

Remembering Faces in Different Places: The Influence of Context on Face Memory

by

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AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

How context affects memory is the central focus of the six experiments making up this PhD thesis. In these experiments, pictures of faces were presented in an incidental encoding phase, paired with a variety of indoor and outdoor context scenes (e.g., park, supermarket, swimming pool), and a recognition memory test ensued in which faces were paired with either the same context (exact same context the face was paired with at encoding), switched context (a context that was presented at study, but not presented with that particular face), or new context (a context never before seen), relative to encoding. In Experiment 1, the importance of instructions at encoding was examined by manipulating instructions to either actively link or passively view the face and context at encoding. Maintaining the same context as at encoding reliably enhanced overall detection, and recollection, of studied faces relative to a new context, replicating the known context reinstatement (CR) effect. There was also a reliable memory benefit for faces paired at test with the same relative to a switched context, indicating a context specificity (CS) effect on memory. Encoding instructions to either actively link, or passively view, face-context pairs during encoding did not influence the presence or magnitude of the CR or CS effects, suggesting that linking of target + context may occur spontaneously. In Experiment 2, dividing attention did not influence CR, but did eliminate the CS effect on overall memory. Findings suggest that the general boost to memory from reinstating an old relative to a totally new context at test is robust, though linking specific contexts to targets is hampered when attention is limited during encoding. In Experiments 3 and 4, familiarity of the face to the observer interacted with context effects. In Experiment 3, face familiarity was manipulated by presenting famous versus non-famous faces during encoding and an attenuated CR effect was observed for famous relative to non-famous (unfamiliar) faces, though CS remained. In Experiment 4, degree of familiarity was controlled by pre-exposing the study faces 0, 1, 3, or 10 times prior to the study phase. After just one pre-exposure to an unfamiliar face, the CR effect was reduced. Experiment 5 examined whether distinctive faces were less susceptible to context effects relative to similarly familiar, but less distinctive, faces. CR and CS effects were predicted for out-group faces (Caucasian faces for Asian participants and Asian faces for Caucasian participants), and a reduction in both CR and CS for in-group faces (Caucasian

faces for Caucasian participants and Asian faces for Asian participants). Results indicated no difference in CR or CS across the conditions, suggesting that distinctiveness may not be an important factor in mediating context effects. The final experiment examined how the expectancy of a face + context pairing influenced CR and CS effects, even when the target face was familiar. There were robust CR and CS effects for faces when these were repeatedly paired with a specific context during study, but a loss of both effects when faces were paired with varying contexts during study. Results extend our current knowledge regarding the role of context in memory and supports memory models that suggest context information presented at test acts as a cue that uniquely specifies a particular target.

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Dedication

I dedicate this thesis to my wonderful parents, Muayad and Brwa Koji, the two greatest people in the world. It is because of their love and encouragement that I have been able to reach this point in my career. I would also like to dedicate this thesis to my brother, Beewar Koji, whose silly antics kept me laughing throughout this entire process.

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Chapter 1

General Introduction

1.1 Memory for Targets and the Influence of Context

Memory is at the core of many psychological processes, making it a vital area of research. Memory has been studied as a psychological process for over a century, with some of the first research dating back to Ebbinghaus' studies on his own memory for letter strings (Ebbinghaus, 1885/1913). Though memory for target items presented in isolation is the usual method of presentation in research (see Baddeley, 1997), in real life we virtually never encounter a single to-be-remembered item presented on its own. Rather, we are presented with an assortment of visual information (including but not limited to objects, people, and animals) within a plethora of varying context scenes, which likely influence memorability of targets. The focus of this thesis is to determine how surrounding context information influences memory for target items, and what factors play a role in modulating this effect. A common example of how context might impair memory is when you run into an acquaintance that seems to know you, but you are unable to accurately recognize him. Could this lapse in memory possibly be due to the encounter occurring in an environment that is different from the one in which you originally met? The present thesis seeks to answer this question, and to clarify the conditions under which memory would be negatively affected.

Examination of the influence of visual context on recognition has been a "hot topic" in the memory literature for over ninety years. Experimental studies of the effects of environmental context, on various aspects of memory, date back to Carr (1925) who examined the influence of environmental manipulations at retrieval on maze running in rats. He showed that reinstating the same context at retrieval as at encoding enhanced maze performance. Context has been shown to

significantly affect memory, with studies indicating that memory for target information benefits when contextual cues present at encoding are also present at retrieval. For instance, research has shown that students who have learned material in a specific classroom and are tested in that same room scored higher at test compared to students tested in a different classroom (Smith, 1979, 1984). The same environment from study to test may provide cues, which may aid recognition and recall. This phenomenon has been referred to as the *context reinstatement effect* (CR effect; see Smith & Vela, 2001, for a review). The CR effect refers to the finding of better memory when the learning environment is reinstated at test relative to when testing occurs in a different environment than during learning.

In a well known study by Godden and Baddeley (1975), participants were asked to study a word list either on land or under water, and then were tested in either the same context in which study took place (land-land/water-water) or in the opposite context (land-water/water-land). They revealed significantly higher word recall when test and study took place in the same context relative to when they took place in opposite contexts. Smith and Sinha (1987) replicated these results in more controlled settings, providing converging evidence for the effects of context change on memory. These were some of the first demonstrations of the context reinstatement effect and the role that context plays in memory.

Historically, context effects have typically been examined for memory of words (Godden & Baddeley, 1975; Godden & Baddeley, 1980; Grant, Bredahl, Clay, Ferrie, Groves, McDorman, & Dark, 1998; Light & Carter-Sobell, 1970; Thomson, 1972; Schwabem, Böhringer, & Wolf, 2009; Smith, 1985; Smith, Glenberg, & Bjork, 1978; Smith, Heath, & Vela, 1990; Smith & Sinha, 1987; Tulving & Thomson, 1971). However, Tulving (1972) argued that while words are the stimulus of choice in memory experiments for reasons of convenience, to

construct general theories of memory, further investigations involving other types of stimuli are crucial. When examining context effects on memory using word stimuli, typically, pairs of words are presented at study with one word as the target and the other serving as “context”. At test, the context word is either reinstated (same pair as seen at study) or changed. These studies have demonstrated mixed results regarding the existence of the CR effect, with some finding clear CR effects (Geiselman & Glenny, 1977; Geiselman & Bjork, 1980; Godden & Baddeley, 1975; Smith, 1986; Smith & Vela, 1992), and others not finding a CR effect at all (Fernandez & Glenberg, 1985; Godden & Baddeley, 1980; Jacoby, 1983; Murnane & Phelps, 1993, 1994, 1995; Smith et al. 1978). It has been suggested that this discrepancy may be due to the issue that words have a preexisting semantic organization (Tulving & Thomson, 1971), which could influence both the presence and the magnitude of CR effects. That is, the effect of CR may be underestimated because the target item already has such a large network of other “contexts” connected to it, and therefore the paired associate context word may not play much of a role in boosting memory.

Another common procedure has been to present words as the targets, displayed on backgrounds of varying colors as the context, and manipulating the word and background colors at test (Dougal & Rotello, 1999; Murnane & Phelps, 1993; 1994; 1995; Murnane, Phelps, & Malmberg, 1999). Smith (1988) argued that this procedure may not be ideal as our strong familiarity with words, and language in general, leads to an uneven distribution of interest and attention directed to the word stimuli relative to such simple secondary context information, leading to an underestimate of the effects of context on memory. As this issue is difficult to circumvent using word stimuli, the use of other types of stimulus materials is necessary

(Winograd & Rivers-Bulkeley, 1977). Specifically, it is important to consider target and context stimuli that are equally unfamiliar (Russo, Ward, Geurts, & Scheres, 1999).

1.2 Effects of Context on Face Memory

Undoubtedly, one of the most common memory demands encountered in everyday life is the recognition of faces that we meet in an assortment of environmental contexts. Examining memory for faces, using various scenes as ‘context’, would allow for the generalization of the CR effect to other types of episodic events. Additionally, testing the recognition of unfamiliar faces paired with unfamiliar context scenes would allow us to examine episodic memory while avoiding problems of using verbal information as stimuli, which hold considerable pre-existing semantic content, which could bias performance (Smith, 1988; Tulving, 1972).

Kerr and Winograd (1982) examined the role that an elaborated verbal encoding context had on face recognition. The verbal context was composed of short descriptive phrases about the stimulus face, and degree of elaboration was manipulated by varying the number of phrases across the study faces. Results demonstrated that participants were more likely to recognize a face when they had received information about that face relative to when no information was provided, indicating that the presence of context (in this case verbal elaboration) could facilitate recognition memory for a target stimulus (in this case faces). The researchers demonstrated a significant effect of the presence of context during encoding on later memory for faces. Unlike everyday life, however, they did not provide context information at test.

In this thesis, I considered how memory for faces would be influenced by context presented at both encoding and test, when the encoding and test contexts were identical and when they were different. In the current experiments, faces were presented at study paired with a variety of indoor and outdoor context scenes (e.g., park, supermarket, swimming pool) and a

recognition memory test ensued in which faces were paired with either the same contexts (exact same context that the face was paired with at encoding), switched contexts (a context that was presented at study, but not presented with that particular face), or new contexts (a context never before seen), relative to encoding.

In the current thesis, I considered memory for target items alone, and the role of context during retrieval. This differs from related work on associative memory, which examine memory for the target and context information as a unit. In such studies, memory for the pair of items (target + context) is examined. For example, Rhodes, Castel and Jacoby (2008) presented participants with face pairs at study followed by an associative recognition memory test. Participants were accurate at recognizing previously presented pairs but were also more likely to incorrectly respond “old” to conjunction pairs (pairs that contained previously studied items that were not studied together), suggesting that presenting familiar but incorrectly paired information negatively affects associative recognition. Related to this, Naveh-Benjamin, Guez, Klib, and Reedy (2004) examined memory for face-name pairs in younger and older adults, and identified an associative memory deficit in older adults, and similar results have been reported by Chalfonte and Johnson (1996).

The type of memory examined in this thesis also differs from source memory, which is memory for the context itself. A somewhat similar paradigm to that used in tests of associative memory is also used in studies of source memory. For example, Horry and Wright (2008) showed White participants White (same-race) and Black (other-race) faces paired with context scenes at study, and demonstrated that participants made more source memory judgment errors at test with Black than with White faces. Such work demonstrates how information about a face can

influence source memory. Here the focus was on memory for the context. In the current line of research, I instead examined how the context influences *memory for the target*.

1.3 Context Reinstatement and Context Specificity

As described earlier, prior work has shown that memory for target information largely benefits when contextual cues present at encoding are also present at retrieval. To reiterate, this phenomenon, called the context reinstatement effect (CR effect; see Smith & Vela, 2001, for a review), refers to the finding of better memory when the learning environment is reinstated at test relative to when testing occurs in a different environment than at learning (Bower & Karlin, 1974; Dalton, 1993; Godden & Baddeley, 1975; Winograd & Rivers-Bulkeley, 1977).

In this thesis, I suggest another, related effect, of context on memory. Looking at recent work there appears to be a *context specificity (CS) effect*, namely an enhancement in memory for the target when it is re-experienced within the exact same, relative to a switched (one that was presented within a study list, but not paired with that particular target), but familiar, context (Gruppuso, Lindsay, & Masson, 2007; Koji & Fernandes, under revision; Vakil, Raz, & Levy, 2007, 2010).

Only a few studies have examined context effects on memory for faces and included conditions that would allow for the investigation of both CR and CS effects. Gruppuso and colleagues (2007) showed participants pictures of faces paired with images of unique context scenes, including photographs of buildings, travel scenery, sports, or animals. They encouraged associative linking of the face and context by asking participants to rate the likelihood that the person in the picture was associated with the context, in an incidental learning phase. At test, studied faces were paired with either a) the *same* context as at encoding, b) a *switched* context (a context that was presented at study, but not presented with that particular face) or c) a brand *new*

context (a context never before seen). New faces were presented as lures and paired with d) *old* or e) *new* context scenes. Results showed a significant boost in recollection memory for studied faces paired with the same context relative to new contexts – the well-known CR effect.

Interestingly, this memory boost was not simply due to the re-presentation of any studied face with any studied context; rather, the boost was specific to the re-presentation of a particular studied face paired once again with its original context. Trials in which the context was old but not re-presented with its originally paired face led to a significant decrease in face memory relative to original face + original context trials, suggesting a context specificity (CS) effect.

Vakil and colleagues (2007) were another group that examined the effects of both CR and CS. They presented faces each topped with a unique hat during encoding and asked participants to rate face-hat compatibility to encourage the association of face and context information. At test, participants viewed old and new faces in conditions similar to those described by Gruppuso et al. (2007). Results replicated Gruppuso et al. (2007), indicating significant CR and significant CS effects, providing converging evidence for the existence of CS.

Most recently, Craik and Schloerscheidt (2011) presented object names or object pictures on background scenes (e.g., outdoor landscape) to younger and older adults. Participants later attempted to recognize previously presented items on background scenes that were same, switched, new, or blank. Reports indicated performance was better in the same relative to new context condition (CR effect), and better in the same relative to switched context condition (CS effect). The aforementioned studies demonstrated that context effects do not solely include CR, but also seem to include CS. Though the examination of CS is relatively novel, and is for the first time ever given a label in this thesis, these studies suggest that the magnitude of the influence of

context on memory may depend on how uniquely the context specifies the target item. This is one of the main focuses of my thesis.

1.4 Theoretical Framework for Context Effects

In the literature on context effects, there has been controversy over whether target + context information is stored separately or as an associated unit (Gillund & Shiffrin, 1984; Hintzman, 1988; Hockley, 1991, 1992; Murdock, 1993). The *global activation model* (Murnane & Phelps, 1993; 1994, 1995) suggests that target + context information are conjoined in memory and are stored as part of a common memory unit. The theory proposes that memory representations contain both context and item information and that memory is activated depending on the degree of match between information in the cue (information viewed at test) and information in memory. The total output from memory is called global activation, which is formed by the test cue activating each item in the memory set. Higher levels of global activation (a greater degree of match) increase the likelihood that the test item will be recognized as old. This account predicts that the specificity of the context cue during retrieval should not differentially affect memory for target information. So long as the context cue is any familiar one that was present during study, memory for the target should receive a significant boost; thus no CS effect. This theory also predicts no differences in response times to access and recognize target items across same, switched, and new contexts (Murnane & Phelps, 1994). Specifically, one branch of the global activation models – the additive global matching models (CHARM: Eich, 1982; TODAM2: Murdock, 1997) – suggests target and context are stored as composite units. The greater the match between stimuli presented during recognition (target + context) to the amalgamated unit stored in memory from encoding, the greater the likelihood of a correct recognition response. In this model, the target and the context do not act as cues for one another,

but instead the memory for the target is matched to the probe target, while the memory for the context is independently matched to the probe context.

Murnane and colleagues (1999) built upon the global matching models of memory and created an *item, associated context, and ensemble (ICE) model*. ICE theory suggests that three types of information are used when recognizing an item that includes the item itself, the context, and the ensemble (ensemble = item + context information). In their research, Murnane and colleagues (1999) demonstrated that memory for target stimuli (words) was better when context was reinstated, relative to when it was different from study to test, but only when the context was meaningful information (pictures of scenes), whereas no context reinstatement benefit was seen when context was not meaningful (foreground and background colour). They concluded that the meaningful context became integrated with the target information during encoding to form an ensemble, which later improved recognition performance when context was reinstated. However, Nairne (2002) and Goh and Lu (2012) have suggested that the degree of match alone is not always the key factor determining what is ultimately remembered. According to these authors, another potential factor may include the diagnostic value of retrieval cues, which can be defined as the degree to which retrieval cues provide diagnostic information about the target. For this reason, it is important to consider an alternate theory that is not concerned with ‘match’ or ‘ensembles’ per se, such as the outshining hypothesis (Smith, 1988, 1994; Smith & Vela, 2001).

The *outshining hypothesis* (Smith, 1988; 1994; Smith & Vela, 2001) suggests that the target and the context act as cues for one another: When the strength of the target item is weak relative to the strength of the context cue, a benefit of reinstating context will be observed. This theory predicts that both CR and CS will be apparent for unfamiliar target stimuli. However, when familiarity of the target becomes stronger, the outshining hypothesis suggests that context

effects will be attenuated, in terms of both CR and CS. That is, highly familiar relative to unfamiliar target stimuli may provide such strong memorability cues on their own, that the memory trace for these items “outshines” any influence that the context might have on memory for the target. As such, context effects are reduced or completely eliminated for highly familiar targets. Thus the global matching models predict similar results to the outshining hypothesis for unfamiliar targets, with the presence of both CR and CS effects. However, when familiarity of the target is considered, very different predictions arise. The role that familiarity plays in context effects will be further discussed in Chapter 3.

Tulving (1974) also described a theory of context memory that likewise viewed target and context as acting as cues for one another. Just as reinstating context improves memory performance, changing context from study to test can lead to forgetting. This phenomenon has been termed context-dependent forgetting (Tulving, 1974). Context-dependent forgetting was described as one of two parts of the *cue-dependent forgetting theory* outlined by Tulving (1974). According to the theory, the environmental setting or the physical surroundings in which information is encoded acts as a cue at test when the same environment is reinstated. For example, this theory would predict a boost in memory observed in recognition of a figure skater when memory for that skater is tested within the same skating arena in which she was originally encoded relative to if the test were to take place in a different environment, such as at a school. The second part of the theory was described as state-dependent forgetting in which the physical/psychological state a person is experiencing during encoding acts as a cue at test when that same state is reinstated. Tulving (1974) described cue-dependent forgetting as the phenomenon that information stored in long-term memory may not be accessible because there is no suitable retrieval cue from the environment to trigger the memory. This theory suggests that

the pertinent information is available but simply not accessible, and the correct cue (state or environmental context) can make that information once again available. Predictions made from the cue-dependent forgetting theory are similar to those made by the outshining hypothesis, as they both view the context as a cue for the target. These theories will be re-examined in later chapters, in light of current thesis results.

