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Associative Recognition Memory and Context Effects Using Objects on Natural Backgrounds

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by

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Abstract

Associative recognition memory and context effects are two lines of research that exist in parallel with little cross talk. Associative recognition tasks ask participants to distinguish the studied associations of two or more items from novel or rearranged associations (e.g., Cohn & Moscovitch, 2007; Craik & Schloerscheidt, 2011), whereas context effect studies have shown that the recognition of an individual object is enhanced when presented in its original context (e.g., Hollingworth, 2006; Hayes, Nadel, & Ryan, 2007). Our study investigated whether familiarity or recollection supports both associative recognition and context effects through the use of a speeded recognition test.

In two experiments, a response deadline did not change the size of the context effect or reduce discrimination of old and rearranged items, indicating that both tasks might rely on familiarity. This occurred both when participants had to engage in associative recognition as it is traditionally studied (discriminating old and rearranged pairings) and when the task asked to discriminate familiar and novel objects and backgrounds. In both studies, a reliable context effect was observed. The results suggest that context effects for object recognition rely on familiarity, which indicates that object and background might be encoded as one coherent representation, not as individual entities (Hayes, Nadel, & Ryan, 2007; Levy, Rabinyan, &Vakil, 2008).

Introduction

The ability to form and retrieve associative information between two or more items is fundamental in the construction of complex memory representations. For example, we associate people's faces and their names after our first time meeting them, in order to address them correctly in subsequent encounters. One of the ways to assess the ability to retrieve a previously encountered association is by testing associative recognition memory. Associative recognition memory is defined as distinguishing the studied association of two or more items from novel associations. This task requires remembering the specific pairing of two items (associative memory) in addition to remembering the individual items (item memory). In the previous example, we need to remember the person's face and the name individually (item memory) in addition to remembering the association between the two (associative memory). These associations are established by memory binding, a process in which multiple items become bound to one another at encoding (Cohen & Eichenbaum, 1997).

Memory binding provides a mechanism that allows for the relations among different stimuli to be encoded. Binding an item to its contextual details improves the ability to retrieve accurate memory sources to later use in retrieval. Impairment in memory binding leads to disturbances in episodic memory, indicating that this process is the foundation for the development of episodic memory. Thus, successful associative recognition memory often relies on memory binding at encoding (Sluzenski, Newcombe, & Kovacs, 2006).

According to Newcombe, Lloyd, & Balcomb (2011), there are two distinct types of binding that support episodic memory: intraobject and interobject binding. Inraobject refers to the association of various features of an object such as shape and color; whereas interobject binding refers to the association between an object and its context such as an environmental setting or a surrounding background. Ecker, Zimmer, and Groh-Bordin (2007) suggested that interobject binding (i.e., object-context binding) might be more relevant to episodic memory, and therefore, will be the focus of the current research.

Previous research has indicated that binding does not only fulfill the demand for remembering the associative information, but also facilitates memory for individual items (e.g., Craik & Schloerscheidt, 2011; Hayes et al., 2007). The role of binding in item memory is evident in the phenomenon referred to as the context effect. The context effect is defined as an increase in memory performance for items that are tested in their original contexts compared to those tested in different contexts (Humphreys, 1976; for a review, see Smith & Vela, 2001). Among early research in context effects are studies conducted by Light and Carter-Sobell (1970). They examined the context effect by comparing word recognition when a word was tested in its original context (the same context as study phase) to when it is presented in a new context, or in no context at all. For example, the word "jam" was paired with "strawberry" at study phase. At test, the participants were asked to recognize the word "jam" when presented in its original context "strawberry jam," in another context "traffic jam" (Experiment 1), or by itself (Experiment 2). Their findings demonstrated that word recognition was highest when presented with its studied paired word, followed by new context items (e.g., "traffic-jam"), followed by single word items. The finding of superior recognition for words tested on the studied context presumably reflects a binding mechanism that occurred during encoding.

More recently, Markopolous and colleagues (2010) studied the context effect using word-background associations. At study, a list of words was presented on various background colors. At test, the words were presented either on the same background as studied, or on a different background. In this study, the context was defined as the background colors. The results indicated a context effect in word recognition - the performance was highest for items that were tested on the same background in which they were studied. These findings indicated that the reinstatement of the studied background facilitated word recognition at test, thus implying that word and background might have been bound together at encoding.

Although there is a large body of research supporting the idea of that context facilitates word recognition (e.g., Craik & Schloerscheidt, 2011; Humphreys, 1976; Light & Carter-Sobell, 1980), fewer studies have examined the context effect in object recognition (e.g., Craik & Schloerscheidt, 2011; Hayes et al., 2007; Levy, Rabinyan, &Vakil, 2008; Nakashima & Yokosawa, 2011). For research in context effects using object-background association, the terms "context" and "background" are used interchangeably, both referring to the background surrounding the objects. Most of the studies on context effects using object-background association employ a paradigm in which the context manipulation is based on the constancy or change of the background at study and at test. Performance in object recognition is compared between the old pairing items (i.e., object tested on the same background as study), rearranged items (i.e., object tested on another studied background that was not paired together with the object at study), new-background items (i.e., object tested on a novel background), and no background items (i.e., object tested on a white background) (see Figure 1).

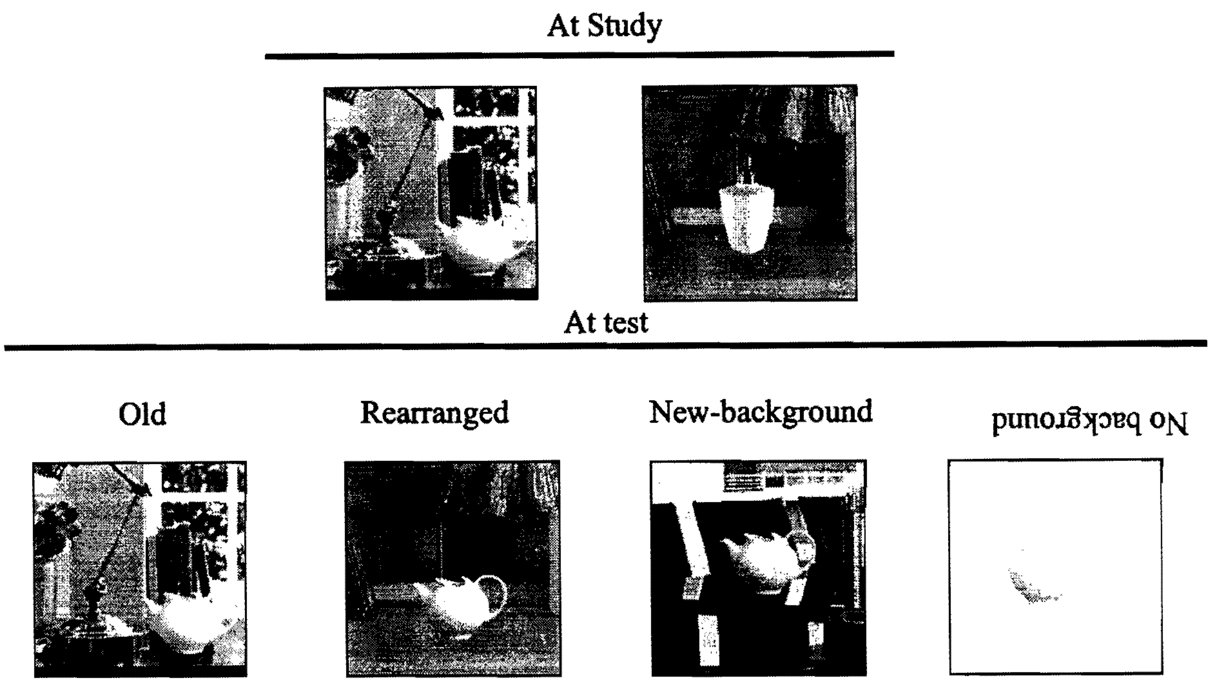

Figure 1. **These stimuli are examples of a paradigm for studying associative recognition and context effects using objects and natural backgrounds.**

Hayes et al. (2007) examined the context effects using images of objects embedded in natural scenes (e.g. a teapot on a wooden table) using a paradigm similar to that of Figure 1. The goal of their study was to compare object recognition between items that were tested on the same background and those tested on a different background. There were four types of test items: two "same context" conditions and two "shifted context" conditions. The "same context" conditions consisted of the "Scene.Scene" items (the objects were studied on a natural background and tested on the same background) and the "Object.Object" condition (the objects were studied on a white background and tested on a white background). The "shifted context" conditions consisted of the "Scene.Object" items (object were studied on a natural background and tested on a white background) and the "Object.Scene" items (objects were studied on a white background and tested on a natural background). Their findings demonstrated context effects; that is, object recognition performance was significantly higher for the "same context" conditions compared to the "shifted context" conditions. The results of this and other studies on context effects using naturalistic object-background association as stimuli have demonstrated a increase recognition performance by as much as 15% in the old pairing items compared to new pairing items.

A theoretically relevant question regarding the nature of associative memory is whether memory binding is an automatic or effortful process. In other words, does the binding between an item and its background occur explicitly? This question has been addressed in studies that manipulate different encoding instruction. Hayes et al. (2009) studied context effects using face-background associations. In this study, participants were instructed to rate friendliness of face images. Face images were embedded on either unique backgrounds (e.g., in front of a building, in a restaurant) or black backgrounds. The results showed that faces were better recognized when tested on the same background in which they were studied. Although the encoding instruction only demanded the processing of faces, context effects for face recognition implied that the face-background association occurred automatically. Similar to this finding, Hayes et al. (2007) studied the automaticity of object-background binding by manipulating the encoding instructions. For the "incidental" condition, participants were instructed to judge the price of the objects: "Does this object cost more than $25?" In the "intentional" condition, participants were told to remember the objects for a later memory test. Context effects were observed in both conditions. Importantly, the sizes of the context effects were similar for both groups, reflecting that object-background binding might occur automatically. Hayes and colleagues (2009) speculated that automaticity in memory binding might occur because we cannot always predict how useful or important certain information might become in the future.

