0000838

Spataro, P., Mulligan, N. W., Bechi Gabrielli, G., & Rossi-Arnaud, C. (2017). Divided attention enhances explicit but not implicit conceptual memory: An item-specific account of the attentional boost effect. *Memory*, *25*(2), 170–175. https://doi.org/10.1080/09658211.2016.1144769

Spataro, P., Mulligan, N. W., & Rossi-Arnaud, C. (2013). Divided attention can enhance memory encoding: The attentional boost effect in implicit memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *39*(4), 1223–1231. https://doi.org/10.1037/a0030907

Swallow, K. M., & Atir, S. (2019). The role of value in the attentional boost effect. *Quarterly Journal of Experimental Psychology: Human Experimental Psychology*, *72*(3), 523–542. https://doi.org/10.1177/1747021818760791

Swallow, K. M., & Jiang, Y. V. (2010). The attentional boost effect: Transient increases in attention to one task enhance performance in a second task. *Cognition*, *115*(1), 118–132. https://doi.org/10.1016/j.cognition.2009.12.003

Swallow, K. M., & Jiang, Y. V. (2011). The role of timing in the attentional boost effect. *Attention, Perception & Psychophysics*, *73*(2), 389–404. https://doi.org/10.3758/s13414-010-0045-y

Swallow, K. M., & Jiang, Y. V. (2012). Goal-relevant events need not be rare to boost memory for concurrent images. *Attention, Perception & Psychophysics*, *74*(1), 70–82. https://doi.org/10.3758/s13414-011-0227-2

Swallow, K. M., & Jiang, Y. V. (2013). Attentional load and attentional boost: A review of data and theory. *Frontiers in Psychology*, *4*, 274. https://doi.org/10.3389/fpsyg.2013.00274

Turker, H. B., & Swallow, K. M. (2019). Attending to behaviorally relevant moments enhances incidental relational memory. *Memory & Cognition*, *47*(1), 1–16. https://doi.org/10.3758/s13421-018-0846-0

Weldon, M. S., & Coyote, K. C. (1996). Failure to find the picture superiority effect in implicit conceptual memory tests. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *22*(3), 670–686. https://doi.org/10.1037/0278-7393.22.3.670

Yebra, M., Galarza-Vallejo, A., Soto-Leon, V., Gonzalez-Rosa, J. J., de Berker, A. O., Bestmann, S., Oliviero, A., Kroes, M. C. W., & Strange, B. A. (2019). Action boosts episodic memory encoding in humans via engagement of a noradrenergic system. *Nature Communications*, *10*(1), 3534.

Received June 5, 2020
Revision received November 25, 2020
Accepted January 22, 2021 ■

AUTHOR QUERIES

AUTHOR PLEASE ANSWER ALL QUERIES 1

AQau— Please confirm the given-names and surnames are identified properly by the colours.
■=Given-Name, ■= Surname
The colours are for proofing purposes only. The colours will not appear online or in print.

AQ1—Author: ?/Au: This article has been lightly edited for grammar, style, and usage. Please compare against your original document and make changes on these paged proofs. If no change is required in response to a question, please write "OK as set" in the margin.

AQ2—Author: ?/Au: Please be sure to provide the name of the department(s) with which you and your coauthors are affiliated at your respective institutes if you have not already done so. If you are affiliated with a governmental department, business, hospital, clinic, VA center, or other nonuniversity-based institute, please provide the city and U.S. state (or the city, province, and country) in which the institute is based. Departments should be listed in the author footnote only, not the byline. If you or your coauthors have changed affiliations since the article was written, please include a separate note indicating the new department/affiliation: [author's name] is now at [affiliation].

AQ3—Author: ?/Au: Please confirm that all authors' institutional affiliations (including city/state/country locations) and correspondence information are correct as shown.

AQ4—Author: ?/Au: Spataro et al. (2015) is not in your references. Please add to the reference list or delete from the text (cited 2x).

AQ5—Author: ?/Au: Cohen & Eichenbaum (1993) is not in your references. Please add to the reference list or delete from the text.

AQ6—Author: ?/Au: Einstein & Hunt (1980) is not in your references. Please add to the reference list or delete from the text (cited 5x).

AQ7—Author: ?/Au: Boccardi and Cappa (1997) is not in your references. Please add to the reference list or delete from the text.

AQ8—Author: ?/Au: Please review the typeset table(s) carefully against your original table(s) to verify accuracy of editing and typesetting.

AQ9—Author: ?/Au: Mulligan (2001) is not in your references. Please add to the reference list or delete from the text.

AQ10—Author: ?/Au: Yonelinas (2002) is not in your references. Please add to the reference list or delete from the text.

AQ11—Author: ?/Au: Per journal style, all journal references should include an issue number; please supply any that are missing.

AQ12—Author: ?/Au: Please confirm figure(s) and legend(s) as set.