1.5 The Current Paradigm

The current thesis was aimed at examining memory for face stimuli within the context of varying real-life scenes presented visually on a computer, in pairs, at both encoding and test. Faces were the to-be-remembered stimuli of choice in the current paradigm because of a distinctive special property they maintain. Specifically, a face can be completely unfamiliar to an individual, yet still be recognizable as a human face and even more, be distinguishable from other faces. This special property makes faces the perfect target stimuli to use to avoid the issue of a pre-existing semantic network as is the case with word stimuli, as discussed earlier. Another reason that faces were used in the current line of research was inspired by the fact that the majority of us may have experienced our own memory failure in recognition of a face in our everyday lives. Consider the following common scenario: While out, someone we think is a stranger approaches us as if we should know him and to our dismay, and embarrassment, we are unable figure out who this person is. It is not until they provide us with some context of our initial encounter, or other details from past encounters, that we are able to correctly identify the individual. Mandler (1980) described this phenomenon using the example of a “butcher-on-the-bus”. He described a scenario in which you run into your butcher, who you’ve encountered multiple times in his shop, on a city bus, and experiencing difficulty figuring out exactly who the person is, even though you may have a sense of knowing him. Mandler believed that this

difficulty in recognizing the butcher was because the context in which you usually encounter him (the butcher shop) was now different (the bus), and the change in context hindered memory.

The current thesis examined the role of context presented at both encoding and recognition on memory for face stimuli using a paradigm similar to that used by Gruppuso and colleagues (2007). The basic procedure that was used in each experiment involved showing participants pictures of faces paired with images of unique context scenes (such as photographs of buildings, travel scenery, sports, or animals) and we encouraged associative linking of the face and context by asking participants to rate the likelihood that the person in the picture is associated with the context (unless this step was manipulated for empirical purposes as will be discussed in Chapter 2). The study task was an incidental learning phase and at test studied faces were paired with either a) the *same* context as at encoding, b) a *switched* context (a context that was presented at study, but not presented with that particular face), or c) a brand *new* context (a context never before seen). New faces were presented as lures at test and paired with d) old or e) new context scenes. As previously mentioned, this testing procedure allowed for the examination of both CR and CS, and permitted for a comprehensive understanding of the types of memory processes involved when context is affecting memory. Moreover, the current paradigm provided a stable base procedure, which was manipulated in specific ways to get at particular questions regarding contexts effects on memory to further understand the factors important in these effects.

In Experiment 1, the importance of active associative linking of target (face) and context (environmental scene) was examined by manipulating instructions to link the face and context at encoding (instructions to actively link and make an associative rating or instructions to passively view images). The purposes of this first experiment were first to establish the existence of both CR and CS effects, and second, to examine whether encoding instructions to either actively link,

or passively view, face-context pairs during encoding influenced the presence or magnitude of the CR or CS effects. Experiment 2 was aimed at investigating the role that attention plays in CR and CS. This experiment was geared toward examining how the general boost to memory, from reinstating an old relative to a totally new context at test compared to linking specific contexts to targets may be differentially affected when attention was limited during encoding. The purpose of Experiments 3 and 4 was to examine the role that familiarity of the target (face) plays in context effects (CR and CS). Some theories such as the outshining hypothesis predict context to affect memory for the face differently depending on whether the face is familiar (a reduced effect of context) or unfamiliar (a robust effect of context) to the observer, while other theories such as the global matching model predicts no differential effect of context on familiar compared to unfamiliar faces. Face familiarity was manipulated by presenting famous versus non-famous faces during encoding in Experiment 3, and in Experiment 4 the degree of familiarity was controlled by pre-exposing the study faces 0, 1, 3, or 10 times without an accompanying context before encoding.

The aim of Experiment 5 was to examine the role that distinctiveness of the target (face) has on CR and CS. Experiment 5 examined whether distinctive faces were less susceptible to context effects relative to similarly familiar, but less distinctive faces. It was predicted that we should see the presence of both CR and CS for out-group faces (Caucasian faces for Asian participants and Asian faces for Caucasian participants), as these are akin to unfamiliar faces, but we should see a reduction in both CR and CS for in-group faces (Caucasian faces for Caucasian participants and Asian faces for Asian participants), as these are akin to familiar faces. In the final experiment, the relative expectancies of face-scene pairings were manipulated in Experiment 6. From everyday experience, we know that even though a face is familiar, we

sometimes still experience difficulty in recognizing that face when there is a change in context. This final experiment examined how the expectancy of a face + context pairing influenced CR and CS effects, even when the target face was familiar.

1.6 Summary

Many studies to date have investigated context reinstatement effects on memory for words (Godden & Baddeley, 1975; Smith, 1979; Smith, 1985; Smith, et al., 1990), however, few studies have examined this effect on memory for faces, and even fewer have examined the role of context specificity on memory for any type of target stimuli. The purpose of my PhD research was to examine the effect that context has on memory, using faces as target stimuli and photographs of real-life images as context scenes. Specifically, my PhD research was concerned with empirically examining factors that seem to influence contexts effects on memory for target items in everyday life – including purposeful associative linking of face + context information, attention, familiarity with the face, distinctiveness of the face, and expectancy of the face + context pairs – to better understand why memory can sometimes fail us when the context is different from study to test, and to determine which factors are important in contributing to this phenomenon. This research will allow for a better understanding of why you may have been unable to recognize that acquaintance when encountering him in a different context from where the initial encounter took place. In sum, the goal of this thesis was to answer the question of how surrounding context information influences memory for target items, and what factors play a role in this effect.

Chapter 2

The Role of Associative Linking and Attention in Context Effects on Memory

2.1 Introduction

2.1.1 Influence of Encoding Instructions and Attention

The purpose of Experiment 1 was first to establish the existence of both CR and CS effects, and second, to examine whether encoding instructions either to actively link or to passively view face-context pairs during encoding influenced the presence or magnitude of the CR or CS effects. Additionally, the degree to which recruitment of sufficient attention during encoding is required for the CR and CS effects was investigated in Experiment 2.

2.1.2 The Role of Associative Linking During Encoding in CR and CS Effects

In Experiment 1, the importance of active associative linking of target (face) and context (environmental scene) was examined. Studies to date have exclusively considered how either active association (Craik & Schloerscheidt, 2011; Gruppuso et al., 2007; Vakil et al., 2007, 2010) or passive encoding instructions (Hayes, Baena, Truong, & Cabeza, 2009) influence context effects. No studies to date have included both instruction types at encoding, allowing for a direct comparison of the role of this factor. The current study included *both* a condition in which participants were instructed to actively form a link between the face and context and one in which they were instructed to passively view the paired images during encoding. The passive instruction condition is more akin to how we encounter faces every day, as the majority of humans do not walk around explicitly forming associations between items, especially between faces and the environment in which it is encountered. We asked whether humans form these

associations anyhow, even if not consciously trying to do so, and whether this encoding manipulation influences CR and CS differently.

Some suggest that linking context to targets is self-initiated and explicit instructions to do so are not necessary (Bastin & Van der Linden, 2006; Bower & Karlin, 1974; Castel, 2005; Craik, 1982; Craik & Byrd, 1982; Naveh-Benjamin, 2000; Naveh-Benjamin & Craik, 1995; Naveh-Benjamin et al., 2004; Rhodes et al., 2008; Winograd & Rivers-Bulkeley, 1977; Underwood, 1969; Watkins, Ho, & Tulving, 1976). Some evidence of self-initiated linking of face to context comes from a recent fMRI study (Hayes, 2009). Participants in that study were instructed to focus only on a face during both encoding and retrieval, and were given no explicit instructions to associate the face to the visual context with which it was presented. In their work, faces were either presented alone during both encoding and retrieval (context reinstatement), or presented overlaid on scenes during encoding but alone during retrieval (context change). Worse memory performance was found for faces that were originally paired with a context during study and later presented without a context, relative to faces presented without a context at both study and test (context reinstated). Functional magnetic resonance imaging (fMRI) data collected during the memory test phase revealed greater activation in bilateral hippocampal regions for correctly recognized faces when context was reinstated at test relative to when it was not. The authors suggest that even without active linking instructions during encoding, target information may still be associated or bound to non-target information, as was apparent by participants' enhanced performance in conditions in which context was reinstated. Hayes and colleagues argued that we do not normally try to remember associations between faces and contexts in everyday life, but even so, these associations are established spontaneously. Experiment 1 was designed to determine conclusively whether spontaneous linking of target and context

information indeed occurs by manipulating encoding instructions in a between-subject experiment with encoding instruction as a factor.

2.1.3 Role of Attention in CR and CS Effects

In addition to manipulating active versus passive instructions during encoding, another approach, used in Experiment 2, in determining the resources required during encoding to facilitate context enhancements, is the divided attention technique. Research to date suggests that it is unclear to what degree recruitment of sufficient attention, during encoding or retrieval, is required for the CR effect. Kinoshita (1999) examined performance on a word stem completion task when attention was divided during test. Results indicated that reinstating context boosted memory for target words in the full attention condition, but this CR effect was lost when attention was divided at retrieval. Other research has suggested that CR is robust and is not affected by manipulations of attention at study and test (Vakil et al., 2010). Vakil and colleagues (2010) divided attention at both study and test, delaying the retrieval test for one week (in Experiment 1), and by testing seniors with varying medial temporal lobe (MTL) capabilities (in Experiment 2). Stimuli included images of faces (targets) topped with unique hats (context). The authors suggested that dividing attention, and delaying test, simulated impairments in MTL functioning; they predicted that MTL impairment would result in the maintenance of CR but a loss of what we call CS. Results showed no effect of divided attention on CR or CS, however, in the delayed test condition CR was maintained while the CS effect was attenuated.

It is evident that the role of attention in mediating context effects on memory remains uncertain, thus, in addition to examining CR and CS effects using non-verbal stimuli, and manipulating encoding instructions, the aim of Experiment 2 was to provide some clarity regarding the role of attention in the CR and CS effects.

2.1.4 Response Times

A key addition to the literature of the current work was to examine response times for correct responses to old faces at test, in the different trial types, including same, switched, and new context at test trial types. To our knowledge, response times have not been examined in the literature investigating context effects to date, which is curious as they can provide us greater insight into the mechanism underlying any effects of context on memory. This will allow for a clearer understanding of which theories better explain the mechanisms that lie behind the context effects in question.

Specifically, the global activation approach (Murnane & Phelps, 1993, 1994, 1995) suggests that memory representations contain both context and item information and that memory is activated to a degree determined by the match between the information in the cue and in memory. Then the summed activation from all activated memory representations is used as the basis for recognition. This theory predicts no CS effect (Murnane & Phelps, 1994) and also predicts no differences in response times across same, switched, and new conditions. The outshining hypothesis (Smith, 1988, 1994; Smith & Vela, 2001), however, predicts a CS effect as well as similarly fast RTs for correct responses to same and new contexts because the presence or absence of these contexts at study is similarly unambiguous at test. This hypothesis also predicts slowest response times for switched contexts, as these contexts act as cues for the study set in general, but not as a direct cue for a specific face, leading to longer processing times.

2.2 Experiment 1

In the present study, memory for faces was examined in conditions similar to those in Gruppuso et al. (2007). Faces were presented during encoding, paired with a variety of context scenes, and a recognition memory test ensued in which studied faces were paired with *same*,

switched, or *new* context scenes, and new faces were paired with old or new context scenes. Including both *same* and *switched* context conditions allowed for the examination of both CR and CS effects. Additionally, half of the participants were given instructions at study that would encourage associative linking of the face and context (direct replication of Gruppuso et al., 2007), while the other half of the participants were given instructions to passively view the images. Bastin and Van der Linden (2005) examined memory for temporal context (source memory) and found that there was no benefit of intentional over incidental encoding. We predict similar results, with no difference in context effects between groups who received active associative relative to passive instructions at encoding. Nevertheless, because encoding instruction was not directly manipulated in Bastin and Van der Linden's work, (but instead whether encoding was intentional or incidental was manipulated), Experiment 1 sought to clarify whether encoding instructions might influence CR and CS.

Moreover, Macken (2002) suggested that it is important to consider both recollective and familiarity aspects of recognition memory (Tulving, 1985) when examining context effects, as these effects may be present only when memory requires explicitly remembering the context in which the target was initially presented. Indeed, the use of response types, that indirectly reflect recollection and familiarity, has been examined in the past using the RKN procedure described by Tulving (1985) (Gruppuso et al., 2007; Skinner & Fernandes, 2009; Skinner, Grady & Fernandes, 2010). In this procedure, participants are instructed to report whether their memory for items on a recognition task is accompanied by recollection of the details in which the target item was initially encoded by giving a "remember" (R) response, or whether they believe an item was on the original study list, but they cannot recollect any details of that prior occurrence by giving a "know" (K) response. They respond "new" (N) when they believe the probe item is a

distractor. In the current study, we used a variation of this RKN procedure to examine whether CR and CS effects were driven primarily by remember responses, as suggested by Gruppusso and colleagues (2007).

We sought to compare CR and CS effects when participants were either told to explicitly link face and context information at study, as is traditionally done (e.g., Craik & Schloerscheidt, 2011; Grupusso et al, 2007; Vakil et al., 2007) or were given passive viewing instructions, without explicit instructions to form an association between the two. The passive instruction condition is more akin to how we encounter faces every day, as the majority of humans do not walk around explicitly forming associations between items, especially between a face and the environment in which it is encountered. We asked whether humans form these associations anyhow, even if not consciously trying to do so, and whether this encoding manipulation influences CR and CS differently.

2.2.1 Method

2.2.1.1 Participants

Sixty undergraduate students completed the study (38 females, M age = 19.78, SD = 1.80, Range = 17-27 years). Participants were recruited through the University of Waterloo SONA system, an online database of Psychology students willing to participate in research for course credit. All students were enrolled in undergraduate Psychology classes and received course credit or token monetary remuneration for their participation.

2.2.1.2 Materials

Stimuli consisted of 96 photos of faces with happy expressions (half male/half female) and 96 photos of context scenes (half indoor/half outdoor) presented in colour. Faces were chosen from the Center for Vital Longevity Face Database (Minear & Park, 2004). Faces

included those of young to middle-aged adults of an assortment of ethnicities, with the photograph including the head and shoulders only; they were free of any facial accessories such as hats, glasses, or sunglasses, and were presented on a neutral white background. Context scenes were obtained through an Internet search of various websites that provided public access to their images. Scenes were selected to include images of outdoor scenery (e.g., beach, park, baseball field) and indoor scenery (e.g., living room, restaurant, basketball court). Context scenes may or may not have included people, however, faces in any scene were not discernable (see Figure 1 for sample stimuli).



Figure 1. Experiment 1: Sample stimuli – photo of face on left and photo of outdoor scene on right

2.2.1.3 Procedure

The group of 96 faces and 96 context photos were randomly paired and then split in half to create two lists (A and B), each consisting of 48 faces (half male/half female) and 48 context scenes (half indoor/half outdoor). During the study phase, 48 faces plus 48 context scenes were paired together (List A). At test, all 48 faces and all 48 contexts from encoding were re-presented, along with 48 new faces and 48 new contexts (from List B). Five recognition test trial types were created, as in Gruppuso et al. (2007). Trial types were 1) old face + same context, 2) old face + switched context, 3) old face + new context, 4) new face + old context, and 5) new face + new context. In total, there were 48 old and 48 new faces, with 24 old faces paired with 24

old contexts, 24 old faces paired with 24 new contexts, 24 new faces paired with 24 old contexts and 24 new faces paired with 24 new contexts. Presentation of List A stimuli at study and List B stimuli at test was counterbalanced across participants.

Testing was conducted individually in approximately 30 minutes. During the experimental task, participants were first presented with 48 pairs of face + context images from one of the two lists (counterbalanced across participants) in an incidental encoding phase. Each face + context pair was presented for 2250 msec followed by the presentation of a fixation cross in the centre of the screen for 500 msec. Participants were asked to focus their attention on the fixation cross in between trials to ensure central fixation when the next face + context pair appeared, and to discourage biased looking toward either the face or the context. For each participant, the order of presentation of face-scene images was random. Half the participants were assigned to the active association instruction condition ($N = 30$) while the other half were assigned to the passive instruction condition ($N = 30$).

In the association condition, a screen appeared after each image pair depicting a Likert-type scale that remained on the screen until the participant made a response. Participants were instructed to make a response on a scale of 1-6, rating the likelihood that the person in the photo was associated with the scene (1 = very unlikely, 6 = very likely). Participants were asked to make a rating response using the numbers on the top row of a standard keyboard. In the passive instruction condition, participants were asked simply to view each set of images as they would a television screen and not to press any keys as the images would advance automatically.

At test, face + context pairs were presented for 5000 msec and participants were asked to make a recognition decision about their memory for each face. Participants were told that they would view similar images as at study, with faces presented on the left and scenes presented on

the right, and that some of the faces would be new, while others would be old. They were asked to decide whether they previously saw the *face* or not. Participants were instructed to press the key labeled “R”, representing a “remember” response, if they felt that they previously viewed the face *and* remembered the context with which it was originally paired, regardless of whether the scene at test was the same to that presented at study, to press the key labeled “K”, representing a “know” response, if they felt that they previously viewed the face but did not remember its context pairing from study, or to press the key labeled “N”, representing a “new” response, if they felt that they did not previously see the face at study. They were asked to respond as quickly and accurately as possible with their dominant writing hand.