Other methods have been employed to examine whether binding is always an explicit and conscious process. In Levy, Rabinyan, and Vakil's (2008) study, objects and context pictures (i.e., a picture of a scene background) were presented simultaneously side by side on a screen. At test, participants were asked to recognize the objects and the specific position of the context pictures. The results showed that the presence of the context pictures facilitated recognition for the objects; however, explicit information regarding the context picture (i.e., the studied position) was not remembered. Thus, context effects occurred even when the contextual information is not directly recognized, suggesting that context effects might not require explicit memory for contextual information.

On the other hand, Nakashima and Yokosawa (2011) have argued that object-background binding requires explicit encoding instructions. In their study, participants viewed rich background scenes, each consisted of fifteen objects. The results revealed that object-background binding only occurred for tasks in which the contextual information was required (e.g., intentional memory task), but not for those in which contextual information was not required (e.g., object change detection task). Based on this finding, the authors suggested that object-background binding does not always occur automatically.

The literature suggests the involvement of two associative mechanisms underlying the context effect: (1) the object and background are fused into a single representation, and (2) the representations of object and background are arbitrarily associated (Hayes et al., 2007). This theoretical perspective is built upon the dual processing theory by Mandler (1980) – a dominant theory that has been supported by many different lines of research in recognition memory (for a review, see Yonelinas, 2002). According to this theory, recognition memory relies on two processes: familiarity and recollection. Familiarity refers to a subjective feeling of having encountered an item before without retrieval of any specific details about the encoding episode. Recollection refers to the ability to retrieve specific details associated with the experience during encoding. Recollection-based retrieval is therefore an effortful process, which takes longer than familiarity. For example, it takes a brief moment to recognize a familiar teapot; however, it frequently takes a longer to recollect when and where the teapot was previously encountered in the past (e.g. the teapot was on top of a wooden table and next to a lamp). In this example, the initial recognition relies on familiarity and the retrieval of context relies on recollection. A large body of research, using the dual-process models, has suggested that item recognition is supported by familiarity, whereas associative recognition relies on recollection (e.g., Hockley & Consoli, 1999; Rotello & Heit, 2000; Yonelinas, 1997, 2002).

Although researchers have considered associative recognition to be supported recollection (Speer & Curran, 2007; for review, see Yonelinas, 2002), some studies have shown that familiarity can support associative recognition in events where two items are "unitized" at encoding (Hayes-Roth, 1977; Kelly & Wixted, 2001). Unitization is defined as a process in which two or more items are "fused" together and encoded as one coherent representation (Graf & Schacter, 1989). Yonelinas et al. (1999) demonstrated evidence for the role of familiarity in unitized association in studies examining discrimination abilities for studied faces and rearranged faces (i.e., rearranged features of hair, eyes, nose). This finding suggested that the association of eyes, nose and mouth are encoded as one single representation (face). Other studies using word pairs have employed encoding manipulation to induce unitization at encoding (e.g., Quamme, Yonelinas & Norman, 2007) and demonstrated that a unitized association could be supported by familiarity.

The notion of unitization is important in this literature of context effects. As Hayes et al. (2007) mentioned, objects and backgrounds might be integrated and encoded as a single representation (i.e., unitization), or encoded individually and linked together through an arbitrary association (i.e., binding). If the object and the background are, in fact, unitized during encoding, then recognition for object-background association can be supported by familiarity.

There is discrepancy in previous studies examining whether familiarity or recollection supports the context effect. The studies by Hayes et al. (2007) using an encoding instruction manipulation demonstrated automaticity of the object-background binding, which implies that this process might rely on familiarity. This argument is especially supported by two main findings. In all experiments, the participants were told to pay attention to the objects only. A reliable context effect observed across all experiments showed that the binding of object and background might have occurred even when the associative information is not demanded at encoding or at retrieval. Secondly, in Experiment 2, the "object.object" items (objects were studied on a white background and tested on a white background) also yielded higher recognition compared to the shifted background conditions. This finding showed that object-background binding occurs regardless of whether the background is rich or sparse. Although Hayes and colleagues (2007) did not explore the implications of this finding in a framework of dual-process theory, this result indirectly addresses the question of whether recollection or familiarity supports context effect in object recognition. The observed context effects suggested that the correct recognition for the "object.object" items is supported by familiarity. At study, all objects were studied on a white background; therefore, the retrieval of the objects may not rely on recollection due to absence of contextual information of the background to be recollected to support recognition. This finding provided evidence that recollection failed to account for changes in levels of correct object recognition. The context effects in object recognition might have primarily worked via the assessment of the objects' familiarity.

In addition to behavioral findings, many studies have investigated the neural correlates for memory binding and context effects in associative recognition memory. It is well established that the Medial Temporal Lobes (MTL) subregions are important for memory binding. Different subregions might mediate different aspects of a visual stimulus (Ranganath, 2010). The perirhinal cortex (PRc) is associated with processing specific information about objects' physical properties. The parahippcampal cortex (PHc) is associated with processing the contextual information such as "when" and "where" components of the visual experience (e.g. Davachi, 2006; Hayes et al., 2007, 2009; Howard et al., 2011). The outputs of the PRc and the PHc are received by the entorhinal cortex and subsequently become integrated in the hippocampus (for review, see Eichenbaum, Yonelinas & Ranganath, 2007).

Researchers have also explored the neural correlates of the context effects. Hayes et al. (2009) aimed to identify the brain regions associated with viewing faces when contextual information was present at encoding, as well as at successful subsequent retrieval, using fMRI. At study, participants were presented with a series face images embedded either on natural backgrounds (FS-F) or on black backgrounds (F-F). Participants were instructed to rate the levels of friendliness of the person in the picture. At test, participants were asked to discriminate faces on black backgrounds as "old" or "new." There were three main findings. First, there was a higher activation in the hippocampus for successful recognition trials (hit > miss) for the FS-F compared to the F-F conditions. This indicated that binding between face and background was mediated by the hippocampus. Second, there was greater PHc activation in the FS-F than in the F-F condition, indicating reactivation of the background at test. Similar findings were reported in Experiment 4 of Hayes et al. (2007), which demonstrated that PHc may be responsible for reinstatement the original context when being objects were tested on the "context shift" conditions. These results are consistent with previous research suggesting that the PHc mediates scene processing (Epstein & Kanwisher, 1998). Third, there was a hemispheric asymmetry in medial temporal lobe activation at encoding, with the left PHc activation correlated with smaller context effects, whereas the right correlated with larger context effects.

Other studies in recognition memory have also examined the neural correlates for familiarity- and recollection-based memory responses. Findings from previous research have shown that the activation in the PRc is associated with familiarity, whereas those in the hippocampus and the PHc are associated with recollection (e.g., Kirwan & Stark, 2004; Ranganath, 2004). In cases in which unitization occurs, Haskins and colleagues (2008) found that word pair unitization is correlated with PRc's activation during study and test. This finding is consistent with results from studies showing that damage in the hippocampus does not impair unitized associations (Ranganath, 2010).

Despite their common underlying process of memory binding, associative memory and context effects have been investigated together in one paradigm by only a few studies. Cohn and Moscovitch (2007) studied associative recognition and context effects by comparing two different task demands at retrieval: associative identification and associative reinstatement tasks. In their experiments, the participants studied a list of unrelated word pairs (e.g., shirt-chair; book-jar). At test, the associative identification task requires the participant to distinguish the old pairing (e.g., shirt-chair) from novel pairings (rearranged pair: shirt-jar and half-items: shirt-beef). Associative identification is an associative recognition task that requires explicit retrieval of the association between two words in addition to remembering the individual words. The rearranged pairs (e.g., shirt-jar) are made up of both old items, but the association is novel. Based on the dual-process theory, the ability to recognize old association requires recollection, whereas the ability to recognize an old item only requires familiarity. Therefore, in this task, participants have to rely on recollection to recognize the old pairs and correctly reject the rearranged pairs.

In the associative reinstatement task, participants were asked to recognize whether both words are old, regardless of their previous pairing. The retrieval of the associative information is not required in this task because the correct "old" responses would also apply in both the old and the rearranged pairs. The authors noted that this task is essentially an item recognition task because the retrieval of the association is not required. Performance on the associative reinstatement task, however, demonstrates the context effects in item recognition. That is, the paired counterpart item is present in the old pairs, but not in the rearranged pairs. Thus, higher recognition for old pairs compared to rearranged pairs would indicate that the reinstatement of the paired items facilitates word recognition, regardless of whether the retrieval of the association is demanded. In other words, higher recognition for old pairs compared to rearranged pairs in the associative reinstatement task would indicate context effects in word recognition.

Cohn and Moscovitch (2007) aimed to better understand the binding process of word pairs at the retrieval level. They used the response deadline method, which requires the participants in the "speeded" condition to respond in less than 1000ms, while those in the "non-speeded" condition to respond after 1000ms has passed. The length of the response deadline is based on previous findings suggesting a duration window of familiarity to be under 1000ms. It has been suggested that recognition that takes longer than 1000ms is supported by some degree of recollection. Therefore, a response deadline of 1000ms should negatively affect recollection-based recognition such as associative identification, but not familiarity-based recognition such as item recognition (for a review, see Yonelinas, 2002). This methodology investigated the nature of the associative recognition as well as context effects, and allows the comparison of accuracy performance for different task demands at retrieval.