2.2.2 Results

2.2.2.1 Memory

Response bias can alter participants’ performance on a recognition test, which is independent of their true ability to recognize whether an item is old or new. One of the most accepted ways for taking this problem into account in recognition tests is to apply ideas from signal detection theory (Green & Swets, 1966). To measure memory performance for the recognition of faces, several d' measures were calculated, a measure of discrimination, using hit rate for overall correct responses and overall false alarms (regardless of whether these were given to R or K responses), for R responses and R false alarm rates, for R responses and overall false alarm rates, for K responses and K false alarm rates, for K responses and overall

¹ Estimating familiarity based solely on Know responses makes the assumption that Remember and Know responding are mutually exclusive processes, which is an assumption considered valid by some (Gardiner, Java, & Richardson-Klavehn, 1996). Others, however, argue that recollection and familiarity are independent processes (Yonelinas & Jacoby, 1995). According to this model, the proportion of Know responses underestimates the value of familiarity, since some items are both recollected and known. Estimates of independence remember-know (IRK) familiarity are thus developed by dividing the proportion of Know responses by the opportunities available to make a Know response (i.e., $1 - \text{proportion of Remember responses}$; see Yonelinas & Jacoby, 1995, for further details).

false alarm rates, for IRK familiarity¹ and K false alarm rates, and IRK familiarity and overall false alarm rates.

d' for overall responses was calculated using hit rate for R + K responses and overall false alarms. d' scores for R responses and K responses were also calculated separately, as well as d' for IRK familiarity. Because it is unclear what drove participants to make false R versus false K classifications, we decided to calculate these d' scores using overall false alarm rates (but see Footnotes 2 and 3 for R and K d' scores calculated using false alarms rates conditionalized on R or K response type, respectively).

The influence of context on these d' measures were evaluated using four separate 3 (Context Type) X 2 (Encoding Instruction) repeated measures mixed ANOVAs, with Context Type as a within-subject variable (same, switched, new) and Encoding Instruction as a between-subject variable (active, passive). Mean d' scores along with mean hit rates for each measure of memory are shown in Table 1. Mean false alarm rates are shown in Table 2.

Table 1. Experiment 1 d' Scores, Hit Rates, and Median Response Times (in milliseconds), with Standard Deviations in Parentheses, for Overall, R, K, and IRK Familiarity, for Each Trial Type at Test, Following Active and Passive Encoding Instructions

Memory Measure and Context at Test	Active Encoding Instruction			Passive Encoding Instruction		
	d'	Hit Rate	RT	d'	Hit Rate	RT
Overall						
Same	1.94 (0.83)	.79 (.14)		1.71 (0.74)	.74 (.17)	
Switched	1.64 (0.90)	.70 (.17)		1.54 (0.67)	.69 (.19)	
New	1.27 (0.87)	.58 (.14)		1.26 (0.61)	.60 (.10)	
R responses						
Same	1.23 (0.97)	.57 (.20)	1760 (568)	.89 (0.97)	.47 (.26)	1444 (591)
Switched	.37 (0.95)	.28 (.19)	1911 (834)	.28 (0.74)	.28 (.21)	1689 (1047)
New	-.14 (1.08)	.16 (.16)	1431 (1130)	-.15 (0.91)	.18 (.18)	1428 (1063)
K responses						
Same	.21 (0.98)	.22 (.17)	1845 (953)	.26 (0.84)	.26 (.22)	1760 (919)
Switched	.83 (0.92)	.42 (.15)	1823 (610)	.71 (0.84)	.42 (.22)	1800 (754)
New	.81 (.98)	.42 (.18)	1810 (710)	.71 (0.87)	.42 (.20)	1698 (859)
IRK Familiarity						
Same	1.03 (1.12)	.49 (.25)		1.03 (1.01)	.51 (.29)	
Switched	1.33 (.93)	.59 (.19)		1.13 (.87)	.55 (.26)	
New	1.00 (1.01)	.48 (.19)		.89 (.84)	.48 (.20)	

Note: All d' scores calculated with overall FAs; Overall = R + K responses, R = Remember responses, K = Know responses, IRK Familiarity = $K / (1 - R)$

Table 2. Experiment 1 False Alarm Rates, with Standard Deviations in Parentheses, for Each Trial Type for Each Condition

	Active Encoding Instruction	Passive Encoding Instruction
Overall (R+K & Old+New Contexts)	.20 (.22)	.19 (.12)
R+K Old Contexts	.27 (.29)	.23 (.17)
R+K New Contexts	.14 (.19)	.14 (.13)
 R Old + New Contexts	 .04 (.07)	 .05 (.06)
R Old Contexts	.07 (.12)	.07 (.08)
R New Contexts	.02 (.04)	.03 (.06)
 K Old + New Contexts	 .16 (.20)	 .14 (.10)
K Old Contexts	.20 (.24)	.16 (.13)
K New Contexts	.12 (.19)	.12 (.11)

2.2.2.1.1 Overall Responses

We found a significant main effect of Context Type, $F(2, 116) = 28.96$, $MSE = .16$, $p < .001$, with simple contrasts indicating that participants made significantly more correct responses when an old face was re-presented with the same context compared to with a new context at test $F(1, 58) = 61.28$, $MSE = .31$, $p < .001$, a clear demonstration of the CR effect. Importantly, we also saw a CS effect, in which participants made significantly more correct responses to old faces paired with same contexts relative to switched contexts, $F(1, 58) = 11.00$, $MSE = .31$, $p < .005$. Results also revealed a non-significant Context Type X Encoding Instruction interaction, $F(2, 116) = .98$, $p > .05$, as well as a non-significant main effect of Encoding Instruction, $F(1, 58) = .39$, $MSE = 1.40$, $p > .05$, suggesting that participants likely formed an associative link between the face and context during encoding regardless of whether they were instructed to do so. See Figure 2 for a graphical depiction of the pattern of results.

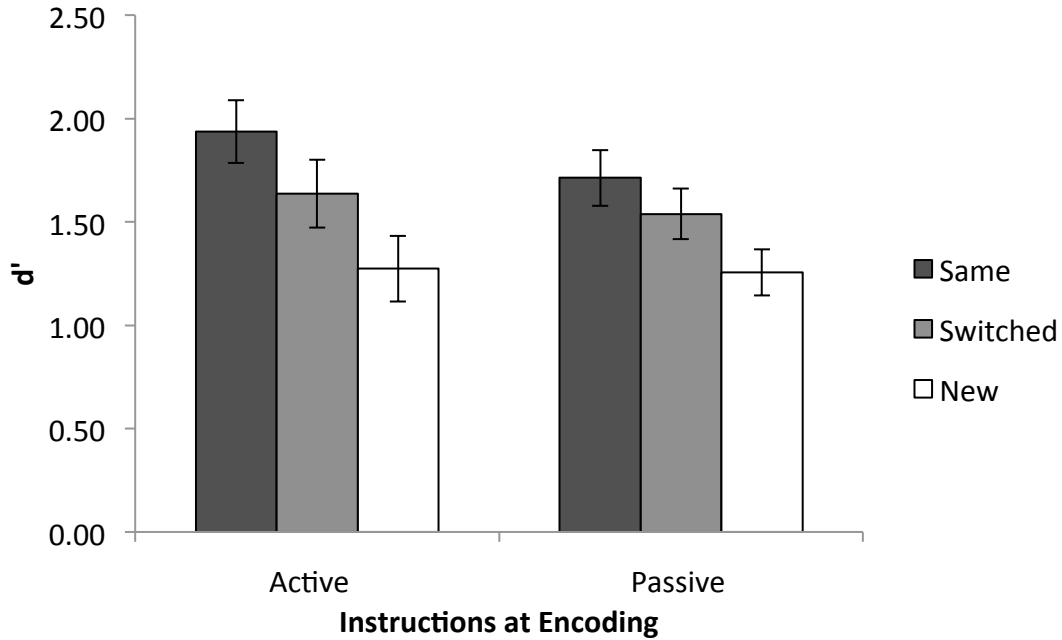


Figure 2. Experiment 1: Recognition memory for faces as measured by d' scores for instructions at encoding by context type at test

2.2.2.1.2 R Responses

Replicating results from overall d' scores, a significant main effect of Context Type was demonstrated, $F(2, 116) = 75.64$, $MSE = .29$, $p < .001$, with simple contrasts revealing that participants made significantly more correct remember responses when an old face was re-presented with the same context compared to when an old face was paired with a new context at test, $F(1, 58) = 107.03$, $MSE = .81$, $p < .001$ (the CR effect). Also similar to the overall results, we found a strong CS effect, in which participants made significantly more correct remember responses to old faces paired with same contexts relative to switched contexts at test, $F(1, 58) = 63.82$, $MSE = .50$, $p < .001$. Results again showed a non-significant Context Type X Encoding Instruction interaction, $F(2, 116) = 1.64$, $p > .05$, as well as a non-significant main effect of Encoding Instruction, $F(1, 58) = .45$, $MSE = 2.08$, $p > .05$. Analysis of d' for R responses

calculated using FAs for R responses revealed that all effects and interactions followed a similar pattern as reported for overall responses.²

2.2.2.1.3 K Responses

In terms of Know responses, analyses revealed a significant main effect of Context Type, $F(2, 116) = 21.30$, $MSE = .27$, $p < .001$, with lowest K d' scores for old faces paired with the same context as at encoding. Specifically, participants made significantly fewer correct Know responses when an old face was presented with a same context relative to a new context, $F(1, 58) = 23.98$, $MSE = .70$, $p < .001$ (reversed CR effect), and fewer correct Know responses when an old face was presented with a same relative to switched context, $F(1, 58) = 33.00$, $MSE = .52$, $p < .001$ (CS effect also reversed here). The Context Type X Encoding Instruction interaction, $F(2, 116) = .42$, $p > .05$, as well as the main effect of Encoding Instruction, $F(1, 58) = .07$, $MSE = 1.93$, $p > .05$, were non-significant. Analysis of d' for K responses calculated using FAs for K responses revealed that all effects and interactions followed a similar pattern as reported for K responses calculated using overall FA rates.³

2.2.2.1.4 IRK Familiarity

Analyses for IRK familiarity d' data (calculated using overall FA rates) revealed a marginally significant main effect of Context Type, $F(2, 116) = 3.00$, $MSE = 1.27$, $p > .05$, with simple contrasts revealing non-significant differences between memory for faces paired with a

² Replicating results from overall d' scores, a significant main effect of Context Type was demonstrated, $F(2, 116) = 75.64$, $MSE = .29$, $p < .001$, with simple contrasts revealing that participants made significantly more correct Remember responses when an old face was re-presented with the same context compared to when an old face was paired with a new context at test, $F(1, 58) = 107.03$, $MSE = .81$, $p < .001$ (the CR effect). Also similar to the overall results, we found a strong CS effect, in which participants made significantly more correct Remember responses to old faces paired with same contexts relative to switched contexts, $F(1, 58) = 63.82$, $MSE = .50$, $p < .001$. Results again showed a non-significant Context Type X Encoding Instruction interaction, $F(2, 116) = 1.64$, $p > .05$, as well as a non-significant main effect of Encoding Instruction, $F(1, 58) = 1.10$, $MSE = .49$, $p = .05$.

same context relative to a new context at test, $F(1, 58) = .41$, $MSE = .92$, $p > .05$, and a non-significant effect of memory for old faces paired with a same relative to switched context at test, $F(1, 58) = 2.50$, $MSE = .99$, $p > .05$. The Context Type X Encoding Instruction interaction, $F(2, 116) = .36$, $p > .05$, as well as the main effect of Encoding Instruction, $F(1, 58) = .26$, $MSE = .65$, $p > .05$, were non-significant as well.

2.2.2.2 Response Times

Median response times (RTs) were measured for each participant in each condition, for R and K responses separately (see Table 1 for means).

2.2.2.2.1 R Responses

There was a main effect of Context Type, $F(2, 116) = 3.82$, $MSE = 540199.91$, $p < .05$, such that participants were slower to correctly identify, with an R response, old faces paired with switched relative to new contexts at test, $F(1, 58) = 5.88$, $MSE = 1400289.86$, $p < .05$, and marginally slower to correctly identify old faces that were paired with switched relative to same contexts at test, $F(1, 58) = 2.81$, $MSE = 838301.62$, $p = .099$. There was a non-significant main effect of Encoding Instruction, $F(1, 58) = 1.08$, $MSE = 1354134.67$, $p > .05$, as well as a non-significant Context Type X Encoding Instruction interaction, $F(2, 116) = .72$, $p > .05$. Results indicated that it took longer to make a correct R response to old faces paired with a switched context relative to same and new contexts.

³ In terms of Know responses, analyses revealed a significant main effect of Context Type, $F(2, 116) = 21.30$, $MSE = .27$, $p < .001$, with lowest K d' scores for old faces paired with the same context as at encoding. Specifically, participants made significantly fewer correct Know responses when an old face was presented with a same context relative to a new context, $F(1, 58) = 23.98$, $MSE = .70$, $p < .001$ (reversed CR effect), and fewer correct Know responses when an old face was presented with a same relative to switched context, $F(1, 58) = 33.00$, $MSE = .52$, $p < .001$ (CS effect also reversed here). The Context Type X Encoding Instruction interaction, $F(2, 116) = .42$, $p > .05$, as well as the main effect of Encoding Instruction, $F(1, 58) = .003$, $MSE = .50$, $p > .05$, were non-significant.

2.2.2.2.2 K Responses

There was a non-significant main effect of Context Type, $F(2, 116) = .16$, $MSE = 349723.431$, $p > .05$, and Encoding Instruction, $F(1, 58) = .19$, $MSE = 1267640.41$, $p > .05$, as well as a non-significant Context Type X Encoding Instruction interaction, $F(1, 116) = .09$, $p > .05$, indicating that participants did not take more time to respond with a correct K response across the same, switched, and new context conditions at test.

2.2.3 Discussion

In Experiment 1, we saw a clear demonstration of both CR and CS effects, regardless of encoding instructions. Results directly replicated those of Gruppuso et al. (2007), with greater memory for faces paired with same contexts relative to new contexts at test, an observable demonstration of the CR effect. In addition, memory was greater for faces paired with same relative to switched contexts at test, evidence for the existence of the CS effect. Results also revealed no significant difference in memory performance, when looking at both d' scores and RT, across the two encoding instruction conditions. This pattern of results indicated that CR and CS effects were evident only in R, and not K, responses, in line with the claim by Gruppuso et al. (2007) that such effects are driven by recollection.

2.2.3.1 Theoretical Implications of Experiment 1

The global activation approach (Murnane & Phelps, 1993; 1994, 1995) suggests that memory representations contain both context and item information and that memory is activated to a degree determined by the match between the information in the cue and in memory; the summed activation from all activated memory representations is used as the basis for recognition. This theory predicts no CS effect (Murnane & Phelps, 1994) and also predicts no differences in response times across same, switched, and new conditions. The outshining

hypothesis (Smith, 1988; 1994; Smith & Vela, 2001), on the other hand, predicts a CS effect, as well as comparably fast RTs for correct responses to same and new contexts because the presence or absence of these contexts during study is similarly unambiguous at test. This hypothesis also predicts slowest response times for switched contexts, as these contexts act as cues for the study set in general, but not as a direct cue for a specific face, leading to longer processing times. The results of Experiment 1 are in line with the outshining hypothesis.

From Experiment 1 we can conclude that context significantly boosts memory for faces when an old context is reinstated at test. Additionally, we see a boost when this context is the exact one as was originally presented with the face compared to any context from study. Moreover, no effect of encoding instruction suggested that CR and CS do not require explicit instructions during encoding to link target to context.

2.3 Experiment 2

The aim of Experiment 2 was to investigate whether attentional resources at encoding are necessary for the CR and CS effects to be present at test. Limited attentional resources may reduce one's ability to link context at encoding to the target. As previously outlined, Vakil and colleagues (2010) tested this hypothesis by dividing attention at both study and test, by delaying the retrieval test for one week (in Experiment 1), and by testing seniors with varying medial temporal lobe (MTL) capabilities (in Experiment 2). The authors suggested that dividing attention, and delaying test, simulated impairments in MTL functioning; they predicted that MTL impairment would result in the maintenance of CR but a loss of CS. Results showed no effect of divided attention on CR or CS. However, in the delayed test condition, CR was maintained while the CS effect was attenuated. Vakil et al. (2010) went on to suggest that the lack of a significant interaction of attention and context type may have been because the divided attention task was

not sufficiently demanding, as well as the fact that the hats used as context in the experiment were very unique and distinguishable, making their recognition task too easy, even under divided attention conditions.

In Experiment 2, we developed a stimulus set that was arguably more difficult to recognize – faces as targets and photographs of scenes as context. It is also important to note that performance in the divided attention group in Vakil et al.'s (2010) study was as accurate as performance in the full attention group, suggesting that the divided attention task may not have been difficult enough, and attention may not have truly been divided. In typical divided attention tasks, a main effect of attention on secondary task performance should be present such that performance is poorer in the divided relative to the full attention condition. In Experiment 2, we used a secondary task that has been shown to reliably decrease available attentional resources (Craig, 1982), to examine how divided attention affects CR and CS effects.

In this second experiment, we sought to replicate the results of Experiment 1, and to compare the results of a full attention condition to a condition in which attention was divided at encoding. Divided attention was achieved by presenting participants with face-scene images, while simultaneously doing a digit monitoring task in which they were asked to monitor a list of digits being read aloud and to say “yes” out loud when 3 odd digits were sequentially presented. A secondary task within the auditory domain was chosen to avoid structural interference with presentation of items for the memory task, which were visually presented. Since Experiment 1 indicated no significant difference between the active and passive instruction conditions, all participants were instructed to actively make a judgment about the face-context pairings. Additionally, active associative linking instructions is what the majority of others researchers in

the field have used, which allowed us to make more direct comparisons of this experiment to past work.

If division of attention disrupts MTL as suggested by Vakil and colleagues (2010), and such processing is indeed important for the CS, but not the CR effect, then we should see an attenuated CS but maintained CR effect in healthy young adults who experience divided attention during study, whereas we should see a replication of our Experiment 1 results in healthy young adults in the full attention condition. We hypothesized that if full attentional resources are not present at encoding, a robust association will not be made between the face and context, resulting in a reduced CS effect. Gardiner and Parkin (1990) divided attention at study and found that it affected R but not K at test. Therefore, as in Experiment 1, we predicted this effect to be driven by a reduction in R responses, when the context at test was a switched relative to same one.

2.3.1 Method

2.3.1.1 Participants

Sixty-one undergraduate students completed the study, with the removal of one participant who did not perform the distracting task at all (0% accuracy), thus total participant count was $N = 60$ (46 females, M age = 20.40, $SD = 2.12$, Range = 17-30 years). Participants were recruited through the University of Waterloo's SONA system. All students were enrolled in undergraduate Psychology classes and received course credit or token monetary remuneration for their participation.

2.3.1.2 Materials

Stimuli. Stimuli in the face memory task were identical to those used in Experiment 1. In the divided attention condition of this experiment, a variation of Craik's (1982) digit monitoring task was implemented in which a series of digits were heard aloud, played from a tape recorder.

2.3.1.3 Procedure

The procedure was identical to that of Experiment 1 in the Full Attention condition. In the Divided Attention condition, the procedure was identical to that in Experiment 1 except for the addition of a secondary task administered to participants during the study phase. Participants first practiced the secondary task on its own, in which they were told to listen to a series of digits spoken aloud played from a tape recorder and to respond "yes" out loud when they heard three successive odd digits (e.g., 3, 9, 17, or 5, 21, 1); the experimenter recorded accuracy. The digits were spoken at a rate of 1 digit every 1.5 seconds. In the practice phase, 20 digits were read aloud with one target run of three consecutive odd digits. In the experimental phase, the digits task was administered as long as the encoding phase lasted, with a total of 152 possible digits heard, with 27 targets (of three consecutive odd digits). During the study phase, during stimulus presentation and while making rating judgments, participants also performed the digit-monitoring task. Participants were instructed to divide their attention equally between the two tasks.

2.3.2 Results

To ensure that participants were indeed dividing their attention between the two tasks, the digit monitoring data were analyzed and any participant who scored 0% on this task was removed from the data set. This resulted in the removal of 1 participant. After removal of this

participant, performance ranged from 39% - 100%, with a mean performance of 72% (SD = 17%).

2.3.2.1 Memory

Scores for the d' measures were computed for each participant for each condition in the same manner as described in Experiment 1 (but see Footnotes 4 and 5 for R and K d' scores calculated using false alarms rates conditionalized on R or K response type, respectively). The means of the resulting d' scores and hit rates are shown in Table 3, and FA rates are shown in Table 4. The influence of context on d' for overall responses, d' for R responses, d' for K responses, and d' for IRK familiarity were evaluated using four separate 3 (Context Type) X 2 (Attention) repeated measures mixed ANOVAs, with Context Type as a within-subject variable (same, switched, new) and Attention as a between-subject variable (full, divided).

Table 3. Experiment 2 d' Scores, Hit Rates, and Median Response Times (in milliseconds), with Standard Deviations in Parentheses, for Overall, R, K, and IRK Familiarity, for Each Trial Type at Test, under Full or Divided Attention Conditions During Encoding

	Full Attention			Divided Attention		
	d'	Hit Rate	RT	d'	Hit Rate	RT
Overall						
Same	1.89 (0.65)	.77 (.17)		0.63 (0.17)	.63 (.17)	
Switched	1.48 (0.76)	.65 (.20)		0.58 (0.18)	.58 (.18)	
New	1.29 (0.86)	.59 (.18)		0.45 (0.17)	.45 (.17)	
R responses						
Same	1.08 (0.63)	.50 (.20)	1654 (441)	0.38 (0.19)	.38 (.19)	1636 (662)
Switched	0.33 (0.74)	.26 (.18)	1691 (874)	0.21 (0.17)	.20 (.18)	1537 (1054)
New	0.02 (1.03)	.19 (.15)	1403 (881)	0.10 (0.10)	.09 (.11)	1588 (1405)
K responses						
Same	0.36 (0.84)	.27 (.16)	1943 (715)	0.26 (0.15)	.25 (.16)	1615 (763)
Switched	0.71 (0.82)	.38 (.18)	2239 (677)	0.38 (0.14)	.38 (.14)	1868 (663)
New	0.76 (0.83)	.40 (.21)	1921 (532)	0.36 (0.17)	.36 (.17)	1736 (606)
IRK Familiarity						
Same	1.18 (.87)	.54 (.26)		.45 (.75)	.39 (.22)	
Switched	1.13 (.86)	.53 (.22)		.75 (.71)	.48 (.17)	
New	1.00 (.85)	.48 (.21)		.49 (.63)	.39 (.17)	

Note: All d' scores calculated with overall FAs; Overall = R + K responses, R = Remember responses, K = Know responses, IRK Familiarity = $K / (1 - R)$

Table 4. Experiment 2 False Alarm Rates, with Standard Deviations in Parentheses, for Each Trial Type for Each Condition

	Full Attention	Divided Attention
Overall (R+K & Old+New Contexts)	.18 (.15)	.24 (.14)
R+K Old Contexts	.25 (.21)	.29 (.17)
R+K New Contexts	.12 (.14)	.19 (.14)
 R Old + New Contexts	 .03 (.04)	 .05 (.06)
R Old Contexts	.04 (.07)	.08 (.10)
R New Contexts	.01 (.04)	.03 (.05)
 K Old + New Contexts	 .15 (.12)	 .19 (.10)
K Old Contexts	.20 (.16)	.21 (.13)
K New Contexts	.11 (.12)	.17 (.11)

2.3.2.2 Overall Responses

As predicted, we found a significant main effect of Context Type, $F(2, 116) = 14.95$, $MSE = .15$, $p < .001$, such that participants were more accurate to respond to faces re-presented with the same relative to new contexts at test, $F(1, 58) = 25.84$, $MSE = .35$, $p < .001$ (CR effect), and were more accurate to respond to faces presented with same relative to switched contexts at test, $F(1, 58) = 12.18$, $MSE = .26$, $p = .001$ (CS effect). Supporting the assumption that attention was actually divided by the secondary task in our divided attention condition, we found a significant main effect of Attention, $F(1, 58) = 73.47$, $MSE = .62$, $p < .05$, with participants' accuracy in detecting old faces significantly reduced in the divided relative to the full attention condition.

These main effects were qualified by a significant Context Type X Attention interaction, $F(2, 116) = 4.87$, $p < .05$. Results in the full attention condition directly replicated results of Experiment 1, where we saw the established pattern of both the CR effect: memory was better

for faces paired with the same relative to new context at test, $t(29) = 3.97, p < .001$, and CS effect, in which memory was better for faces paired with the same relative to a switched context at test, $t(29) = 3.20, p < .005$. Importantly, in the divided attention condition, we observed a different pattern of results, whereby we still saw the CR effect, $t(29) = 5.90, p < .001$, but no longer saw the CS effect, $t(29) = 1.62, p > .05$. See Figure 3 for a graphical depiction of the pattern of results.

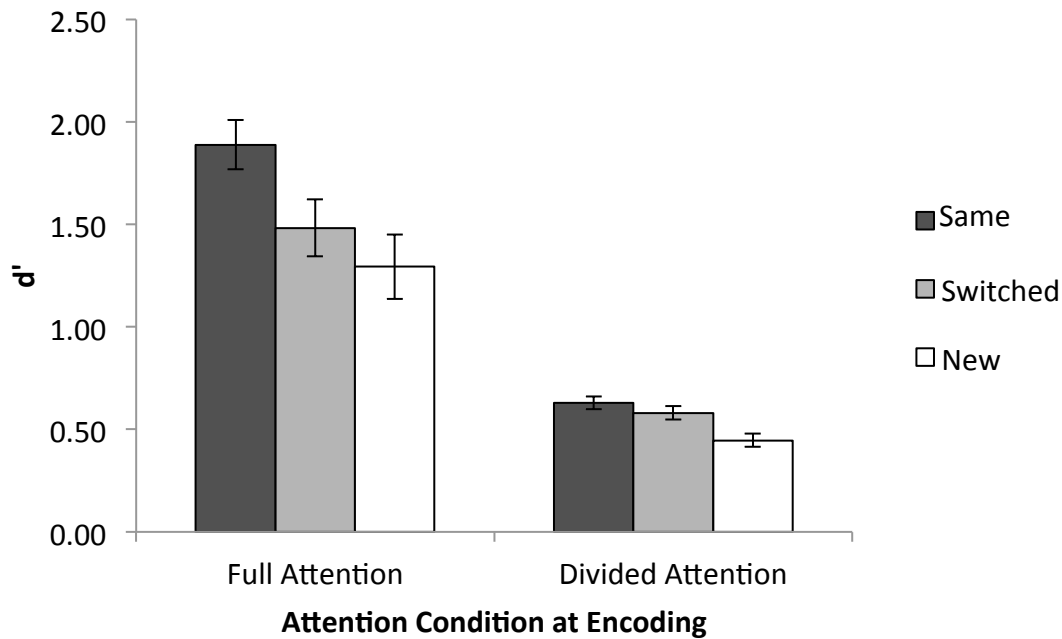


Figure 3. Experiment 2: Recognition memory for faces as measured by d' scores for attention at encoding by context type at test

2.3.2.3 R Responses

Replicating results from overall d' scores, we found a significant main effect of Context Type, $F(2, 116) = 44.86, MSE = .16, p < .001$, such that participants were more accurate to respond to faces re-presented with the same relative to new contexts at test, $F(1, 58) = 59.61$,

$MSE = .45, p < .001$ (CR effect), and were more accurate to respond to faces presented with same relative to switched contexts at test, $F(1, 29) = 55.57, MSE = .23, p < .001$ (CS effect). As well, we found a marginally significant main effect of Attention, $F(1, 58) = 3.73, MSE = .73, p = .06$, with participants' accuracy in detecting old faces significantly reduced in the divided relative to the full attention condition, overall. Once again, as predicted, these main effects were qualified by a significant Context Type X Attention interaction, $F(2, 116) = 15.72, p < .05$.

Results in the full attention condition replicated those of Experiment 1 – a CR effect, in which memory was better for faces paired with the same relative to new context at test, $t(29) = 6.27, p < .001$, and a CS effect, in which memory was better for faces paired with the same relative to a switched context at test, $t(29) = 6.32, p < .001$. In the divided attention condition, we saw a preserved CR effect, $t(29) = 7.30, p < .001$, along with a preserved, but attenuated CS effect, $t(29) = 4.89, p < .001$, accounting for the interaction. Analysis of d' scores for R responses calculated using FAs for R responses revealed that main effects followed a similar pattern as reported for R responses calculated using overall FA rates.⁴

2.3.2.4 K Responses

In terms of Know responses, analyses revealed a significant effect of Context Type, $F(2, 116) = 7.59, MSE = .16, p < .001$, and a significant effect of Attention, $F(1, 58) = 4.72, MSE = .75, p < .05$, but the Context Type X Attention interaction, $F(2, 116) = 2.37, p > .05$, was non-

⁴ Replicating results from overall d' scores, we found a significant main effect of Context Type, $F(2, 116) = 65.05, MSE = .26, p < .001$, such that participants were more accurate to respond to faces re-presented with the same relative to new contexts at test, $F(1, 58) = 96.06, MSE = .68, p < .001$ (CR effect), and were more accurate to respond to faces presented with same relative to switched contexts at test, $F(1, 58) = 68.41, MSE = .40, p < .001$ (CS effect). As well, we found a significant main effect of Attention, $F(1, 58) = 17.05, MSE = .24, p < .001$, with participants' accuracy in detecting old faces significantly reduced in the divided relative to the full attention condition. The Context Type X Attention interaction was not, however, significant, $F(2, 116) = .28, p > .05$, and so differences between context conditions within each attention condition were not further explored.

significant. Analysis of d' for K responses calculated using FAs for K responses revealed that all effects and interactions followed a similar pattern as reported for K responses calculated using overall FA rates.⁵

2.3.2.5 IRK Familiarity (d' calculated using overall FAs)

Analyses for IRK familiarity d' data revealed a significant main effect of Attention, $F(1, 58) = 11.79$, $MSE = 1.12$, $p < .005$, with greater accuracy in the full relative to the divided attention condition, as would be expected. However, the Context Type X Attention interaction, $F(2, 116) = 1.23$, $p > .05$, as well as the main effect of Context Type, $F(2, 116) = 1.63$, $MSE = .36$, $p > .05$, were non-significant.

2.3.3 Response Times

Median response times were measured for each participant in each condition, for R and K responses separately (see Table 3 for means).

2.3.3.1 R Responses

There was a non-significant Context Type X Attention interaction, $F(2, 116) = .61$, $p > .05$, as well as a non-significant main effect of Context Type, $F(2, 116) = .52$, $MSE = 726386.21$, $p > .05$ and Attention, $F(1, 58) = .001$, $MSE = 1176693.18$, $p > .05$.

2.3.3.2 K Responses

There was a main effect of Context Type, $F(2, 116) = 4.75$, $MSE = 271009.23$, $p < .05$, such that participants were slower to correctly respond with a K response to old faces paired with

⁵ In terms of Know responses, analyses revealed a significant effect of Context Type, $F(2, 116) = 11.47$, $MSE = .25$, $p < .001$, a marginally significant effect of Attention, $F(1, 58) = 3.18$, $MSE = .31$, $p = .08$, and a non-significant Context Type X Attention interaction, $F(2, 116) = .25$, $p > .05$.

switched relative to same contexts at test, $F(1, 58) = 7.18$, $MSE = 630062.82$, $p < .05$, and slower to correctly respond with a K response to old faces paired with switched relative to new contexts at test, $F(1, 58) = 5.95$, $MSE = 513349.67$, $p < .05$. As well, there was a significant main effect of Attention, $F(1, 58) = 5.02$, $MSE = 778936.46$, $p < .05$, such that participants were slower to correctly identify an old face with a K response in the Full Attention relative to the Divided Attention condition. The Context Type X Attention interaction was non-significant, however, $F(2, 116) = .53$, $p > .05$.

2.4 Discussion

There was a significant effect of CR in the full and divided attention conditions. There was also a significant effect of CS in the full attention condition but, importantly, the effect of CS was lost in the divided attention condition, when looking at the reduction in overall d prime scores, and attenuated when looking at R response d prime scores calculated using overall FA rates. Results appear to be driven by a loss in CS specifically for R memory classifications. These results suggest that a reduction in available attention during encoding impacts the CS but not the CR effect. The boost in memory we see for faces paired with the same context relative to a switched context at test likely requires a robust link between face and context. Dividing attention at encoding may disrupt this linking process, whether through a reduction in frontal-lobe mediated attention (Craik, Luo, & Sakuta, 2010) or MTL-mediated binding processes (Vakil et al. 2007, 2010), accounting for the reduction in the CS effect. Notably, the preservation of the CR effect suggests that the reinstatement of the same relative to new context at test is successful in boosting memory even when there are distracting factors at encoding.

We acknowledge that the loss of the CS effect under divided attention depended on whether one differentiates between false alarms given R versus K classifications, or not, and uses

overall (R + K) false alarms in the calculation of d' primes. Because it is unclear what drove participants to make incorrect R versus false K classifications, and others similarly collapsed false alarms, regardless of R or K classification (van Erp et al., 2008), we feel it is sound to make conclusions based on results from the collapsed (R + K) hit rate and false alarm data. We acknowledge, nonetheless, that future studies ought to determine how division of attention influences false alarms in general, and different calculations of memory accuracy in such paradigms.

2.5 General Discussion

We examined CR and CS effects using non-verbal stimuli. Altering the context at test, from a new to the same one as at encoding reliably enhanced overall detection, and recollection, of old faces, replicating the known CR effect. Participants also showed enhanced memory for old faces when these were paired at test with the same relative to a switched, but old, context, indicating a CS effect on memory. Manipulations of encoding instructions, to either actively link, or passively view, face-context pairs did not significantly influence the presence or magnitude of these effects. Dividing attention did not influence CR, but attenuated the CS effect. Findings suggest that the general boost to memory from reinstating an old relative to a totally new context at test is robust, though our observed reduction in the CS effect in the divided attention condition suggests that linking specific contexts to targets is hampered when attention is limited during encoding.