One way Cohn and Moscovitch (2007) assessed accuracy performance was by computing the discrimination rating (hit rate for old pairs – false alarm rate for rearranged pairs). When a task requires recollection, speed should impede participants' ability to recognize old pairs and correctly rejecting rearranged pairs. For the associative identification task, Cohn and Moscovitch (2007) found discrimination rates of .09 and .57 for the speeded and non-speeded groups, respectively. For the associative reinstatement task, they found discrimination rates of .10 and .11 in the speeded and non-speeded groups, respectively. The results revealed that speed impaired the accuracy performance in the associative identification task, but not in the associative reinstatement task. This indicates that the associative identification task involves recollection, whereas the associative reinstatement task appears to be similar to an item recognition task, which does not necessitate recollection. Importantly, context effects were demonstrated in the associative reinstatement task, reflected by an increase in recognition for "old" compared to "rearranged" word pairs. This shows that the presence of the pair-word facilitates word recognition, in the absence of the demand for the retrieval of associative information.

Few studies have combined the two lines of research in associative recognition memory and context effects together in one paradigm. Therefore, Cohn and Moscovitch's (2007) studies were important because they (1) demonstrated context effects in word recognition in the associative reinstatement task; (2) compared the two types of task demands (item recognition and associative recognition) simultaneously, and (3) used speed to dissociate the contribution of familiarity and recollection on different recognition tasks. However, because the study used word pairs, it is not certain that the results will apply to objects in natural scene.

Craik and Schloerscheidt (2011) examined the involvement of familiarity and recollection in word-background association as well as object-background associations. Their studies focused on the effect of aging on context effects in item and associative recognition. Previous research has suggested that older adults exhibit poor binding abilities (Castel & Craik, 2003, Naveh-Benjamin, 2000), as well as higher reliance on familiarity, compared to younger adults (Chalfonte & Johnson, 1996, Jennings & Jacoby, 2003). Craik and Schloerscheidt reasoned that if binding between the item and the background could not occur at encoding, word/object recognition would not depend on the consistency or change of the studied context. Given this rationale, they hypothesized that context effect would be less prominent in older adults compared to younger adults due to their reduced ability of binding.

In experiment 1a, words were shown against a city and landscape backgrounds. In experiment 1b, pictures of the common objects superimposed on city and landscape backgrounds were studied after participants were instructed to make a connection between the object and its background at study. At test, the items (words in experiment 1a, and objects in experiment 1b) were tested on an old, a rearranged, a new, or no background. The participants were asked to recognize the items as old or new regardless of the status of the background. The results revealed that recognition performance was highest for the old items, followed by the rearranged, the new-background, and the no-background items in both age groups. The magnitudes of the context effects were similar for words and objects (a decrease of 12% in hit rate between old and rearranged items). Importantly, in contrast to what they had expected, old adults benefitted from context effect to a similar extent as younger adults, despite their declined abilities to rely on recollection. These findings imply that the context effect might only require the involvement of familiarity and not recollection.

In Experiment 2, the participants performed an associative identification task (object-background associative recognition) by recognizing whether the object-background pairing was old or new (rearranged or old object - new background items). In one fourth of the trials, the participants were presented with the object on no background and asked to recall the background that was associated with that object. The results showed that for the recognition test, older adults performed more poorly than younger adults in discriminating old pairings from new pairings. Specifically, older adults had higher false alarm rate (i.e. incorrect "yes" responses) for the rearranged items than that of the new-backgrounds items. This finding is consistent with previous research indicating that older adults have a deficit for recollection, which decreased their ability to correctly reject novel associations that made up of old items. For the recall test, older adults performed much worse compared to younger adults. Recall memory is primarily driven by recollection; thus, this finding also agrees with the notion that older adults exhibit recollection deficit. Together, the results from Experiment 2 are consistent with the idea that older adults rely more heavily on familiarity than recollection to discriminate old from new items.

There are two ways in which Craik and Schloerscheidt's (2011) findings contribute to the understanding of the context effect as well as associative recognition memory. First, context effects were illustrated to the same extent in both age groups. Second, the object-background associative recognition task is similar to Cohn and Moscovitch's description of associative identification task in which the nature of the task demands strategic retrieval of the associations between two items. Together, both studies found that the associative identification task requires recollection-based recognition. On the other hand, item recognition can rely primarily on familiarity, shown in the enhancement of object recognition in the presence of the studied context for older adults regardless of the declined abilities to use recollection.

Current study

Previous research has indicated that memory binding supports not only recognition memory for associative information, but also the context effects that facilitates memory for item information (Cohn & Moscovitch, 2007; Craik & Schloerscheidt, 2011; Sluzenski et al., 2006). However, few studies have focused on how the two lines of research meet to answer different aspects of the same question. Adding another layer of complexity when examining the contribution of familiarity and recollection to context effect is the fact that some studies used verbal stimuli, while others used object-background stimuli. Although both lines of research fall under the umbrella of the associative recognition memory, one cannot be sure that (1) the binding of word pair would be the same as object-background association, and (2) the context effects observed in one type of stimuli would have the same effect on another type of stimuli. Little attention has been paid to verifying whether object-background associative recognition should be conceptualized similarly to word pair associations. If not, what might the differences be in the associations between multiple verbal stimuli, and those between objects and backgrounds? These are empirical questions that need to be addressed in order for different research to collectively understand the role of context in recognition memory as one comprehensive picture.

The main goal of the current study is to examine the context effects in associative recognition tasks as well as item recognition tasks. In addition to using a context manipulation, we also investigated the effect of task demands at retrieval on context effects. Our primary research question concerned whether familiarity or recollection support the three types of tasks: the associative identification task, the associative reinstatement task, and the object recognition task. In two experiments, we combined the paradigms employed by Craik and Schloerscheidt (2011), and Cohn and Moscovitch (2007).

The robust context effects found in Hayes et al.'s study (2007) might be due to the fact that they used objects embedded on natural backgrounds, as opposed to other research that uses arbitrary backgrounds (e.g., Craik & Schloerscheidt, 2011; Lloyd, Doydum, & Newcombe, 2009; Sluzenski, Newcombe, & Kovacs, 2006). Craik and Schloerscheidt' stimuli (2011) used common objects superimposed on city and landscape scenes. The associability between the objects and backgrounds in these two experiments might differ immensely; and thus, could be a critical factor in the way object and background are bound at encoding. Similar to Hayes et al. (2007), our interest focused on the naturalistic association between objects and natural backgrounds (e.g., a teapot on a wooden table), with the intention to mimic our frequent encounters with objects in our environment.

The way in which context effects facilitate item recognition at retrieval has remained unclear. The dual-process theory indicates two independent processes that comprise recognition memory: familiarity and recollection. Many different methods have been employed to answer the question as to which process – familiarity or recollectioncontributes to the context effect of object recognition. Some of these methods include the "Remember/Know" paradigm (e.g., Macken, 2002), confidence rating paradigm (e.g., Humphreys, 1976) as well as age group comparisons (Castel & Craik, 2003; Craik and Schloerscheidt, 2011). One of the limitations of both the "remember/know" and the confidence rating paradigms is that they rely on subjective reports (for a review, see Yonelinas, 2002). The current studies employed the response deadline method to dissociate the contribution of the two measures of recognition. Similar to Cohn and Moscovitch's (2007) study, this method assumes that the speeded responses (<1000ms) should primarily on familiarity, whereas the non-speeded responses should rely on recollection (for a review, see Yonelinas, 2002). There is a debate in some previous research on whether or not object-background binding is automatic (Hayes et al., 2007; Levy et al., 2008) or effortful (Nakashima & Yokosawa, 2011) at encoding.

Using the response deadline method would provide an additional measure as to which process accounts for the retrieval of different recognition task demands. If speed negatively impairs recognition performance, it suggests that the task relies on recollection. However, if the recognition performances are similar between the speed and non-speeded groups, it suggests that the task relies primarily on familiarity.

To summarize, the present research aims to contribute to the existing literature in the following ways:

(1) Previous research has mainly focused on instruction manipulations at encoding, whereas few studies have used test instruction manipulation to examine to effect of task demand at retrieval on context effects. (2) Previous research has mainly employed the Remember/Know (e.g., Macken, 2002) and confidence rating paradigms (e.g., Tulving &

Thompson, 1971) to dissociate the contribution of familiarity and recollection in the context effect. Not many studies have used response deadline method to determine the contribution of these processes (Cohn & Moscovitch, 2007). (3) To date, no study of which we are aware has compared performance on item and associative recognition tasks simultaneously to study object-background association. The closest is work by Cohn and Moscovitch (2007) using word pair association and response deadline manipulation to study item and associative recognition tasks at retrieval.

Experiment 1

Method

We examined the effect of speed on two different recognition tasks, the associative identification task and an object recognition task. Based on the dual-process theory, the object-background associative task requires recollection; whereas the object recognition, an item recognition task, would rely on familiarity (Craik & Schloerscheidt, 2011; Levy et al., 2008). From this standpoint, speed should have a negative impact on the object-background associative task, but not the object recognition task. The main goal of this experiment is to investigate whether familiarity or recollection supports the two different recognition tasks at retrieval.

Consistent with previous research (Cohn and Moscovitch, 2007, Jones & Jacoby, 2001; Light et al., 2004), we expected that the speeded group would perform more poorly compared to the non-speeded group, in the associative identification task, but not the object recognition task (but see Macken, 2002; Nakashima & Yokosawa, 2011). For the associative identification task, we expected the hit rate to be higher and the false alarm rates to be lower for the non-speeded group compared to the speeded group because the contribution of recollection would allow participants to recognize old pairings and correctly reject novel ones. We also hypothesized that there will be a context effect in object recognition: the "old" items would yield that highest recognition, followed by the rearranged and the new-background items as is reported in Hayes et al.'s (2007) study.