The global activation model (Murnane & Phelps, 1993; 1994, 1995) suggests that memory representations contain both context and item information and that memory is activated depending on the degree of match between the information in the cue and in memory, and the summed activation from all activated memory representations. This account predicts no CS

effect (Murnane & Phelps, 1994) and also predicts no differences in response times across same, switched and new conditions. On the other hand, the outshining hypothesis (Smith, 1988; 1994; Smith & Vela, 2001) suggests that the target and the context act as cues for one another – when the strength of the target item is weak relative to the strength of the context cue, a benefit of reinstating context will be observed. The outshining hypothesis predicts a CS effect as well as similarly fast RTs for correct responses to same and new contexts, and slowest response times for switched contexts. In line with this model, Experiment 1 showed significant slowing in correct R response times for old faces paired with switched relative to same or new contexts, and the full attention condition in Experiment 2 also showed this in K responses and as a trend in R responses. As suggested by Nairne (2002) and Goh and Lu (2012), the degree of match alone is not always the key factor determining what is ultimately remembered. Our study echoes this idea in that we showed that it is not only the match that matters, but that the context information presented at test seems to act as a cue that uniquely specifies a particular face.

Moreover, Macken (2002) suggested that it is important to consider both recollective and familiarity aspects of recognition memory (Tulving, 1985) when examining context effects, as context effects may be present only when memory requires explicitly remembering the context in which the target was initially presented. Analysis of IRK familiarity data in Experiments 1 and 2 revealed non-significant effects of context (though a significant effect on R), suggesting that context changes at test influenced R but not K responses. These results are in line with Gruppuso and colleagues (2007) who also reported that context influenced recollection differently than familiarity. Global matching models would predict a similar pattern of responses for both recollection and familiarity decisions, whereas dual-process models (Yonelinas, 2002) suggest different patterns, as we found.

Research suggests that the hippocampus is important in memory for configural (Rudy & Sutherland, 1995) or relational (Eichenbaum & Cohen, 2001; Squire et al., 2004) associations between stimuli. Some have suggested that the MTL is especially important for the CS effect. Kan, Giovanello, Schnyer, Makris, and Verfaellie (2007) described the performance of amnesic patients with medial temporal lobe damage on an associative recognition task employing word pairs. Controls showed a CS effect but amnesics did not, in a paired-associates paradigm, while both groups maintained robust CR effects. Related to this, Vakil et al. (2010) demonstrated that younger adults who were tested one-week post study, and older adults with lower functioning MTLs, did not show the CS boost, whereas younger adults tested immediately following study and older adults with higher functioning MTLs did (though all groups in their study exhibited the CR effect). Vakil and colleagues (2010) have suggested that dividing attention overloads the MTL and disrupts MTL functioning. It is likely that in our Experiment 2, in which attention was divided at study, MTL processes were otherwise engaged (with processing novel, incoming digits), limiting relational processing of the face-context pairs during encoding. As such, the CS effect, which requires specific knowledge of which context was paired with which face, was impaired when attention was divided at encoding.

It would be informative to extend our results, and those of Vakil et al. (2010) using a) neuroimaging techniques to determine the neural basis for the CS effect, and b) populations with known reductions in available attention, such as an aging population. The idea would be to determine more precisely whether the loss of the CS effect stems from the MTL being compromised by having to detect/process multiple novel stimuli when encoding is done simultaneously with another task (under divided attention), or whether it is the reduction in attention specifically that disrupts the CS effect. For example, some suggest that in younger

adults the linking of target and context information is spontaneous or self-initiated and explicit instructions to do so are not necessary, as was also demonstrated in the current research in Experiment 1, however, many argue that this linking does not occur spontaneously in older adults (Bastin & Van der Linden, 2006; Bower & Karlin, 1974; Castel, 2005; Craik, 1982; Craik & Byrd, 1982; Naveh-Benjamin, 2000; Naveh-Benjamin & Craik, 1995; Naveh-Benjamin et al., 2004; Rhodes et al., 2008; Winograd & Rivers-Bulkeley, 1977; Underwood, 1969; Watkins et al., 1976). Research suggests a loss in older adults' ability to spontaneously make use of context information at study to boost later recognition of targets (Skinner & Fernandes, 2009), though they can do so when given explicit encoding instructions. Little work has been done on CS effects in older adults, and future work could help determine the neural and cognitive basis for this effect by examining an aging population.

2.6 Conclusion

We examined the influence of encoding instructions, and division of attention, on context reinstatement, and context specificity, effects in memory for faces. Encoding instructions to either actively link, or passively view, face-context pairs during encoding did not influence the presence or magnitude of these effects. Dividing attention did not influence context reinstatement, but eliminated the context specificity effect on overall memory. Our study suggests that linking specific contexts to targets is hampered when attention is limited during encoding.

Chapter 3

How Face Familiarity Influences Context Effects on Face Memory

3.1 Introduction

Intuition, past research, and the studies described in the previous chapter of this thesis suggest that changing the context in which we initially encounter an individual impairs later memory for that face (e.g., Gruppuso, et al., 2007; Mandler, 1980; Vakil et al., 2007; 2010). However, experience tells us that there are certain faces (such as a good friend) that we are able to recognize in any context, whether it is at a shopping mall, on a university campus, or at the local skating arena. What is it about these faces that make them so special? What is the important factor that makes a certain subset of faces in one's life immune to the effects of contexts that have been so reliably demonstrated in the literature?

We suggest that one of these important factors is the familiarity of the face to the observer. The faces we tend to be able to recognize in a myriad of contexts or scenes are usually faces for which we have had numerous encounters. For example, during the long process of earning a graduate degree, one usually has a plethora of interactions with one's supervisor, and these repeated exposures might be what allow you to recognize him or her in any number of circumstances. On the other hand, that teller at the bookstore you encountered last Sunday afternoon may now be serving you a coffee at the campus coffee shop, but you are unable to correctly identify that you know the individual now that the context is different. Is this perhaps because you only had a single exposure to that face? Does increasing the number of exposures one has with a face, or any target item, allow for a certain 'immunity' to be built against the impairing effect of a switched context?

3.1.1 Theoretical Framework

As outlined earlier, the global activation model (Murnane & Phelps, 1993; 1994, 1995) suggests that memory representations contain both context and item information and that memory is activated depending on the degree of match between the information in the cue and in memory, and the summed activation from all activated memory representations. On the other hand, the outshining hypothesis (Smith, 1988; 1994; Smith & Vela, 2001) suggests that the target and the context act as cues for one another - when the strength of the target item is weak relative to the strength of the context cue, a benefit of reinstating context will be observed.

In the current experiment, we examined how target familiarity may influence the CR and CS effects. Predictions about the influence of familiarity of the target stimuli to the observer can be made based on the models described above. The outshining hypothesis (Smith, 1988; 1994; Smith & Vela, 2001) suggests that the target and the context act as cues for one another, and when the strength of the target item is weak relative to the strength of the context cue, a benefit of reinstating context will be observed. In other words, both CR and CS will be apparent for unfamiliar target stimuli. However, when familiarity of the target becomes stronger, the outshining hypothesis suggests that context effects will be attenuated, in terms of both CR and CS. That is, highly familiar relative to unfamiliar target stimuli may provide such strong memorability cues on their own that the memory trace for these items “outshines” any influence the context might have on memory for the target. As such, context effects are reduced or completely eliminated for highly familiar targets.

Additive global matching models (CHARM: Eich, 1982; TODAM2: Murdock, 1997) suggest that target and context are instead stored as composite units. The greater the match of stimuli presented during recognition (target + context) to the amalgamated unit stored in memory

from encoding, the greater the likelihood of a correct recognition response. Thus the global matching models predict similar results to the outshining hypothesis for unfamiliar targets with the presence of both CR and CS effects. However, when familiarity of the target is considered, very different predictions arise. Additive global matching models (TODAM2: Murdock, 1997; CHARM: Eich, 1982) suggest that degree of match between the test probe (probe target + context) and a memory representation (amalgamated context + target unit) is an additive function of their featural overlap. In these models, the target and the context do not act as cues for one another, but instead the memory for the target is matched to the probe target, while the memory for the context is independently matched to the probe context. Since target and context behave independently in this model, context effects should be seen regardless of target familiarity.

3.1.2 The Influence of Familiarity on Context Effects

Researchers have examined the role of target familiarity in context effects on memory, however support for either of these models has been quite variable. Dalton (1993) provided empirical evidence for the outshining hypothesis, demonstrating a robust recognition benefit for more weakly encoded items (novel faces) that were tested in their original context (same room as at study) than when tested in a new context (different room than at study), indicating a significant CR effect. However, no such context benefit for more strongly encoded items (faces familiarized by a single pre-study exposure) was found. Empirical results from Godden and Baddeley (1980), Smith et al. (1978), Fernandez and Glenberg (1985), and Eich (1985) also provide support for the outshining hypothesis, demonstrating reduced context effects (reduced CR) for familiar relative to unfamiliar word stimuli.

Similarly, Dougal and Rotello (1999) examined the role of familiarity on context effects in a series of three experiments, and found a different influence of target familiarity on context

effects across each. Familiarity of target words was manipulated by increasing the frequency of presentation during encoding (Experiments 1 and 2) and through a Levels-of-Processing manipulation during encoding (Experiment 3), with different background colours serving as context. In their first two experiments, no influence of target familiarity on context effects was found, however, they did find a reduced CR effect for deeply relative to shallowly encoded words in Experiment 3, suggesting a diminishing effect of context as depth of processing increased. Experiments 1 and 2 provided support for the additive global matching model, while Experiment 3 provided support for the outshining hypothesis. Unfortunately, they did not examine how their manipulation influenced the CS effect, and their stimulus materials were confined to words, which could have differences in baseline level of familiarity across participants bringing about the diverging results.

It is possible that one of the main reasons for the variable findings with respect to influence of familiarity on context effects in the previously described research, along with other studies (Dalton, 1993; Dougal & Rotello, 1999; Eich, 1985; Godden & Baddeley, 1980; Fernandez & Glenberg, 1985; Smith et al., 1978) may lie in the fact that the traditional stimulus of choice has been words as targets. Words are generally familiar to participants, and it is therefore difficult to create a truly “unfamiliar” set of words (Tulving, 1972). One major advantage of the current paradigm is that the target items are photos of faces, and contexts are photos of scenery, stimuli for which familiarity can be more easily controlled experimentally. Given that current theories predict different effects of context depending on target familiarity, we sought clarification using stimuli for which we could more easily determine levels of familiarity, to examine how familiarity interacts with context effects.

Another hole in the current literature is that examination of target familiarity on context effects has been restricted to context reinstatement effects, with no studies examining the influence of what we term CS effects. As shown in Experiment 2 of this thesis, CR and CS effects may be driven by different processes, as CS but not CR was influenced by our manipulation of divided attention. That is, CR was relatively robust and immune to effects of reduced attention, while CS was reduced by this factor.

Experiments 3 and 4 followed a similar paradigm to that of Experiments 1 and 2, where faces were presented at study paired with a variety of indoor and outdoor context scenes (e.g., park, supermarket, swimming pool) and a recognition memory test ensued in which faces were paired with either the same context, a switched context, or a new context with respect to encoding. Including both same and switched context trial types allowed for the examination of both CR and CS effects; once again, the dependent measure of interest was memory performance.

Familiarity of target faces was manipulated in two different ways. In Experiment 3 familiarity of the face was manipulated by presenting participants with photographs of famous versus non-famous individuals. In Experiment 4 we presented participants with a set of unfamiliar faces, but controlled the degree of familiarity of a particular face by pre-exposing the participants to the study faces 0, 1, 3, or 10 times, without any accompanying context scenes. Varying the degree of familiarity of a face in different ways, and comparing context effects for familiar relative to unfamiliar faces, allowed us to better understand the influence of context on memory. The use of faces as target stimuli is ideal because their familiarity can be more easily experimentally manipulated than words. The current design thus allowed for a more precise assessment of the role of target familiarity on context effects.

Because the interest in the following experiments was now in identifying factors that influence CR and CS *in general*, and because the pattern of results in Experiments 1 and 2 was generally similar when either overall or conditionalized false alarm rates were used, data from this point on will be presented collapsed across R and K for measures of hit rate and false alarm rates, which were then used to calculate d' primes. Furthermore, response time data were not of interest in the following experiments, as there is no precedent in the literature suggesting that there should be differences in response times depending on face familiarity and context type at test.

3.2 Experiment 3

Our first goal was to test whether familiarity, as defined by fame status of target items (faces in our study) in Experiment 3, reduced CR and CS effects. To this end, famous and non-famous faces were presented during study, each paired with an image of either an indoor or outdoor scene as context. At study, participants were instructed to make a judgment about how related they felt the face was to the scene, ensuring that an equal amount of attention was paid to both face and context images at study (replicating the active linking condition of Experiment 1). It was hypothesized that we should see an attenuated, or perhaps even a non-existent, effect of context on face memory for the famous faces (attenuated or abolished CR and CS effects) as memory strength would be higher for these items relative to unfamiliar faces, and context would not influence performance as predicted by the outshining hypothesis (Smith, 1988; 1994; Smith & Vela, 2001). For unfamiliar faces, it was predicted that we would see results replicating previous research, depicting robust CR and CS effects (e.g., Gruppuso et al., 2007; Koji & Fernandes, under review).

3.3 Method

3.3.1 Participants

Fifty undergraduate students completed the study (38 females, M age = 19.78, SD = 1.80, Range = 17-27 years). Participants were recruited through the University of Waterloo's SONA system. All students were enrolled in undergraduate Psychology classes and received course credit or token monetary remuneration for their participation.

3.3.2 Materials

Face stimuli consisted of 96 photos of faces with happy expressions: 48 were of famous faces and 48 of non-famous faces (half female). Famous faces were selected from a famous face database established by the Fernandes Lab at the University of Waterloo. Famous faces in this database are of celebrity figures that are often seen in the media, and includes actors (e.g., Brad Pitt), TV personalities (e.g., Oprah Winfrey), singers/musicians (e.g., Celine Dion), and sports figures (e.g., Tiger Woods; see Figure 4 for sample stimuli). Pilot testing was conducted to ensure that these faces were recognizable to the age group of interest and all participants in the current study participated in a post-study identification task to further ensure that the famous faces were recognizable (could be correctly named) by this particular set of participants. Non-famous faces were chosen from the Center for Vital Longevity Face Database (Minear & Park, 2004). Both famous and non-famous faces included those of young to middle-aged adults of an assortment of ethnicities. All photographs of faces were presented in front view, in colour, with a white background, showed head and shoulders only, and were devoid of any facial accessories such as glasses/sunglasses, and hats. Context stimuli were identical to those used in Experiments 1 and 2.



Figure 4. Experiment 3: Sample stimuli – (Top) photo of famous face on left and indoor scene on right; (bottom) photo of non-famous face on left and outdoor scene on right.

3.3.3 Procedure

The group of 96 faces and 96 context photos were randomly paired and then split in half to create two study lists (A and B), each consisting of 48 faces (half famous/half non-famous and half male/half female) and 48 context scenes (half indoor/half outdoor). For half of the participants, List A was presented at study. At test, all 48 faces and all 48 contexts from encoding (all list A) were re-presented, along with 48 new faces and 48 new contexts (list B stimuli). Five trial types were created within the test list: 1) old face + same context, 2) old face + switched context, 3) old face + new context, 4) new face + old context, 5) new face + new context. Thus, in total there were 48 old and 48 new faces, with 24 old faces (12 famous/12 non-famous) paired with 24 old contexts, 24 old faces (12 famous/12 non-famous) paired with 24 new contexts, 24 new faces (12 famous/12 non-famous) paired with 24 old contexts, and 24 new faces (12 famous/12 non-famous) paired with 24 new contexts. For the other half of the

participants, List B was presented at study and List A stimuli were used as new items on the recognition test. For both study and test, the face was always presented on the left and context scene on the right (see Figure 4 for samples). The rest of the procedure was identical to that of Experiment 1's associative linking condition. All trials were presented in a random order in both study and test phases, with famous and non-famous face trials inter-mixed.

At the end of the study, participants were given a booklet containing all 48 famous faces and were asked to a) write the name of the person, or b) check a box if they knew the face but didn't know the name, or c) check a box if they didn't know the face at all.

3.4 Results

3.4.1 Memory

To measure memory performance for the recognition of faces, a sensitivity measure, d' , was calculated for overall memory scores. For this we added R + K hits for a calculation of proportion of hits, and R + K false alarms for proportion of false alarms.

Overall hit rate was computed for each participant separately for each trial type, as $(\# \text{ correct R} + \# \text{ correct K}) / \text{total number of old faces}$ (e.g., for the old famous face + old context condition, overall memory was computed as $(\# \text{ correct R} + \# \text{ correct K responses}) / 6$). False alarm rate was calculated for each participant, separately for famous and non-famous lure faces as $(\# \text{ new famous faces identified as old with an R response} + \# \text{ new famous faces identified as old with a K response}) / 24$ (the total number of new famous faces in the recognition test), and $(\# \text{ new non-famous faces identified as old with an R response} + \# \text{ new non-famous faces identified as old with a K response}) / 24$ (the total number of new non-famous faces in the recognition test). The mean overall false alarm rate for famous faces was .09 ($SD = .15$), and for non-famous faces was .22 ($SD = .17$). See Table 5 for d' and hit rate means.

Table 5. Experiment 3 d' Scores and Hit Rate, with Standard Deviations in Parentheses, as a Function of Context Type during Test, and Fame Status of Target Face

	Famous Face		Non-Famous Face	
	d'	Hit Rate	d'	Hit Rate
Same	2.76 (0.70)	.94 (.11)	1.78 (0.72)	.81 (.19)
Switched	2.46 (0.76)	.83 (.15)	1.35 (0.75)	.66 (.24)
New	2.62 (0.94)	.84 (.16)	1.18 (0.63)	.60 (.18)

The influence of context on d' was evaluated using a 3 (Context Type) X 2 (Fame Status) repeated measures ANOVA, with Context Type (same, switched, new) and Face Status (famous, non-famous) as within-subject factors.

There was a significant main effect of Context Type, $F(2, 98) = 24.11$, $MSE = .19$, $p < .001$, with simple effects contrasts indicating that participants better discriminated old faces that were re-presented with the same context compared to a new context at test, $F(1, 49) = 40.06$, $MSE = .18$, $p < .001$, a clear demonstration of the CR effect. We also saw a CS effect, whereby participants better discriminated old faces paired with same relative to switched contexts at test, $F(1, 49) = 35.54$, $MSE = .19$, $p < .001$. A main effect of Fame Status was also found, $F(1, 49) = 151.11$, $MSE = .69$, $p < .001$, such that participants had better memory for famous than non-famous faces, in line with previous research showing that famous faces are better recognized than non-famous (unfamiliar) faces (Carbon, 2008; Jackson & Raymond, 2008; Voss & Paller, 2006; Zion-Golumbic et al., 2010). These main effects were qualified by a significant Context Type X Fame Status interaction, $F(2, 98) = 8.17$, $MSE = .17$, $p = .001$.

As predicted by the outshining hypothesis, and replicating previous research, the effect of context was present when examining memory for non-famous faces as indicated by simple

contrasts, indicated by a significant CR effect, with non-famous faces paired with same contexts better remembered than non-famous faces paired with new contexts at test, $F(1, 49) = 51.39$, $MSE = .36$, $p < .001$; and a significant CS effect, with non-famous faces paired with same contexts better remembered than non-famous faces paired with switched contexts at test, $F(1, 49) = 14.84$, $MSE = .63$, $p < .001$. Importantly, and also as predicted by the outshining hypothesis, the effect of context was attenuated for famous faces, such that we saw a dissolved CR effect, with memory for famous faces paired with new contexts being just as accurate as memory for famous faces paired with same contexts at test, $F(1, 49) = 3.33$, $MSE = .31$, $p > .05$. Surprisingly, however, we did still see a significant CS effect, with more accurate memory for famous faces paired with same contexts relative to switched contexts at test, $F(1, 49) = 22.83$, $MSE = .20$, $p < .001$. See Figure 5 for a graphical depiction of the pattern of results.

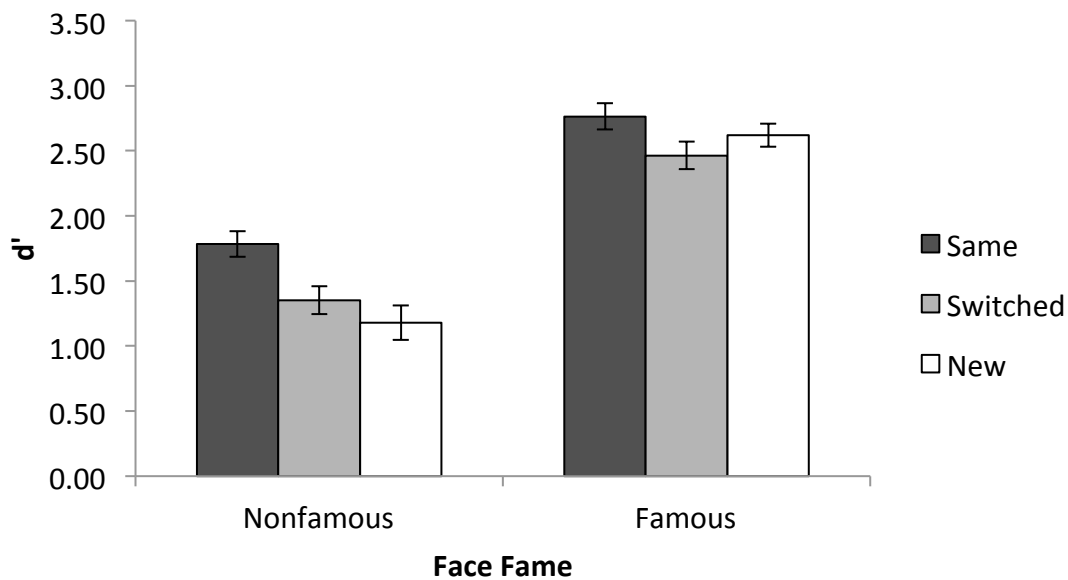


Figure 5. Experiment 3: Recognition memory for faces as measured by d' scores for face fame by context type at test

Because fame status was being manipulated in this experiment, we wanted to examine whether the pattern of results would change for those participants who were relatively less familiar with our chosen “famous” faces. We calculated scores on the fame test, conducted at the end of the experiment, such that number of correctly identified famous faces, and number of boxes checked as “know face but don’t know name”, were tallied for each participant, yielding a percentage correct score for famous face identification. On average, participants recognized 89% (SD = 12%) of the famous faces, with a range from 41% – 100% of correctly identified famous faces. We re-analyzed our memory data, including only participants who correctly recognized more than 80% of the famous faces and excluded data from nine participants. Results indicated an identical pattern of results as when the entire sample was analyzed.

3.5 Discussion

In Experiment 3, we saw a clear demonstration of both CR and CS effects when faces were non-famous, but an attenuated effect of context when faces were famous, providing direct support for the outshining hypothesis. Specifically, results for non-famous faces directly replicated those of Gruppuso et al. (2007), with greater memory (significantly larger d' scores) for faces paired with same contexts relative to new contexts at test, a clear demonstration of the CR effect. Also, memory was greater for faces paired with same relative to switched contexts at test, evidence for the existence of a CS effect. On the other hand, when faces were famous, we no longer saw the CR effect, as old famous faces paired with new contexts were just as well remembered as old famous faces paired with same contexts at test, as predicted. Curiously, when faces were famous we still saw a significant CS effect, such that old famous faces were better remembered when paired with same relative to switched contexts at test.

Results suggested that the familiarity of a face, manipulated in this experiment by using famous and non-famous faces, significantly changed the influence of context on face memory. Nonetheless, comparing memory for famous relative to non-famous faces may not have been the ideal method of manipulating face familiarity. Post-experiment assessment of fame status revealed that participants had different levels of familiarity with the famous face, such that recognition of the famous faces varied greatly across participants (from 44% to 100% correctly identified famous faces). As well, the relative fame of a given face, within the famous face set, may also have differed across participants. For example, based on anecdotal reports from participants, a participant who is a big movie buff who scours celebrity gossip websites daily would have had many more previous exposures to a face such as that of Brad Pitt compared to a participant who only watches movies every few months and has no interest in celebrity gossip. Furthermore, celebrity faces have much more information associated with them. For example, when an image of Brad Pitt is seen, other information such as “he is married to Angelina Jolie”, “he has many children”, “he was once married to Jennifer Aniston” is activated, and some argue that these extra tidbits of information can also be considered “context” (Carbon, 2008; Jackson & Raymond, 2008; Russo et al. 1999; Voss & Paller, 2006; Zion-Golumbic, Kutas, & Bentin, 2010). As such, the influence of fame of the face on memory, and the corresponding context effects, may not have been adequately manipulated. For this reason, it is difficult to determine whether the results we saw in Experiment 3 were due to familiarity of the famous faces as induced by repeated exposures to them, or due to the extraneous information that some participants may or may not have known about that face.

Nonetheless, based on Experiment 3 we can conclude that context significantly boosts memory for non-famous faces when an old context is reinstated at test, and we see an even

greater boost when this context is the exact same as was originally presented with the face. Fame status of the target (face) abolished the context reinstatement (CR) effect, suggesting that the familiarity of the face is an important factor mediating the influence of context on memory. In Experiment 4, we controlled for the degree of familiarity of a face, across all participants, by experimentally manipulating familiarity through repeated pre-exposures to unfamiliar faces. In this way, we directly examined how the relative degree of familiarity with a face influenced the presence or absence of context effects.

3.6 Experiment 4

The aim of Experiment 4 was to replicate findings in Experiment 3 with more experimental control. Specifically, we wanted to control for *the degree of* familiarity of the target face. It was difficult to control for differences, across participants, in exposure to the famous face set in Experiment 3 and so in Experiment 4 we wanted to quantify the number of pre-exposures to a given face prior to using them in our study. By controlling for the amount of pre-exposure to each face, Experiment 4 also allowed us to determine how many repeated encounters with a face are needed before we see attenuated CR and CS effects on face memory. In this experiment, participants were pre-exposed to target faces prior to taking part in our paradigm. We wanted participants to become familiar with a set of faces that were previously unfamiliar to them, so we varied the number of times participants saw each face. We included 4 different exposure conditions (0, 1, 3, and 10). A subset of the faces were purposely not presented in the pre-exposure phase to maintain a condition in which faces were completely unfamiliar, providing yet another condition in which results could be directly compared to those of previous experiments in this thesis.

We again hypothesized an attenuated effect of context on face memory for familiar relative to unfamiliar faces, in line with the outshining hypothesis (Smith 1988, 1994; Smith & Vela, 2001). Specifically, we predicted a significant Context Type X Face Familiarity interaction, such that unfamiliar faces (those not seen in the pre-exposure phase) would be significantly influenced by the reinstatement of same, switched, and new contexts at test. Specifically, we expected to see a significant CR effect, with more accurate memory for faces paired with same relative to new contexts at test, as well as a significant CS effect, with more accurate memory for faces paired with same relative to switched contexts at test. For familiar faces (those viewed 10 times in the pre-exposure phase), we predicted that the CR and CS effects would be reduced or completely eliminated, replicating the pattern of results observed in Experiment 3 with famous faces, as the context would no longer be important in aiding memory of the faces at test. We included the 1X and 3X pre-exposure conditions in an effort to map the progression of change in the influence of context on face memory. We predicted that the 1X condition would not induce enough familiarity to affect the context effects, though in the 3X condition we might start seeing a trend such that the CR and CS effects would be attenuated.

3.7 Method

3.7.1 Participants

Fifty undergraduate students completed the study (46 females, M age = 20.40, SD = 2.12, Range = 17-30 years). Participants were recruited through the University of Waterloo's SONA system. All students were enrolled in undergraduate Psychology classes and received course credit or token monetary remuneration for their participation.

3.7.2 Materials

We used 96 photos of faces with happy expressions (half male/half female). These were chosen from the Center for Vital Longevity Face Database (Minear & Park, 2004). Faces included those of young to middle-aged adults of an assortment of ethnicities. All photographs of faces were presented in front view, in colour, with a white background, showed head and shoulders only, and were devoid of any facial accessories such as glasses/sunglasses, and of hats. The same 96 photos of context scenes (half indoor/half outdoor) from Experiment 3 were used in this experiment.

3.7.3 Procedure

The group of 96 faces and 96 context photos were randomly paired and then split in half to create two study lists (Group A and Group B), each consisting of 48 faces (half male/half female) and 48 context scenes (half indoor/half outdoor). Lists were created as in Experiment 3 for the experimental phase. A pre-exposure phase was administered prior to the experimental phase to familiarize participants to the faces. The 48 faces that would be seen in the Study Phase (either from lists A or B depending on counterbalanced experimental condition) were divided into 4 groups (12 in each). Of the 48 study faces, 12 were not shown at all in the pre-exposure phase (0 pre-exposures), 12 were shown one time (1 pre-exposure), 12 were shown 3 times (3 pre-exposures) and 12 were shown 10 times (10 pre-exposures), allowing for four pre-exposure conditions (see Figure 6). Faces in the pre-exposure phase were presented in an inter-mixed and randomized order. Faces from the other list (counterbalanced across participants) were used as lures in the test phase.

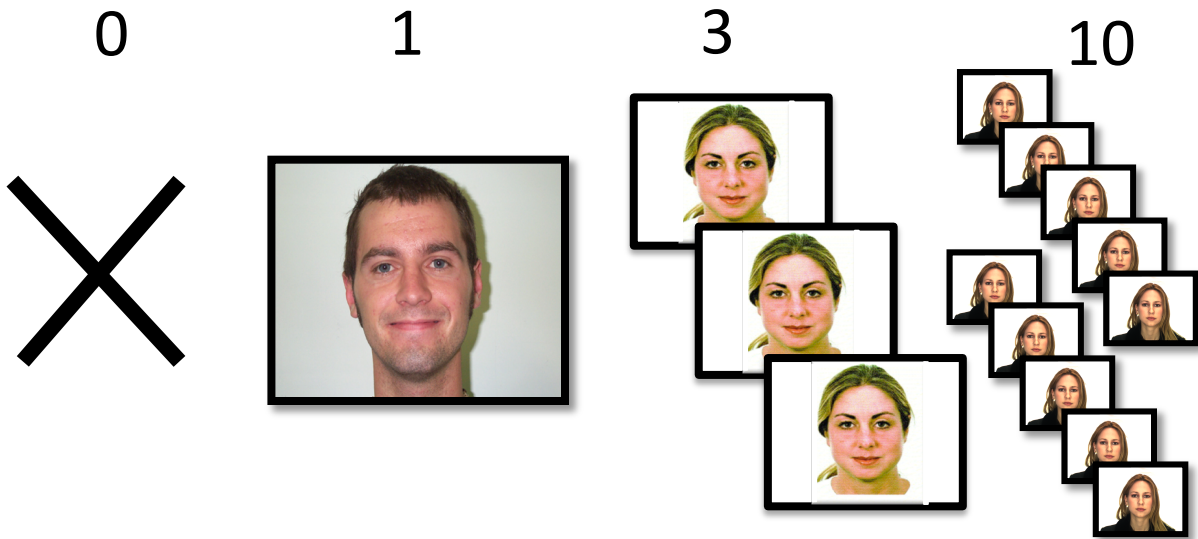


Figure 6. Experiment 4: Trial types included in the pre-exposure phase - faces were presented in an inter-mixed and randomized order

Testing was conducted individually in approximately 30 minutes. In the pre-exposure phase, participants viewed images of the study faces presented one at a time on a white background, in the centre of the screen without a context scene. Faces were presented for 3500 msec followed by a fixation cross presented for 500 msec, and were presented in random order. Participants were asked to press the “v” key on a standard keyboard marked “M” if the face was male, or the “b” key marked “F” if the face was female. During the experimental task, participants were first presented with pairs of 48 face + context images from one of the two lists (A or B, counterbalanced across participants) in an incidental encoding phase. Each face + context pair was presented, as in Experiment 3. For each participant, the order of presentation of face-scene images was random. The test phase was identical to that of Experiment 3.

3.7.4 Results

As in Experiment 3, d' was calculated for overall memory scores: we added R+K hits for calculation of proportion hits, and R + K false alarms for false alarm proportions with a mean overall false alarm rate of .15 ($SD = .15$). The means of these d' scores and hit rates, as a function of pre-exposure condition, for each of the context types at test, are shown in Table 6.

Table 6. Experiment 4 d' Scores and Hit Rates, with Standard Deviations in Parentheses, as a Function of Context at Test and Number of Pre-Exposures to Face Targets

	0 Pre-Exposures		1 Pre-Exposure		3 Pre-Exposures		10 Pre-Exposures	
	d'	Hit Rate	d'	Hit Rate	d'	Hit Rate	d'	Hit Rate
Same	1.64 (0.80)	.69 (.29)	1.90 (0.77)	.84 (.25)	2.17 (0.69)	.97 (.09)	2.14 (0.68)	.96 (.13)
Switched	1.36 (0.70)	.55 (.34)	1.73 (0.77)	.74 (.26)	2.07 (0.73)	.92 (.22)	2.06 (0.73)	.91 (.20)
New	1.12 (0.79)	.45 (.21)	1.74 (0.97)	.68 (.24)	2.08 (0.86)	.80 (.23)	2.23 (0.85)	.85 (.20)

The influence of context on d' for overall memory scores was evaluated using a 3 (Context Type) X 4 (Pre-Exposures to Face) repeated measures ANOVA, with Context Type (same, switched, new) and Pre-Exposures to Face (0, 1, 3, 10 pre-exposures) as within-subject factors.

As predicted, and replicating the results of Experiment 3, a significant main effect of Context Type was found, $F(2, 98) = 7.65$, $MSE = .24$, $p = .001$, with simple effects contrasts indicating that memory accuracy was higher for old faces paired with same relative to new contexts at test (CR effect), $F(1, 49) = 9.31$, $MSE = .16$, $p < .05$, and higher for old faces paired with same relative to switched contexts at test (CS effect), $F(1, 49) = 14.23$, $MSE = .09$, $p < .001$. We also found a significant main effect of Pre-Exposures to Faces, $F(3, 147) = 88.96$, $MSE = .22$, $p < .001$, such that memory performance increased as the number of pre-exposures in the pre-study phase increased.

These main effects were qualified by a significant Context Type X Pre-Exposure interaction, $F(6, 294) = 5.31$, $MSE = .16$, $p < .001$. As predicted, and replicating the non-famous condition in Experiment 3, for the 0 exposure condition, a significant CR effect was found as indicated by simple contrasts, with higher performance for faces paired with same relative to new contexts at test, $F(1, 49) = 27.47$, $MSE = .51$, $p < .001$, along with a significant CS effect, with higher performance for faces paired with same relative to switched contexts at test, $F(1, 49) = 5.84$, $MSE = .70$, $p < .05$. Interestingly, after seeing a particular face just one time in the pre-exposure phase, the effect of context was lost, as indicated by both non-significant CR, $F(1, 49) = 2.70$, $MSE = .52$, $p > .05$, and CS effects, $F(1, 49) = 3.72$, $MSE = .40$, $p > .05$. As predicted, the effect of context was also lost for faces presented three times in the pre-exposure phase, as indicated by non-significant CR, $F(1, 49) = 1.01$, $MSE = .38$, $p > .05$, and CS effects, $F(1, 49) =$

3.31, $MSE = .15$, $p > .05$. The context effects were similarly lost in the 10X condition, as indicated by non-significant CR, $F(1, 49) = 1.99$, $MSE = .19$, $p > .05$, and CS effects, $F(1, 49) = 3.86$, $MSE = .09$, $p > .05$. Results suggest that the degree to which a face is familiar is important to consider when describing the role that context plays when trying to remember a particular face. See Figure 6 for a graphical depiction of the pattern of results.