Participants

Fifty-eight Seton Hall University students participated in the study for course credit.. All students received credit, however, one participant's data were removed from the analysis due to programming error. Each participant was tested individually on a computer or in a room with another participant. In instances where two participants were tested in the same room, a large board separated the two computers so that the participants could not see each other's computer screen. Twenty-eight and twenty-nine participants were in the speeded and non-speeded groups, respectively

Materials and Apparatus

A total of 120 pictures were used in this study. Some of the pictures were taken from Hayes et al.'s (2007) study. Others were taken from Internet image searches in order to have enough stimuli. All stimuli were manipulated using Adobe Photoshop CS5. The experiment was programmed using E-Prime 2.0 (Psychology Software Tools, Pittsburgh, PA).

Design

The experimental design was a 4 (status: old, rearranged, new-background, new) x 2 (response deadline: speeded, non-speeded) x 2 (task: associative identification, object recognition) mixed design. Response deadline was manipulated between-participants, and the other variables were manipulated within-participants. The dependent variable was the proportion of "yes" responses.

Procedures

This experiment consisted of two phases: a study phase and test phase. At study, 80 pictures plus 10 buffer pictures were presented serially 3000ms each with a 1500ms ISI, similar to the timing used in Hayes et al.'s (2007) study. Encoding instructions were given as follows "Remember the objects and the backgrounds for an upcoming memory test."

The test phase immediately followed the study phase. At the beginning of the test phase, participants were informed that there were two types of questions. For the "object + background?" question (i.e., the associative identification task), the participants were instructed to respond "yes" if they saw the object and the background previously paired together. For the "object?" question (i.e., the object recognition task), the participants were instructed to respond "yes" if they saw the object, regardless of the background. The participants were instructed to respond by pressing labeled keys "yes" and "no", which corresponded to keys j and f on the keyboard, respectively. A practice phase, consisting of 5 associative identification task trials and 5 object recognition task trials given in a randomized order, was given after the test instruction. During the practice and recognition tests, two types of tasks were given in a randomized order. The test phase consisted of 80 items: 20 old, 20 rearranged, 20 new-background, and 20 new items, given in a randomized order. Out of 80 total trials, 40 associative identification and 40 object recognition task trials were given in a randomized order. The questions ("object + background?" or "object?") were presented on the screen for 1500ms, followed by the picture. The participants in the speeded condition were instructed to respond in less than 1000ms after the onset of the picture presentation, and that a red screen with the words "Speed up" would appear after 1000ms has passed. Only the responses made within the window of 0 - 1000ms were recorded. For the non-speeded condition, the pictures were presented on the screen for 1000ms at test, followed by a blank screen. The participants could only respond after the 1000ms had passed. Two sets of pictures were used to counterbalance pictures between participants. Each picture in the two lists was counterbalanced so that each picture was viewed in any of the item statuses an equal number of items across participants. The presentation orders of pictures were randomized for each participant at study and test phase.

Results

The proportion of "yes" responses was the dependent variable. In the associative identification task, the proportion of "yes" responses for the old items was the hit rate; whereas the proportion of "yes" responses for the rearranged, new-background and the new items was the false alarm rate (see table 1). In the object recognition task, the proportion of "yes" responses for the old, rearranged, new-background items were the hit rates; whereas the proportion of "yes" responses for the new items are the false alarm rate. The proportion of responses that were made before the 1000ms deadline in the speeded group was .92. The significance level for initial analysis, post-hoc and planned comparisons were set at .05. In events of problems with sphericity, the Greenhouse-Geisser values were used. Means as a function of item status and response deadline are summarized in Table 2.

Table 1. *Correct response for each condition in three recognition tasks in Experiment 1*

Test Instruction	**Old**	**Rearranged**	**New-background**	**New**
Associative Identification task	Yes	No	No	No
Object Recognition	Yes	Yes	Yes	No

Table 2. *Mean proportion of "yes" responses for four item conditions in the associative identification task and the object recognition task for Experiment 1. Standard deviations are reported in parentheses.*

Associative Identification Task

	Old	Rearranged	New-background	New
Speeded	.53 (.22)	.39 (.22)	.38 (.20)	.23 (.17)
Non-speeded	[illegible]	[illegible]	[illegible]	[illegible]

Object Recognition Task

Speeded	.61 (.23)	.49 (.23)	.46 (.20)	.29 (.19)
Non-speeded	[illegible]	[illegible]	[illegible]	[illegible]

Comparisons between Associative Identification and Object Recognition Performance

We analyzed the effect of response deadline across both the associative identification and the object recognition tasks by conducting a 2(status: old, new) x 2 (task: associative identification, object recognition) x 2 (response deadline: speeded, non-speeded) mixed factor ANOVA. This analysis only considered variables for which the same answer was correct for both tasks. An omnibus ANOVA measure would not be appropriate for this analysis using all four levels of status. Therefore, only the old and the new item statuses were analyzed because the correct answers for these items are the same for both tasks (i.e. the proportion of "yes" responses was the hit rate for the old items, and the false alarm rate for the new items). There was a main effect of status [$F(1, 55)= 11.34, p< .05, \eta^2= .17$]. Overall, the hit rate for old items ($M= .62$, $SE= .03$) were higher than false alarm rate for new items ($M= .27$, $SE=$ 03). There was a main effect of task [$F(1, 55)= 122.33, p< .001, \eta^2= .70$]. Overall, participants were more likely to respond "yes" in the object recognition task ($M= .47$, SD= .02) than in the associative identification task ($M= .42$, $SD= .02$). There was no main effect of response deadline [$F(1, 55)= 2.67, p= .11, \eta^2= .05$]. Overall, the speeded ($M= .41$, $SE= .03$) and the non-speeded groups ($M=$. 48, $SE= .03$) performed similarly. There was no significant interaction between status and response deadline [$F(1, 55)= 1.13, p= .26, \eta^2= .02$]. The effect of response deadline on the hit and the false alarm rates were similar for the old and new items. There was no significant interaction between task and status [$F(1, 55)< 1$,

$p = .69$, $\eta^2 = .00$]. Participants' hit and false alarm rates were similar between the associative identification and the object recognition tasks. There was no significant interaction between task and response deadline [$F(1, 55) = 1.31$, $p = .26$, $\eta^2 = .02$]. The effect of response deadline on the overall performance was similar between the associative identification and the object recognition tasks. The three-way interaction of status, task, and response deadline was not significant [$F(1, 55) < 1$, $p = .90$, $\eta^2 = .00$].

The effect of response deadline on the associative identification task

The next set of analyses focused on each recognition memory task individually. The results for the Associative Identification Task are displayed in Figure 2.

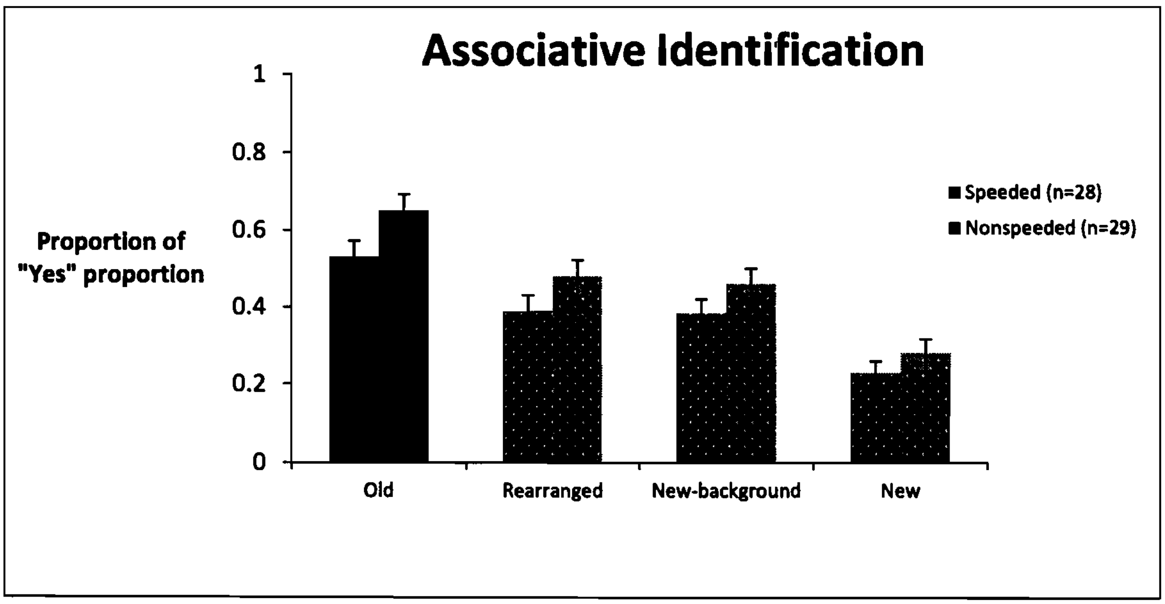

Figure 2. **The mean proportion of "yes" responses for the four item types in the Associative Identification Task of Experiment 1. The dotted bars represent false alarms and the error bars reflect standard error.**

We conducted a 4 (status: old, rearranged, new-background, new) x 2(response deadline: speeded, non-speeded) repeated measures ANOVA on the "yes" responses to associative identification trials. There was a main effect of status [$F(3, 55)= 31.01, p< .001, \eta^2 = .36$]. Overall, participants responded differently across the four item statuses. There was a main effect of response deadline [$F(1, 55)= 4.50, p< .05, \eta^2 = .08$]. Overall, participants were more likely to respond "yes" in the non-speeded group ($M= .47$, $SE= .03$) than in the speeded group ($M= .38$, $SE= .03$). There was no significant interaction between status and response deadline [$F(3, 55)= .35, p= .79, \eta^2 = .01$]. The effect of response deadline was similar across the four types of test items (old, rearranged, new-background, and new items)

To further analyze the main effect of status, paired-sample t tests were conducted to compare the hit and false alarm rates across four item statuses. The results revealed that the hit rate for old items ($M= .59$, $SE= .03$) was significantly higher than the false alarm rates for the rearranged items ($M= .43$, $SE= .03$), [$t(56)= 3.99, p< .001$], and the new-background items ($M= .42$, $SE= .03$), [$t(56)= 4.63, p< .001$]. There was no significant difference in the false alarm rates between the rearranged items and the new-background items [$t(56)= .38, p= .70$]. On average, the false alarm rate for the new items ($M= .25$, $SE= .03$) was significantly lower compared to the old items [$t(56)= 9.25, p< .001$], the rearranged items [$t(56)= 4.90, p< .001$], and the new-background items [$t(56)= 6.29, p< .001$].

The effect of response deadline on the object recognition task

The next set of analyses focused on each recognition memory task individually. The results for the Object Recognition Task are displayed in Figure 3.

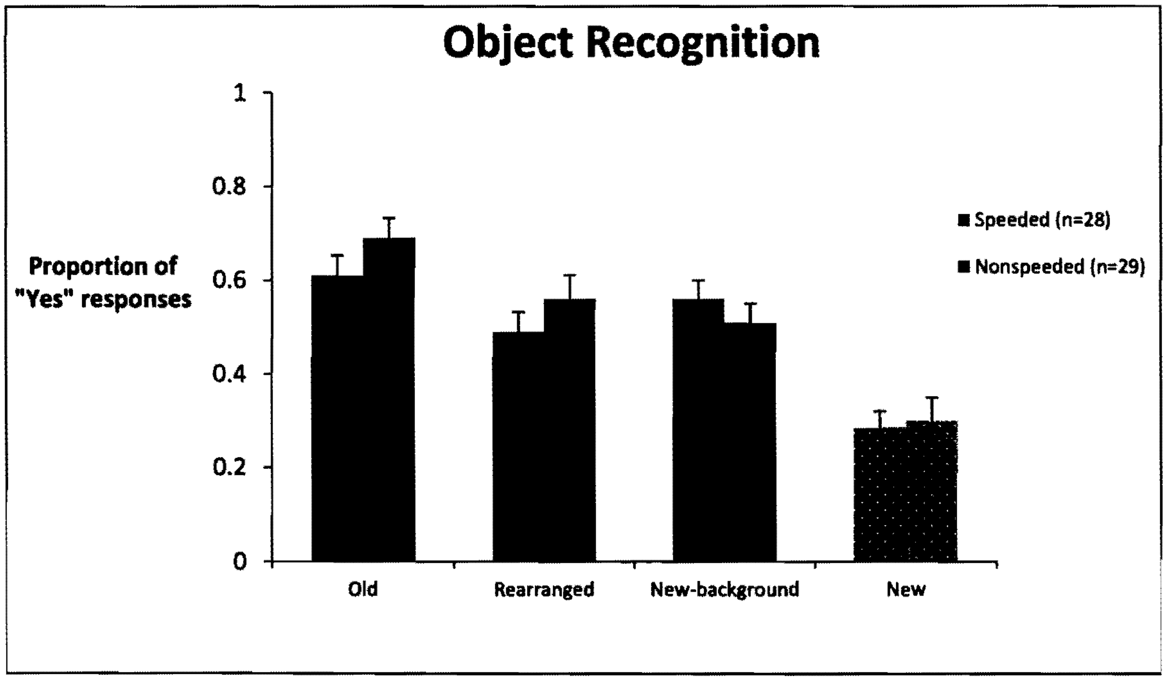

Figure 3. **The mean proportion of "yes" responses for the four item types in the Object Recognition Task of Experiment 1. The dotted bars represent false alarms and the error bars reflect standard error.**

We conducted a 4 (status: old, rearranged, new-background, new) x 2 (response deadline: speeded, non-speeded) repeated measures ANOVA on the proportion of "yes" responses to the context trials. There was a main effect of status [$F(3, 55)= 31.34, p<$ .001, $\eta^2 =$ .36]. Participants responded differently across four item statuses. There was no main effect of response deadline [$F(1, 55)= 2.08, p= .16, \eta^2 =$ .04]. Overall, the speeded ($M=$ .46, $SE=$ .03) and the non-speeded groups ($M=$ .52, $SE=$ .03) performed similarly.

There was no interaction between status and response deadline [$F(3, 55) = .29$, $p = .84$, $\eta^2 = .01$]. The effects of response deadline were similar across four item statuses.

To interpret the main effect of status, paired-sample t tests were conducted to compare the hit and false alarm rates in the four item statuses. The results revealed that the hit rate was significantly higher for the old items ($M = .65$, $SE = .03$) compared to the rearranged items ($M = .53$, $SE = .03$), [$t(56) = 3.64$, $p < .05$], and the new-background items ($M = .49$, $SE = .03$), [$t(56) = 4.16$, $p < .001$], representing the context effect. There was no significant difference in hit rates between the rearranged items and the new-background items [$t(56) = .97$, $p = .34$]. The false alarm rate for the new items ($M = .29$, $SE = .03$) was significantly lower than the hit rates for the old items [$t(56) = 9.44$, $p < .001$], the rearranged items [$t(56) = 6.16$, $p < .001$], and the new-background items [$t(56) = 5.27$, $p < .001$]. These results parallel those of the Associative Identification task.

Discussion

Overall, the results showed that hit and false alarm rates were similar between the associative identification and the object recognition tasks. Further the response deadline did not have an effect on the accuracy performance of either task. In fact, the pattern of responses was very similar across the two types of test questions.

Associative Identification Task

Overall, participants were successful at discriminating between old pairings from novel pairings, indicated by a significantly higher hit rate for old items than the false alarm rates in three other statuses. However, there was no significant difference in false alarm rates between the rearranged and the new-background items, suggesting that the reinstatement of a familiar background that was paired with another object at study (i.e. rearranged items) did not elevate false alarm rate compared to presenting the object with a novel background.

The response deadline had an effect on participants' responses, which was driven by overall elevation of "yes" responses in the non-speeded compared to the speeded group. That is, not only the hit rate for old items was higher, but the false alarm rates for the rearranged and new-background items were also increased in the non-speeded compared to the speeded group. In a traditional associative recognition paradigm in which an associative task requires recollection, higher hit rate and lower false alarm rate are observed for the non-speeded group compared to the speeded group (Jones & Jacoby, 2001; Light et al, 2004). In contrast, we found an overall elevation for both hit and false alarm rates in the non-speeded compared to the speeded group. Our results demonstrated an absence of response deadline effect on accuracy performance in the associative identification task, implying that this task might primarily rely on familiarity. This may reflect an important difference between memory for arbitrary word pairs and that of objects in natural backgrounds. We will return to this idea in the general discussion.

Our findings were inconsistent with those of Cohn and Moscovitch (2007), who showed that a response deadline impeded performance in the associative identification task. Their results revealed a robust effect of response deadline on discrimination rates between the speeded (.09) and the non-speeded (.57) groups using word pair stimuli. However, our results indicated that response deadline had no effect on accuracy performance in this task. Contrary to our hypothesis, we found evidence for a familiarity-driven process in the associative identification task using object and natural background stimuli.

Object Recognition Task

We replicated context effects as reported by Hayes et al. (2007): the hit rate was the highest for the old items, followed by the rearranged and the new-background items. Consistent with Craik and Schloerscheidt's findings (2011), the results suggested that the reinstatement of a paired background increased object recognition. Further, the failure to observe a difference in hit rates between the rearranged and the new-background items indicated that context effects did not result from a reinstatement of any familiar background, but only from the specific background that was paired with object at study. This finding was of particular interest because it speaks for the nature of object-background binding at encoding. If the object and background were encoded individually at study, one would expect that the reinstatement of an unassociated studied background might induce familiarity to a greater extent than a novel background would. Therefore, the hit rate for the rearranged items would be higher than that for the new-background items. Based the on absence of this difference in hit rates, our results suggested that object and background might not be encoded individually, but rather as one coherent item.

Relevant to this argument is the finding by Craik and Schloerscheidt (2011), showing that older adults could benefit from context effects to a similar extent as younger adults, despite their binding deficits. The observed context effects suggested that object-background binding must have occurred at encoding to some degree in older adults. The question becomes then, how could this binding occur when older adults exhibit poor binding abilities? Although the authors did not address this issue directly, their findings had an implication regarding the nature of object-background binding. The fact that older adults' binding deficits did not attenuate context effects indicated that object and background might be encoded as one whole entity as opposed to two individual items.

In support of our hypothesis, we found that response deadline did not have an effect on participants' performance, suggesting that the speeded and non-speeded groups performed similarly in this task. Craik and Schloerscheidt (2011) found that older adults could benefit from context effects despite of their poor ability to rely on recollection. Together, our findings and those by Craik and Schloerscheidt demonstrated that participants relied primarily on the assessment of the objects' familiarity while performing the object recognition task.

In summary, the results of Experiment 1 showed that both the associative identification and the object recognition task demands might rely on the familiarity, at least for objects embedded in natural backgrounds. We continued to investigate the context effects for item recognition in two tasks: associative reinstatement and object recognition, in Experiment 2.

Experiment 2

Method

We examined the effect of response deadline on two different tasks, the associative reinstatement and the object recognition task. Findings from Cohn and Moscovitch (2007) suggested that the associative reinstatement task is essentially an item recognition task because the retrieval for the associative information is not required. In these trials, participants are asked to endorse an item as old if both the object and background were presented at study either together or separately.

Based on the results of Cohn and Moscovitch (2007), we anticipated that response deadline should not have an effect because recollection is not required to reject rearranged items as novel associations in the associative reinstatement task. Therefore, we hypothesized that response deadline should not have an accuracy effect on either task. Similar to experiment 1, we expected to observed context effects in both tasks: recognition would be highest for the old, compared to the rearranged and the new-background items. Research using the dual-process models has shown that the non-speeded group would be able to rely on recollection to not only endorse old items but also correctly reject new items. Therefore, accuracy performance at performing this task would be similar between the speeded and the non-speeded groups.