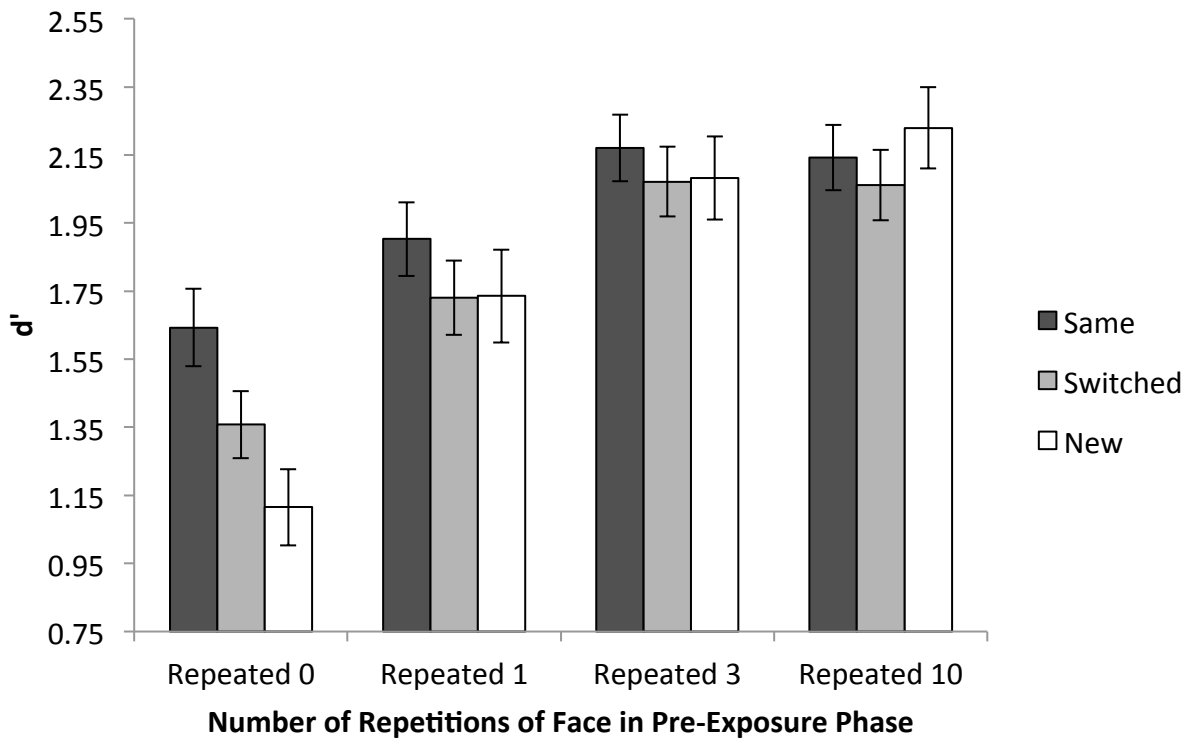


Figure 7. Experiment 4: Recognition memory for faces as measured by d' scores for number of repetitions of faces in pre-exposure phase by context type at test

3.8 Discussion

As predicted based on our results from Experiment 3, and in line with the outshining hypothesis, and replicating previous research (e.g., Gruppuso et al. 2007; Koji & Fernandes, under revision), we found robust CR and CS effects when target faces were completely

unfamiliar to the participants. This indicates that when a face is unfamiliar, re-instating the exact same context, or even an old but not identical context, enhances memory. Importantly, Experiment 4 showed that after just one pre-exposure to a face the influence of context is reduced. As such, the influence of context effects on memory must be qualified such that they only apply to novel faces; once a face is familiar, other factors, such as strength of memory signal, seem to guide performance.

3.9 General Discussion

Results of Experiment 3 demonstrated that the familiarity of a face changes the influence of context on memory for that face. Reinstating the encoding context enhanced memory relative to when context was switched or new, but this effect was reduced for famous relative to non-famous (unfamiliar) faces. Experiment 4 replicated this finding and further showed that a large number of repeated pre-exposures to a face is not necessary to see this change; after just one pre-exposure to an unfamiliar face, the context reinstatement effect was reduced.

The outshining hypothesis (Smith, 1988; 1994; Smith & Vela, 2001) predicts that context effects may only be present for completely novel stimuli, whereas for items that have become familiar through experience, there may be existing representations that are used to build a robust episodic trace, and with this trace in place, context information is less important in aiding recognition. This hypothesis predicts that as memory strength of a target item increases, this masks any benefit from reinstatement of an old context. The additive global matching model predicts much different results, whereby increasing target familiarity should not affect context effects on memory for the target (TODAM2: Murdock, 1997; CHARM: Eich, 1982). Results of Experiments 3 and 4 provided clear support for the outshining hypothesis.

From the current studies, we can conclude that target familiarity is an important factor in producing context effects on memory. An advantage of the current experiments lies in the use of faces as opposed to words, the traditional stimulus of choice for studies examining context effects on memory (Godden & Baddeley, 1975; Grant, et al., 1998; Light & Carter-Sobell, 1970; Thomson, 1972; Schwabem et al., 2009; Smith, 1985; Smith et al., 1978; Smith et al., 1990; Smith & Sinha, 1987; Tulving & Thomson, 1971). The use of faces allowed for stimuli that were recognizable and meaningful, but could be manipulated to be completely unfamiliar, or familiar to varying degrees, to participants.

Moreover, a key addition of the current work to the literature included the examination of not only context reinstatement, but also that of context specificity. Traditionally, research investigating the role of target familiarity and how it may influence context effects on memory has solely examined CR (Bower & Karlin, 1974; Dalton, 1993; Godden & Baddeley, 1975; Smith & Vela, 2001; Winograd & Rivers-Bulkeley, 1977). Very recent research has indicated that context effects are actually specified by two different types, including CS along with CR (e.g., Gruppuso et al., 2007; Koji & Fernandes, under revision). Interestingly, the present research demonstrated a similar effect of target familiarity on both CR and CS in Experiment 4, indicating that these two effects are susceptible to, and influenced by, similar factors, providing a greater understanding of the differences and similarities between CR and CS.

That we found a significant CS effect for famous faces in Experiment 3 was unexpected. As outlined previously, comparing memory for famous relative to non-famous faces may not have been the ideal method of manipulating face familiarity given that post-experiment assessment revealed that recognition of the famous faces varied considerably across participants (from 44% to 100% correctly identified famous faces). In turn, the influence of fame of the face

on memory, and the corresponding context effects, may not have been adequately manipulated in Experiment 3. The design of Experiment 4 allowed for greater control over the manipulation of face familiarity. For this reason, we feel confident in drawing our main conclusions from Experiment 4 results.

A noteworthy finding was that it took only one pre-exposure of a face to make the face familiar enough to see attenuated context effects (diminished CR and CS in Experiment 4). The question that remains is whether there is something special about faces that allow for a face to become familiar after only one exposure, or whether we would see similar results with any type of target stimuli, such as objects, simple spatial designs, or abstract art. Many argue that there is something inherently special about faces (e.g., Ekman, 1970), which leads us to believe that we may not see a similar pattern of results with other stimuli such as words, however, only future research will be able to answer this empirical question.

Chapter 4

How Distinctiveness of a Face May Influence Context Effects on Memory

4.1 Introduction

Through the experiments presented in the previous chapter, it is clear that familiarity of a face significantly influenced the extent to which changes in the context from study to test affect our memory for that face. But what is it about familiarity that leads to this finding? Is it simply repeated exposures to a face that is important? Or is it perhaps that the more exposures we experience with a face, the more distinctive that face becomes to us among the sea of hundreds of faces we already have stored in our memory?

Researchers investigating the effects of race, specifically ethnicity of the face (e.g., White, Black, Asian, etc.), have suggested just this. Empirical work has suggested that repeated exposures to faces of our own race leads to these faces becoming more distinctive from one another, whereas out-group faces (those of a different race) are less distinctive from one another; this effect is commonly referred to as an *Own-Race Bias* (see Meissner, 2001, for a review). In other words, the Own-Race Bias can be described as the propensity of a perceiver to identify greater similarity in the faces of other-race members than in their own (Brigham & Ready, 1985). In turn, faces that are more distinctive (same race) are better remembered than ones that are less distinctive to that individual (other race) (Bothwell, Brigham, & Malpass, 1989; Brigham & Ready, 1985; Chiroro & Valentine, 1995; Chiroro, Tredoux, Radaelli, & Meissner, 2008; Corenblum & Meissner, 2006; Hilliar, Kemp, & Denson, 2010; Hugenberg, Miller, Claypool, 2007; Meissner, 2001; Pezdek, Blandon-Gitlin, & Moore, 2003). For example, Brigham and Ready (1985) asked 90 Black and 78 White participants from Florida State University to

construct lineups of photographs of five distractor photos which were “reasonably similar in general appearance” to a Black or White target photo deemed as the “suspect”. Each participant repeated the process twice - once with a photo of a Black target and photos of Black distractors, and once with a photo of a White target and photos of White distractors - by selecting five photographs that resembled the target face from a set of 78 same-race and age photographs. Results indicated that both Black and White race groups exhibited own-race bias by showing a greater level of selectivity of own-race photos than other-race photos when constructing the lineups. The researchers concluded that both Black and White participants behaved in a manner congruent with the Own-Race bias argument that more similarity was perceived in out-group members' appearance than in in-group members' appearance.

But how will the similarity of out-group faces, or the distinctiveness of in-group faces, change the way context influences memory for a face? Once again we must consider the outshining hypothesis (Smith, 1988; 1994; Smith & Vela, 2001). In accordance with the outshining hypothesis, when the strength of the target item is weak relative to the strength of the context cue, a benefit of reinstating context will be observed (and in turn both CR and CS will be apparent for unfamiliar target stimuli). Conversely, when the strength of the target item is strong, the benefit of reinstating context is lost since the cue for the target is enough to accurately tell us that the item (or face in this case) is indeed old. This was demonstrated in this thesis when memory for famous (Experiment 3) and familiarized (Experiment 4) faces were shown to be less affected by context change from study to test than unfamiliar faces. In line with this idea, the own-race bias literature suggests that memory strength for same-race faces (distinct faces) is much greater than that for other-race faces (non-distinct faces).

Therefore, in accordance with the outlined literature, it is predicted that in-group faces will be less susceptible to the effects of context change from encoding to test; such faces should be more distinctive to an individual relative to an out-group face. Based on this, we should see the presence of both CR and CS for out-group faces (Caucasian faces for Asian participants and Asian faces for Caucasian participants), as these are akin to unfamiliar faces. On the other hand, we should see a reduction in both CR and CS for in-group faces (Caucasian faces for Caucasian participants and Asian faces for Asian participants), as these are akin to familiar faces.

4.2 Method

4.2.1 Participants

Sixty-two participants were recruited from the University of Waterloo SONA system, and were provided with course credit or monetary remuneration for their participation. Half of the participants were Asian ($N = 31$, 12 female, mean age = 19.90, $SD = 2.18$, age range = 18 - 26) while the other half were Caucasian ($N = 31$, 21 female, mean age = 19.84, $SD = 1.77$, age range = 18 - 26). Participants were screened for race prior to the study, and the study was only opened to one race at a time to allow for random selection of participants within each group. Participant selection was conducted through the pre-screening data obtained from the SONA system.

Specifically, for White participants, the following criteria must have been met:

- 1) Born in Canada
- 2) Lived in Canada for entire life (except for vacations) OR lived in Canada since the age of 5 or earlier
- 3) Not bi-racial or multi-ethnic
- 4) Indicated White/Caucasian as ethnic background

- 5) Specific ethnic group most identified with must have been Canadian
- 6) On a question asking “In general, on a scale of 0-10, how much do you identify with this ethnic group?” must have scored 5 or greater

For Asian participants the following criteria must have been met:

- 1) Not bi-racial or multi-ethnic
- 2) For ethnic background chose one or more of the following: Chinese (including Hong Kong Chinese & Taiwanese), Japanese, Korean, or Other Asian groups
- 3) Specific ethnic group most identified with must have been one or more of the following: Cantonese, Chinese, Japanese, Korean, Taiwanese, Vietnamese
- 4) On a question asking “In general, on a scale of 0-10, how much do you identify with this ethnic group?” must have scored 5 or greater

Research conducted by Brigham and Ready (1985) and Wright, Boyd, and Tredoux (2003) has suggested that it may not only be the race of the person which is a factor, but also that the amount of exposure one has to other-race faces may be important in determining own-race bias. As such, further screening was conducted with our participants, following the experiment and prior to debriefing, and participants were asked to fill out a “Race Exposure” questionnaire regarding percentages of in-group and out-group friends they had at the current moment, and have had over their entire life-span. See Appendix for questionnaire.

4.2.2 Materials

A total of 96 faces were selected from the Tarrlab Face Database (Stimulus images courtesy of Michael J. Tarr, Center for the Neural Basis of Cognition, Carnegie Mellon

University, <http://www.tarrlab.org/>) as well as the Japanese and Caucasian Neutral Faces (JACNeuF) database (Matsumoto, 1988). Twelve female Asian faces were selected from the Tarrlab database, 12 female Asian faces were selected from the JACNeuF database, 12 male Asian faces were selected from the Tarrlab database, and 12 male Asian faces were selected from the JACNeuF database. The same selection procedure was followed for Caucasian faces. The selection of the stimuli faces from two different databases was necessary to reach the number of face stimuli required for the current experimental design. Selecting equal numbers of Asian and Caucasian faces from each dataset (as opposed to all Caucasian from one and all Asian from the other) allowed us to ensure that any differences found across conditions were indeed due to differences in the variable of interest (face race) as opposed to any other differences that may be present between images from different database sets (e.g., lighting, distance from camera). All faces were of young to middle aged adults, and none were wearing facial accessories such as hats, glasses or sunglasses. Images were presented in colour, with a white background, and included the head and neck of the person. The creation of stimuli lists was identical to that of Experiment 1 except that half of the faces were Asian and the other half were Caucasian in both the study and test lists. Importantly, face and context scenes were paired such that within each context type at test condition half of the faces were Asian and the other half Caucasian. All 96 context scenes were identical to those used previous experiments in this thesis.

4.2.3 Procedure

The procedure was identical to that of Experiment 1 (with all participants provided with associative linking instructions at study), and participants were not informed of the racial aspect of the study until the debriefing session after the experimental session. As indicated above,

participants were also asked to fill out the “Race Exposure” questionnaire post-study, pre-debriefing.

4.3 Results

As in previous experiments, d' was calculated for overall memory scores: we added $R + K$ hits for calculation of proportion hits, and $R + K$ false alarms for false alarm proportions for each race group (Asian and Caucasian) and stimulus face race type (Asian and Caucasian). The influence of context on d' for overall memory scores was evaluated using a 3 (Context Type) X 2 (Stimulus Face Race) X 2 (Participant Race) repeated measures ANOVA, with Context Type (same, switched, new) and Stimulus Face Race (Asian, Caucasian) as within-subject factors, and Participant Race as a between-subjects factor. Means for d' and hit rates are presented in Table 7. Mean overall false alarm rates are shown in Table 8.

Table 7. Experiment 5 d' Scores and Hit Rates, with Standard Deviations in Parentheses, as a Function of Context Type during Test, Stimulus Face Race, and Participant Race

	Asian Participants				Caucasian Participants			
	Asian Face Stimuli		Caucasian Face Stimuli		Asian Face Stimuli		Caucasian Face Stimuli	
	d'	Hit Rate	d'	Hit Rate	d'	Hit Rate	d'	Hit Rate
Same	1.35 (.55)	.80 (.21)	1.40 (.57)	.74 (.23)	1.31 (.58)	.78 (.16)	1.76 (.65)	.79 (.19)
Switched	.89 (.64)	.63 (.25)	1.06 (.61)	.62 (.21)	.86 (.64)	.63 (.19)	1.26 (.59)	.61 (.17)
New	.77 (.41)	.59 (.16)	.91 (.63)	.57 (.21)	.69 (.56)	.56 (.18)	1.22 (.65)	.59 (.23)

Table 8. Experiment 5 Overall False Alarm Rates, with Standard Deviations in Parentheses, for Caucasian and Asian Participants as a Function of Stimulus Face Race

	Asian Participants	Caucasian Participants
Asian Stimulus Face	.32 (.12)	.33 (.17)
Caucasian Stimulus Face	.25 (.12)	.18 (.10)

4.3.1 Entire Sample

Results revealed a non-significant main effect of participant race, $F(1, 60) = 2.09$, $MSE = .62$, $p > .05$, on overall memory performance. Thus, potential differences between conditions were not simply due to differential memory abilities across the groups. Results also indicated a significant main effect of Stimulus Face Race, $F(1, 60) = 13.80$, $MSE = .57$, $p < .001$, such that Caucasian faces were better remembered overall compared to Asian faces, although this effect was driven by the strong memory for in-group faces for Caucasian participants. As expected, a significant main effect of Context Type, $F(2, 120) = 50.48$, $MSE = .21$, $p < .001$, was found, and simple effects contrasts revealed that memory for faces paired with same contexts was greater than memory for faces paired with new contexts at test (CR effect), $F(1, 60) = 111.73$, $MSE = .17$, $p < .001$, and switched contexts at test (CS effect), $F(1, 60) = 51.69$, $MSE = .23$, $p < .001$.