Participants

Seventy-seven Seton Hall University students participated in the study for course credit. All students received course credit for participation; however, two participants' data were not included in the analysis due to programming errors. Each participant was tested individually on a computer or in a room with another participant. In instances where two participants were tested in the same room, a large board separated the two computers so that the participants could not see each other's computer screen. Thirty-five and forty participants were in the speeded and non-speeded groups, respectively

Materials and apparatus

The materials were identical to those used in Experiment 1.

Design

The experimental design was a 4 (status: old, rearranged, new-background, new) x 2 (response deadline: speeded, non-speeded) x 2 (task: associative reinstatement, object recognition) mixed-participants design. Response deadline was manipulated between-participants, and the other variables were manipulated within-participants. The dependent variable was the proportion of "yes" responses.

Procedure

The procedure was identical to that in Experiment 1, with the exception of the two question types given at test phase. For the "object, background?" question (i.e. the associative reinstatement task), participants were instructed to respond "yes" if they saw the object and the background, regardless of whether they were previously paired together. For the "object?" question (i.e., the object recognition task), the participant was instructed to respond "yes" if they saw the object, regardless of the background. The response deadline manipulation was identical to that in Experiment 1.

Results

The proportion of "yes" responses was the dependent variable. In the associative reinstatement task, the proportion of "yes" responses for the old and the rearranged items was the hit rate; whereas the proportion of "yes" responses for the new-background and the new items was the false alarm rate (see Table 3). The proportion of responses that were made before the 1000ms deadline in the speeded group was .93. The significance level for initial analysis, post-hoc and planned comparisons were set at .05. Means as a function of item status and response deadline are summarized in Table 4.

Table 3. *Correct response for each condition in three recognition tasks in Experiment 2*

Test Instruction	Old	Rearranged	New-background	New
Associative Reinstatement task	Yes	Yes	No	No
Object Recognition	Yes	Yes	Yes	No

Table 4. *Mean proportion of "yes" responses for four item conditions in the associative reinstatement and the object recognition task for Experiment 2. Standard deviations are reported in parentheses.*

	Old	Rearranged	New-background	New
		Associative Reinstatement Task		
Speeded	.57 (.22)	.49 (.22)	.42 (.23)	.28 (.18)
Non-speeded	.70 (.19)	.60 (.23)	.68 (.19)	.24 (.21)
		Object Recognition Task		
Speeded	.56 (.24)	.47 (.24)	.50 (.20)	.28 (.21)
Non-speeded	[illegible]	[illegible]	[illegible]	[illegible]

Comparisons between Associative Reinstatement and Object Recognition Performance

We analyzed the effect of response deadline across both the associative reinstatement and the object recognition tasks by conducting a 3(status: old, rearranged, new) x 2 (task: associative reinstatement, object recognition) x 2 (response deadline: speeded, non-speeded) ANOVA. Similar to Experiment 1, an omnibus ANOVA measure would not be appropriate for this analysis using all four levels of status. Therefore, only the old, rearranged, and the new item statuses were analyzed because the correct answers for these items are the same for both tasks (i.e. the proportion of "yes" responses was the hit rate for the old items and the false alarm rate for the new items). The results showed that there was a main effect of status [$F(2, 73)= 105.40, p< .001, \eta^2 = .59$]. Overall, the proportion of "yes" responses differed for old items (*M*= .63, *SE*= .02), rearranged items (*M*= .54, *SE*= .02), and new items (*M*= .27, *SE*= .02). There was a main effect of response deadline [$F(1, 73)= 7.33, p< 0.05, \eta^2 = .09$]. Overall, the proportion of "yes" responses was higher for the non-speeded (*M*= .53, *SE*= .02) than the speeded group (*M*= .45, *SE*= .02). There was no main effect of task [$F(2, 73)< 1, p=.97, \eta^2 = .59$]. Overall, participants' rates of "yes" responses were similar in the associative reinstatement (*M*= .48, SD= .02) and the object recognition task (*M*= .48, *SD*= .02). There was a significant interaction between status and response deadline [$F(2, 73)= 5.88, p< 0.05, \eta^2 = .08$]. Overall, hit rate for old items was higher for the non-speeded (*M*= .70, *SE*= .03) for the speeded group (*M*= .57, *SE*= .03); the hit rate for the rearranged items were higher in the non-speeded (*M*= .61, *SE*= .03) than the speeded group (*M*= .48, *SE*= .03); and the false alarm rates were similar between the non-speeded (*M*= .25, *SE*= .03) and the speeded group (*M*= .28, *SE*= .03). There was no significant interaction between task and response deadline [$F(1, 73)< .43, p= .52, \eta^2 = .01$]. The effect of response deadline had similar effects on the associative reinstatement and object recognition tasks. There was no significant interaction between status and task [$F(2, 73) < .06$, $p = .94$, $\eta^2 = .00$]. The three-way interaction status, task, and response deadline was not significant [$F(2, 73) < 1$, $p = .98$, $\eta^2 = .00$].

The effect of response deadline on the associative reinstatement task

The next set of analyses focused on each recognition memory task individually. The results for the Associative Reinstatement Task are displayed in Figure 4.

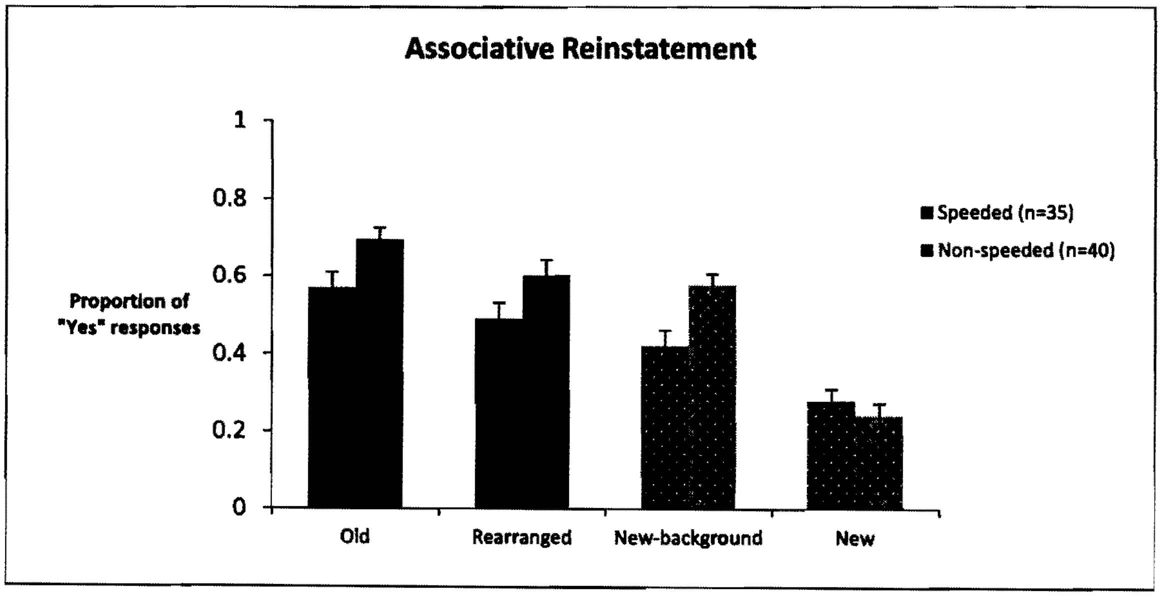

Figure 4. **The mean proportion of "yes" responses for the four item types in the Associative Reinstatement Task of Experiment 2. The dotted bars represent false alarms and the error bars reflect standard error.**

To analyze the effect of response deadline on associate reinstatement performance, we conducted a 4 (status: old, rearranged, new-background, new) x 2 (response deadline: speeded, non-speeded) repeated measures ANOVA. There was a main effect of status [$F(3, 72)= 57.73$, $p< .001$, $\eta^2= .44$]. Overall, participants' proportions of "yes" responses were highest for old ($M= .64$, $SE= .02$), followed by rearranged ($M= .55$, $SE= .03$ and new-background ($M= .50$, $SE= .03$), followed by new items ($M= .26$, $SE= .02$). There was a main effect of response deadline [$F(1, 73)= 7.08$, $p< .05$, $\eta^2= .09$]. Overall, the proportion of "yes" responses was higher for the non-speeded ($M= .53$, $SE= .02$) compared to the speeded group ($M= .44$, $SE= .02$). There was a significant interaction between status and response deadline [$F(3, 73)= 4.05$, $p< .001$, $\eta^2= .05$]. The effect of response deadline differed for the hit and false alarm rates.

To analyze the interaction between status and response deadline, independent t-tests were conducted to compare hit and false alarm rates between the speeded and the non-speeded groups. The results showed that the hit rate for the old items was significantly higher for the non-speeded group ($M= .70$, $SE= .03$) than the speeded group ($M= .57$, $SE= .04$), [$t(73)= -2.55$, $p< .05$]. The hit rates for the rearranged items was significantly higher for the non-speeded group ($M= .60$, $SE= .04$) than the speeded group ($M= .49$, $SE= .04$), [$t(73)= -2.14$, $p< .05$]. The false alarm rate for the new-background items was significantly higher in the non-speeded group ($M= .58$, $SE= .03$) than the speeded group ($M= .42$, $SE= .04$), [$t(73)= -3.08$, $p< .05$]. There was no significant difference in the false alarm rates for the new items between the speeded group ($M= .28$, $SE= .03$) and the non-speeded group ($M= .24$, $SE= .03$), [$t(73)= .81$, $p= .42$].

The effect of response deadline on the object recognition task

The next set of analyses focused on each recognition memory task individually. The results for the Object Recognition Task are displayed in Figure 5.

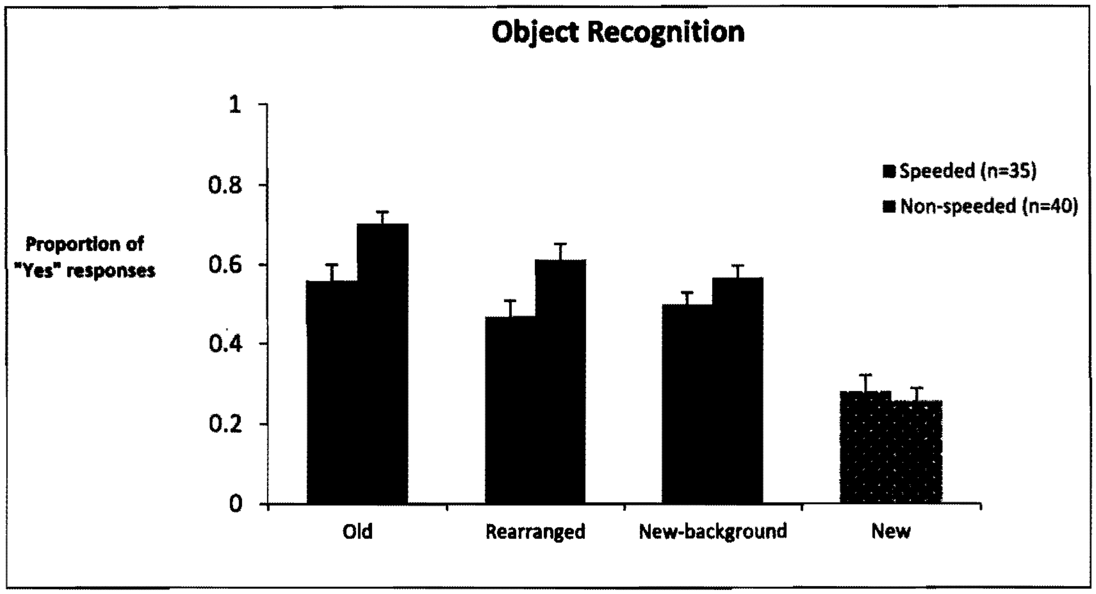

Figure 5. **The mean proportion of "yes" responses for the four item types in the Object Recognition Task of Experiment 2. The dotted bars represent false alarms and the error bars reflect standard error.**

Similar to Experiment 1, to investigate the role of speed on the context effect, we conducted a 4 (status: old, rearranged, new-background, new) x 2 (response deadline: speeded, non-speeded) repeated measures ANOVA. There was a main effect of status [$F(3, 72)= 51.56, p< .001, \eta^{2}= .41$] that was qualified by an interaction with response speed, [$F(3, 72)= 3.07, p< .05, \eta^{2}= .04$]. The effect of response deadline differed for the hit and false alarm rates. There was a main effect of response deadline [$F(1, 73)= 7.55, p< .05, \eta^{2}= .09$]. Overall, participants' proportion of "yes" responses was higher in the non-speeded (M= .54, SE= .02) compared to speeded group (M= .45, SE= .02).

To analyze the interaction between status and response deadline, independent t-tests were conducted to compare the hit and false alarm rates between the speeded and the non-speeded groups for each item status. The hit rate for the old items was significantly higher in the non-speeded group (M= .70, SE= .03) and the non-speeded group (M= .56, SE= .04), [$t(73)$= -2.76, p< .05]. The hit rate for the rearranged items was significantly higher in the non-speeded group (M= .61, SE= .03) and the non-speeded group (M= .47, SE= .04), [$t(73)$= -2.76, p< .05]. There was no significant difference in the hit rate for the new-background items between the speeded group (M= .50, SE= .04) and the non-speeded group (M= .57, SE= .03), [$t(73)$= -1.61, p= .11]. There was no significant difference in the false alarm rates between the speeded group (M= .28, SE= .03) and the non-speeded group (M= .26, SE= .03), [$t(73)$= .41, p= .68]. As in Experiment 1, the results of the two tasks were similar.

To analyze the effect of response deadline on the magnitude of context effects, we computed the increase in object recognition in the old items from the rearranged items (hit rate for old items – hit rate for rearranged items) as well as the new-background items (hit rate for old items – hit rate for new-background items). Independent t test showed that there was no significant difference between in the magnitude of context effects between the old and rearranged items for speeded (M= .09, SE= .05) and the non-speeded group (M= .09, SE= .03), [$t(73)$= -.03, p= .98]. There was also no significant difference between in the magnitude of the context effects between the old and new-background items for speeded (M= .06, SE= .05) and the non-speeded group (M= .14, SE= .03), [$t(73)$= -.03, p= .19]. Thus, the size of the context effects did not differ as a function of response deadline manipulation.

Discussion

The results showed that participants performed similarly in both tasks. The response deadline did not have an effect on the accuracy performance of the associative reinstatement task, nor the size of the context effects in object recognition.

Associative Reinstatement Task

Turning to the associative reinstatement results, participants could discriminate between old and rearranged object-background pairings. However, they could not discriminate between the pairs made up of unassociated object and background from those in which only the object was studied. In other words, participants successfully discriminated between pairs made up of two old items (i.e., old and rearranged items) from pairs made up of only one item (i.e., new-background items), only for cases in which the two old items were specifically paired together (i.e., old items). In cases in which the two old items were not paired together, discrimination diminished.

Contrary to our hypothesis, we found the effect of response deadline had mixed effects on hit and false alarm rates. Hit rates for old and rearranged pairs were higher in the non-speeded group than the speeded group. However, false alarm rate for new-background, but not for the new items, was also higher in the non-speeded compared to the speeded group. Elevated false alarm rate in the new-background items indicated that the effect of response deadline might be driven by "yes" response bias for the items in which the objects were familiar. Similar to the results of the associative identification task in experiment 1, accuracy performance did not appear to be especially impeded by a response deadline. Cohn and Moscovitch (2007) found that the ability to discriminate pairs that made up of two old items from those made up of only one item, did not depend on a response deadline and they concluded that the associative reinstatement task was not dependent on recollection-based measures. Further, because of the elevated false alarm rate for the new-background items, our results also suggested that response deadline did not have an effect on accuracy performance in the associative reinstatement task. Consistent with Cohn and Moscovitch, our results indicated that the associative reinstatement task might rely on familiarity and not recollection.

Indirect context effects were also observed with the associative reinstatement results. There was a superior recognition for items that were tested in the presence of their paired counterpart, compared to those that were tested in the absence of their paired counterpart. The results showed that the reinstatement of the paired counterpart item facilitated recognition for object and background individually, even when task does not demand retrieval for the associative information.

Object Recognition Task

Similar to Experiment 1, the context effects were observed in the object recognition task. The hit rate for the old items (context present) was significantly higher than that for the rearranged and the new-background items (context absent). However, inconsistent with the results in Experiment 1, we found a main effect of response deadline in the object recognition task. The non-speed group recognized more old items compared to the speeded group. These findings indicated that the participants might have relied on recollection to perform this task.

Inconsistent with our hypothesis as well as our results in experiment 1, there was a main effect of response deadline manipulation in that higher hit rates for old and rearranged items were shown in the non-speeded group compared to the speeded group.

However, when comparing the magnitudes of context effects between the speeded and non-speeded group, no significant difference was found. This finding matches with our results in experiment 1 in that participants relied on the assessment of the objects' familiarity while performing this task.

General Discussion

The binding process and the phenomenon of context effects are also investigated outside of memory research. For example, context plays an important role in object identification, occurring at the initial perception (Oliva & Torralba, 2007). In our visual experience, objects do not exist in isolation, but rather within a surrounding context. Our knowledge of objects and backgrounds derives from our exposure to everyday interaction with the environment. Bars (2004) suggested that, when objects appear to be ambiguous when presented in isolation, context disambiguates the identity of objects. For example, it might be easier to identify a toaster when it is presented in a kitchen scene as opposed to being presented in a garden. Previous studies found that presentation of context enhanced the visual search process in object identification task (e.g., Gordon, 2004; Henderson, J. M, 1999). For example, one might be faster at identifying a toaster than a hair dryer in a kitchen background scene. Davenport and Potter (2004) found that participants were better at identifying objects when they were studied in a consistent and meaningful background (e.g., a football player on a field), compared to those presented on an inconsistent and incongruous background (e.g., a football player in a chapel). Similarly, backgrounds were better identified when presented with congruous objects, compared to those presented with incongruous objects. These results indicated that contexts that are consistent with our semantic memory play an important role in object identification (but see Hollingworth & Henderson, 1998). Castelhand & Henderson (2005) suggested that context of an object can be encoded incidentally and facilitate performance in the object searching task. Supporting this claim are findings provided by Chun and Jiang (2003), who found that visual search for objects is facilitated by the presence of congruous backgrounds.

The main goal of the current study was to investigate the context effect in recognition memory using object-background association. We compared the performance of objection recognition task simultaneously to the associative identification task (Experiment 1), and to the associative reinstatement task (Experiment 2) to examine the contribution of familiarity and recollection in different task demands at retrieval. There are three main implications of our findings.

The first implication is with regard to the context effects in item recognition. The current research provided clear evidence for the role of context in item recognition. The robust context effects were found in both the associative reinstatement (9-10%) and the object recognition tasks (5-18%). Neither task required the retrieval for associative information, yet the reinstatement of the context facilitated memory for the objects (in the object recognition task) as well as the objects and backgrounds individually (in the associative reinstatement task). Smith and Vela (2001) noted that findings on context effects in recognition memory were not only inconsistent, but also reported to have smaller effect sizes, compared to those in recall memory (e.g., Godden & Baddeley, 1980; Jacoby, 1983; Smith, Glenberg, & Bjork, 1978). In contrast, reliable context effects were observed across both experiments in our paradigm. This finding might be due to the fact that we used naturalistic stimuli, unlike previous studies using drawing objects on arbitrary backgrounds (e.g., Craik & Schloerscheidt, 2011; Lloyd et al., 2009) or arbitrary associations between items and backgrounds (e.g., Sluzenski et al., 2006). Digitalized objects and natural backgrounds might be more readily to be perceptually associated compared to other stimuli that can only be arbitrarily associated (e.g. unrelated word pairs, words on colored backgrounds, two unrelated objects, objects on an arbitrary background). Our findings provide support for the claim that the inconsistent reports on context effects may reflect the differences in the in the nature of the "context" defined by various studies (McKenzie & Tiberghien, 2004). Variation in the definition of "context" makes the research in context effects difficult to compare across different studies. Findings from both ours and Hayes et al.'s (2007) study indicated that the role of context might be more robust when the nature of the association is more realistic.

One of the main research questions of the present study concerned whether context effects for object recognition were driven by familiarity or recollection. In both experiments, the response deadline manipulation did not have an effect on the magnitude of the context effects. The speeded and the non-speeded groups benefited from the reinstatement of the paired background to a similar extent, indicating that the reinstatement of the background primarily aided the assessment of the objects' familiarity. These results accorded with Craik and Schloerscheidt's (2011) findings on the context effects observed in older adults, despite of their reduced ability to rely on recollection. The current study also provides evidence supporting the ICE (item, context, ensemble) theory (Murnane et al., 1999). This theory argues that the reinstatement of the context increases item recognition via increased familiarity strength, without the contribution of recollection.

The second implication of the results of the present study is with regard to potential differences in the association between using objects and natural backgrounds and using other arbitrary stimuli. Our findings on the associative identification task raised speculations regarding the nature of the object-background binding at encoding. The dual-process theory assumes that item recognition can rely on familiarity, whereas associative recognition relies on recollection (Mandler, 1980; Yonelinas, 2002). The results of Experiment 1 contradicted this assumption because the response deadline did not impede accuracy performance in associative identification task. These results are also inconsistent with those of Cohn and Moscovitch's (2007) study, where they found that response deadline decreased hit rate for the old items and increased false alarm rate for the rearranged items. The inconsistency between our results and Cohn and Moscovitch's might be due to the difference in the stimuli used in these studies. Whereas we used object and natural background association, Cohn and Moscovitch used unrelated word pairs. The inherent naturalistic association between object and background might account for the difference in task demands for associative identification task at retrieval.

Specifically, our findings demonstrated that object and background might have been unitized at encoding. Graf and Schacter (1989) defined "unitization" as a process in which two or more items are integrated together and encoded as one single representation. Evidence that unitized association can be supported by familiarity, as opposed to recollection, has been reported for word pairs, arbitrary object-background, and word-background associations (Hayes-Roth, 1977; Kelly & Wixted, 2001; Yonelinas, 1999). Our results have demonstrated that response deadline did not impede the accuracy performance in the associative identification task, suggesting that the retrieval of object and natural background associations primarily rely on familiarity. This result provided support for the idea of unitization. In the current findings, we demonstrated a familiarity-based associative recognition for object and natural background, because response deadline did not diminish context effects or impair the discrimination of old and rearranged pairs.

An equally important finding was that there was no difference in the hit rates between the rearranged and new-background items for the object recognition task in Experiment 1 and 2. These results provided evidence that objects and backgrounds might not be encoded individually and linked together. If objects and backgrounds were encoded individually and arbitrarily associated together, we should have seen an increase in the hit rate for the rearranged items from new-background items, because an unassociated studied background would have increased familiarity strength for the rearranged pairs. That is, context effects did not result from a reinstatement of any studied background, but only in cases for the specific associated background during study. This finding also supports our explanation of object-background unitization at encoding.

The third implication of the present results concerns the strategy that the participants might have adopted during the test phase when making recognition decisions. The inconsistent results for the object recognition task between two experiments led us to speculate that the discrepancy might have resulted from the different natures of the tasks being performed simultaneously. Cohn and Moscovitch (2007) found that the associative identification task relied on recollection, whereas our results indicated that this task relied on familiarity. Banks (2000) has suggested that by switching between two different tasks, the participants might base their recognition decision on the same criteria at test phase. In the associative identification task, if the object and background are unitized, participants might have treated both tasks as item recognition tasks. In the associative reinstatement task, the participants were asked to respond to the object and the background individually, regardless of their pairing. The nature of this task might have induced a strategy in which the participants were likely to separate objects and backgrounds individually to perform this task. The negative effect of response deadline on hit rates could be due to the fact that the participants were responding to two items as opposed to one. Task switching between the associative reinstatement and the object recognition task in Experiment 2 might have also induced a different criterion for recognition memory decision than that when performing one type of task throughout the test phase.

Our findings lead to a number of empirical questions to be investigated in future studies. One is the issue regarding the automaticity of object-background binding at encoding. In the current research, the participants were instructed to pay attention to the objects and the backgrounds for a later memory test. Our paradigm could not directly answer whether object and background were bound automatically. If the encoding instruction becomes "only pay attention to the objects for a later memory test", will the results show (1) discrimination of the old items from the other items in the associative identification task, and (2) the context effects in the object recognition and the associative reinstatement tasks. If the context effects are found with this encoding instruction, we can infer the object-background binding might occur automatically. Furthermore, if the encoding instruction involves a deeper level of processing (e.g. should this object cost more than $25? – similar to Hayes et al.'s (2007) study), which presumably would discourage the participants to pay attention to the background to a greater extent, would the same results be found? Hayes and colleagues found that the magnitudes of the context effects were similar between the explicit (13%) and implicit (14.7%) encoding instruction groups. Incorporating this manipulation into the current paradigm will further demonstrate the automaticity of the object-background binding, should the results reveal that the discrimination rates and the context effects are similar, irrespective to the encoding instruction.

Although we found that the reinstatement of the context facilitated the item recognition across different tasks and experiments, our design could not directly answer whether the participants explicitly remembered the backgrounds. In the associative reinstatement task, the responses were similar between the rearranged and the new-background items in the both speeded and non-speeded groups, which led us to consider the possibility that the participants merely responded to the status of the objects alone and not the backgrounds. It is also important to note that the pattern of the proportion of "yes" responses in all three tasks appeared to be similar. These similarities include: (1) highest "yes" responses to the old items followed by rearranged and new-background items, (2) similar responses to the rearranged and the new-background items, and (3) no difference in false alarm rates for the new items. Despite the different memory tasks, the participants appeared to respond similarly. One explanation for this is the dominance effect that objects might have over backgrounds, in which the participants responded to the objects more attentively than they did to the backgrounds, irrespective of the recognition tasks.

Related to this idea, Levy et al. (2008) reported that although the participants benefit from the reinstatement of the background, they did not have explicit memory for the backgrounds. This explanation may account for the reason we found context effects (higher recognition for old items than rearranged items), but no difference between the rearranged and the new-background items in the associative reinstatement task. To address this question, future research can include the "new-object" item status (i.e., a novel object embedded on a studied background). This additional item status will allow for the comparison in false alarm rates between the "new-background" items and the "new-object" items in the associative reinstatement task, thereby indicating whether the backgrounds are explicitly remembered. An alternative method is to modify the current paradigm to study context effects on background recognition. A comparison of hit rates for rearranged and new-object items from the current results might provide evidence for the object dominance effect.

Turning to other findings regarding comparison of multiple task performance across participants, the results in this study were inconsistent with Cohn and Moscovitch's (2007) findings for the associative identification and the associative reinstatement task. The design of this study only allowed for cross-experiment comparison between these two tasks. Future research should compare the associative identification and the associative reinstatement tasks in one experiment to further investigate the contribution of the familiarity and recollection in these two task demands at retrieval.

In conclusion, we want to highlight that object and background might be unitized and encoded as one single representation. The current findings combined two lines of research in associative recognition and context effects in one paradigm using object-background associations. Our findings were important regarding the contribution of the familiarity and recollection in object-background recognition and object recognition. There were several differences between our findings and those of Cohn and Moscovitch

(2007). These differences are indicative of the variations in associative recognition literature due to the various types of stimuli.

Previous research in associative recognition memory and context effects have used many different types of stimuli including word pair association (e.g. Castel & Craik, 2003; Cohn & Moscovitch, 2007; Craik & Schloerscheidt, 2011; Jones & Jacoby, 2001; Light & Carter-Sobell, 1970; Macken, 2002; Markopoulos et al., 2010; McKenzie & Tiberghien, 2000; Humphreys, 1976; Tulving & Thomson, 1971), word-background association (e.g., Murnane et al., 1999), object-object association (e.g., Kan et al., 2011), object – natural background association (e.g., Hayes et al., 2007), face-scene background association (e.g., Chua, Hannuala, & Ranganath, 2012; Gruppuso, Lindsey, & Masson, 2007), face – cued objects association (e.g., Vakil, Raz, & Levy, 2007), face-name association (e.g., Chua, Schacter, & Sperling, 2009), animals (e.g., Sluzenski et al., 2006) or objects and arbitrary backgrounds association (e.g. Craik & Schloerscheidt, 2011; Lloyd et al., 2009), simultaneously paired pictures association (Levy et al., 2008; Park et al., 1987) or temporally paired pictures association (e.g. Schwartz et al., 2005). Due to the variation in the stimuli that have been used to study associative memory, the nature of the associations differs vastly in this literature. The variation of stimuli may pose a challenge when comparing associative recognition performance across studies due to the difference in arbitrary or naturalistic association between two stimuli.

The literature in context effects, similar to the associative memory research, encounters the same challenges. Context is defined differently across studies, depending on the types of associations are being employed. Thus, when examining the role of context, researchers should take into account the different types of associations between the stimuli. In the current study, we successfully replicated a robust context effect using objects and natural backgrounds association found in Hayes et al.'s study (2007). Because these stimuli are more similar to everyday memorial experiences, we hope that memory researchers will be willing to continue to investigate differences between natural and arbitrary memory effects.

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