Unfortunately, contrary to our prediction, the Stimulus Face Race X Context Type interaction, $F(2, 120) = .24$, $MSE = .25$, $p > .05$, as well as the Participant Race X Type interaction, $F(2, 120) = .19$, $p > .05$, were non-significant. The three-way Stimulus Face Race X Participant Race X Context Type interaction was also non-significant, $F(2, 120) = .33$, $p > .05$.

Although the interactions were not significant, specific a priori predictions allowed for an examination of CR and CS effects within each participant race group for each face race type. As predicted, t-tests revealed a significant CR effect, $t(30) = 5.68$, $p < .001$, and significant CS effect, $t(30) = 3.96$, $p < .001$, in memory for Asian face stimuli in the Caucasian participant group, as well as a significant CR, $t(30) = 4.43$, $p < .001$, and CS effect, $t(30) = 2.62$, $p < .05$, in memory for Caucasian face stimuli in the Asian participant group. Thus results support the prediction that for out-group faces, context significantly influences memory.

Contrary to our predictions, however, t-tests revealed a significant CR effect, $t(30) = 4.19, p < .001$, and significant CS effect, $t(30) = 3.87, p < .05$, in memory for Caucasian face stimuli in the Caucasian participant group, as well as a significant CR, $t(30) = 5.86, p < .001$, and CS effect, $t(30) = 3.03, p < .05$, in memory for Asian face stimuli in the Asian participant group. See Figures 7 and 8 for graphical depictions of these patterns of results.

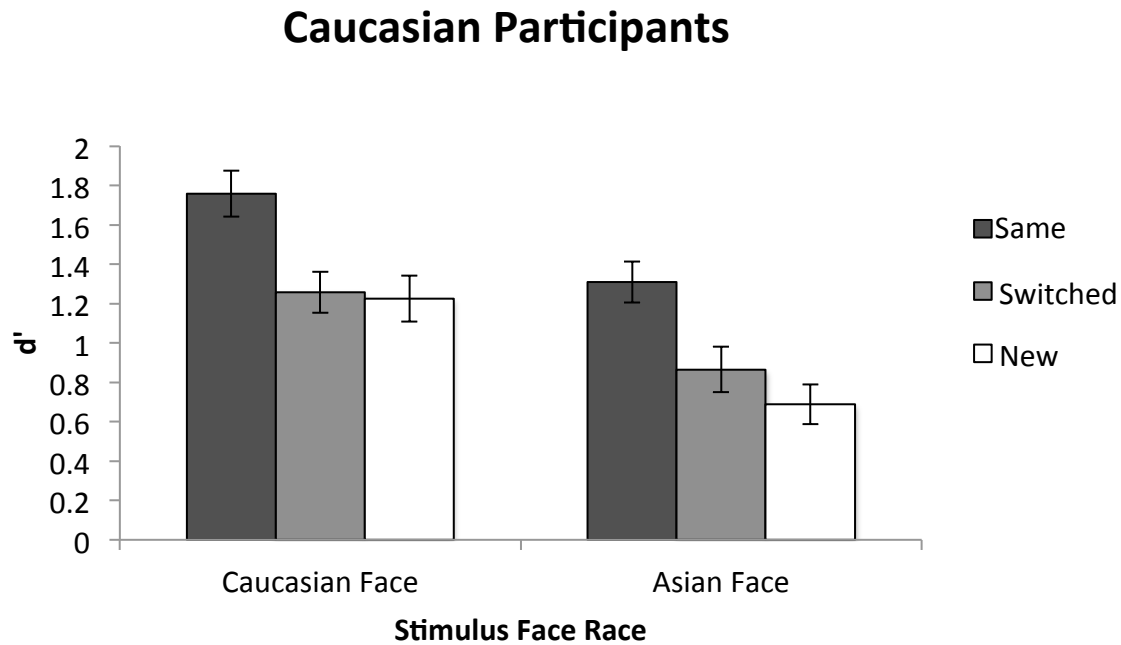


Figure 8. Experiment 5: Recognition memory for faces as measured by d' scores for stimulus face race by context type at test for entire sample

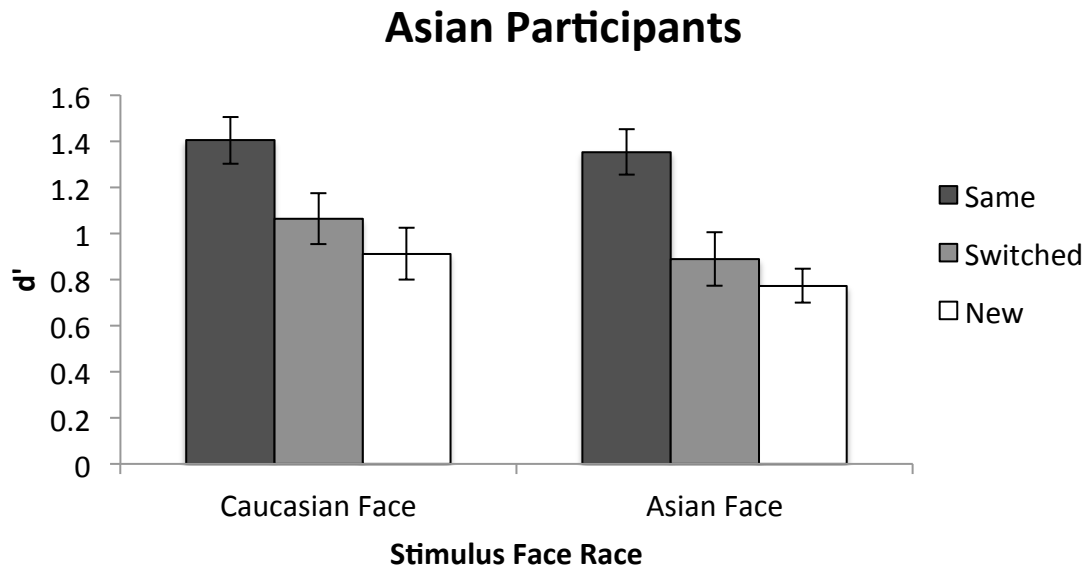


Figure 9. Experiment 5: Recognition memory for faces as measured by d' scores for stimulus face race by context type at test for entire sample

One explanation for our lack of significant interactions is that participants may not have identified ‘purely’ with one group versus another. Rather, the faces we considered to be one’s out-group may not have been strongly so, perhaps because participants in our study are exposed to out-group faces regularly in our University’s unique multi-cultural population, thereby diminishing the out-group status of such faces. Additional analyses were conducted to further investigate this issue.

4.3.2 Controlling for Other-Race Exposure

It seemed optimal to look at percentages of in-group and out-group friends across the entire life span and also at the current moment, as there may have been more or less exposure to out-group faces during different time periods in the participants’ life. To control for the issue of exposure, a 2 (Participant Race) X 2 (Stimulus Face Race) X 3 (Context Type) ANOVA was

conducted with exposure to each race controlled for by using the measures participants provided post-study, regarding the participants' percentage of friends at the current moment and over their lifetime that were Caucasian and Asian. Specifically, the above analyses were repeated twice. In the first follow-up ANOVA, participants were only included if they rated having 80% or greater of same race friends over their entire life spans and 20% or less of the other race friends over their entire life spans. This reduced the sample size to $N = 17$ in the Caucasian group and $N = 17$ in the Asian group. In the second follow-up ANOVA, participants were only included if they rated having 80% or greater of same race friends for current friends, and 20% or less of the other race friends for current friends (leading to a remaining $N = 17$ in the Caucasian group and $N = 13$ in the Asian group). Results of these re-analyses indicated patterns identical to those of the entire sample, with no significant interactions.^{6,7}

4.4 Discussion

As suggested by past research, in-group faces should have been more distinctive to an individual relative to out-group faces, and therefore we should have seen larger context effects

⁶Analysis of participants with a high percentage of in-group friends and a low percentage of out-group friends over their entire life span indicated a non-significant main effect of participant race, $F(1, 32) = .33$, $MSE = .58$, $p > .05$, suggesting that memory performance was similar across both participants groups. Results also indicated a significant main effect of Stimulus Face Race, $F(1, 32) = 18.23$, $MSE = .38$, $p < .001$, and as expected, a significant main effect of Context Type, $F(2, 64) = 34.39$, $MSE = .17$, $p < .001$. Unfortunately, the Stimulus Face Race X Context Type interaction was non-significant, $F(2, 64) = .15$, $MSE = .22$, $p > .05$, as well as the Participant Race X Context Type interaction, $F(2, 64) = 2.16$, $p > .05$. The three-way Stimulus Face Race X Participant Race X Context Type interaction was also non-significant, $F(2, 64) = .74$, $p > .05$. Though the interactions were not significant, specific a priori predictions allowed for an examination of CR and CS effects within each participant race group for each face race type. As predicted, t-tests revealed a significant CR effect, $t(16) = 3.77$, $p < .05$, and significant CS effect, $t(16) = 2.74$, $p < .05$, in memory for Asian face stimuli in the Caucasian participant group, as well as a significant CR, $t(16) = 4.54$, $p < .001$, and a marginally significant CS effect, $t(16) = 1.91$, $p = .07$, in memory for Caucasian face stimuli in the Asian participant group. Not in line with predictions, t-tests revealed a significant CR effect, $t(16) = 2.32$, $p < .05$, and significant CS effect, $t(16) = 3.29$, $p < .05$, in memory for Caucasian face stimuli in the participant Caucasian group, as well as a significant CR, $t(16) = 6.70$, $p < .001$, and CS effect, $t(16) = 2.64$, $p < .05$, in memory for Asian face stimuli in the Asian participant group.

for the in-group than the out-group faces in Experiment 5. As previously discussed, distinctive faces hold similar properties to familiar faces, such that they both allow for the target stimuli to behave as a cue for itself by providing a stronger signal relative to non-distinct and unfamiliar faces. In turn, a significantly reduced effect of CR and CS for in-group relative to out-group faces was predicted, since the outshining hypothesis holds that the benefit of reinstating context is lost for familiar stimuli. In line with predictions, results revealed the presence of both CR and CS for out-group faces (Caucasian faces for Asian participants and Asian faces for Caucasian participants), supporting the notion that in-group faces were less susceptible to the effects of context change from encoding to test. Contrary to predictions, we did not see a reduction in CR and CS for in-group faces (Caucasian faces for Caucasian participants and Asian faces for Asian participants). Results of the current experiment revealed significant effects of context reinstatement and context specificity in all conditions, not supporting our original hypotheses.

4.4.1 Limitations of Current Design

The idea that exposure to out-group faces may mediate the own-race bias has been suggested by many (Brigham & Ready, 1985; Feingold, 1974; Luce, 1974; Wright, Boyd, &

⁷Analysis of participants with a high percentage of in-group friends and low percentage of out-group friends at time of test indicated a non-significant main effect of participant race, $F(1, 28) = .92$, $MSE = .55$, $p > .05$, suggesting that memory performance was similar across both participants groups. Results also indicated a significant main effect of Stimulus Face Race, $F(1, 28) = 16.28$, $MSE = .43$, $p < .001$, and as expected, a significant main effect of Context Type, $F(2, 56) = 40.14$, $MSE = .15$, $p < .001$. Unfortunately the Stimulus Face Race X Context Type interaction was non-significant, $F(2, 56) = .40$, $MSE = .21$, $p > .05$, as well as the Participant Race X Context Type interaction, $F(2, 56) = 2.55$, $p = .088$. The three-way Stimulus Face Race X Participant Race X Context Type interaction was also non-significant, $F(2, 56) = 1.99$, $p > .05$. Though the interactions were not significant, specific a priori predictions allowed for an examination of CR and CS effects within each participant race group for each face race type. As predicted, t-tests revealed a significant CR effect, $t(16) = 3.32$, $p < .05$, and significant CS effect, $t(16) = 3.68$, $p < .05$, in memory for Asian face stimuli in the Caucasian participant group, as well as a significant CR, $t(12) = 3.71$, $p < .05$, but a non-significant CS effect, $t(12) = 1.39$, $p = .19$, in memory for Caucasian face stimuli in the Asian participant group. Not in line with predictions, t-tests revealed a significant CR effect, $t(16) = 2.63$, $p < .05$, and significant CS effect, $t(16) = 4.61$, $p < .001$, in memory for Caucasian face stimuli in the participant Caucasian group, as well as a significant CR, $t(12) = 5.24$, $p < .001$, and CS effect, $t(12) = 3.12$, $p < .05$, in memory for Asian face stimuli in the Asian participant group.

Tredoux, 2003), though there are those who argue that there is no such mediation (Brigham & Barkowitz, 1978; Cross, Cross, & Daley, 1971; Malpass & Kravitz, 1969). In light of the results of Experiment 5, it seems necessary to explore the possibility of an effect of out-group exposure. As previously mentioned, Brigham and Ready (1985), along with Wright and colleagues (2003) have suggested that it may not only be the race of the person that is important in own-race bias effects, but also the amount of exposure one has to other-race faces.

To circumvent this issue, along with strict pre-screening criteria, a post-study questionnaire was administered to allow for further investigation of out-group exposure on the context effects in question. However, even after taking exposure to out-group faces both over the entire life span and at the time of testing into consideration, results were still unclear.

This leads to consideration of a predicament in the current sample, such that at the University of Waterloo, the populations of Caucasian and Asian students are almost equal in number, and therefore exposure to both races occurs simply from being on campus on a daily basis. Although we controlled for friendships with the other race group at the current moment and over the entire life span, mere exposure may be enough to deplete any own-race biases that may have been present beforehand, and exposure does not necessarily involve friends. This may be why we did not see any differences in the effects of context across the different race groups. Wright, Boyd, and Tredoux (2003) also described how varying inter-racial contact can render the own-race bias null and they even contend that exposure to a specific race is more important than the participant's race itself.

4.4.2 Conclusion

Although the current study did not reveal face distinctiveness, based on own-race knowledge, to be an important factor in how context influences memory for a face, we can

conclude that, as predicted, out-group faces were significantly influenced by context effects (presence of both CR and CS). Contrary to the original prediction that in-group faces would receive immunity against context effects on memory, in-group faces still suffered from a change of context from study to test (once again, presence of CR and CS). As discussed, there is the issue that due to the sample, it may not be possible to conclusively say that a subset of the faces in the current study were truly distinct from one another while the other subset was non-distinct to the participants. It is only when an experimental manipulation can be created in which some faces can be made to be truly distinctive while the other faces can be made to be very non-distinct that we can make solid conclusions about the role that distinctiveness of a face may play in context effects. One way to eradicate this issue may be to use a group of caricatures and manipulate specific distinctive features between the face stimuli (e.g., thick eyebrows, big chin, big ears, etc.), and present these along with a group of caricatures that all have very similar and standard or averaged features.

What can be definitively concluded from Experiment 5, however, is that the effects of context are strong and reliable, and that Western (Caucasian) and Eastern (Asian) cultures seem to be similarly affected by changes of context from study to test. The finding that context effects are culturally similar is quite fascinating, as there is a large body of research indicating significant differences in cognitive processes between Western and Eastern cultures, with Westerners tending to be more analytic and Easterners tending to be more holistic in processing (see Varnum, Grossmann, Kitayama, & Nisbett, 2010). The influence of context on memory seems to be robust and culturally universal.

Chapter 5

The Role of Expecting to See a Specific Face in a Specific Context on Context Effects in Memory

5.1 Introduction

From experience, we know that even though a face is familiar, we may still experience difficulty in recognizing that face when there is a change in context. The purpose of this experiment was to examine how the expectancy of a face + context pairing may change how contexts influence face memory, even when a face is familiar. This idea came from the real-life experience that I recently had where I was unable to recognize my landlord when I encountered her at the local supermarket. This failure in memory seemed puzzling, as I had several encounters with her over many years, and her face was familiar to me through multiple repeated exposures. However, what was important to note was that there was an additional factor at work here. In the past, I had always encountered my landlord in the exact same context (the building office), but this time I was seeing her in a completely *unexpected* context. Can expecting to see a specific face in a specific context override the immunity found by familiarity in Experiments 3 and 4?

As outlined previously, the outshining hypothesis (Smith, 1988; 1994; Smith & Vela, 2001) suggests that target and context act as cues for one another, and when the strength of the target item is weak relative to the strength of the context cue, a benefit of reinstating context will be observed. This explains the findings of Experiments 3 and 4 where both CR and CS were apparent for unfamiliar target stimuli, but the effects were lost for familiar target stimuli. The outshining hypothesis, however, predicts a different pattern of results for target stimuli (faces) that are equally familiar, but paired with either the same or different context scenes during a

number of repeated exposures in the study phase. This theory suggests that with repeated face + context pairings the cue association formed between the two stimuli should be reinforced and therefore a greater detriment to recognition of the face should be observed when the context is changed at test (switched or new). However, when a face is paired with a different context at each presentation during study, a cue association should not be strongly established between that face and any specific context. If there indeed is no association of a face to any context, no detriment in recognition of the face should be observed when context is changed at test.

In accordance with this theory, it is predicted that faces viewed with the same context a repeated number of times (expected condition) may be more susceptible to context change at test, and therefore robust CR and CS effects should be identified. For faces viewed with a different scene each time (unexpected condition), on the other hand, changing the context should not matter, and so a loss of CR and CS should be found.

When discussing conditions such as the expected and unexpected conditions of the current paradigm, it is important to consider the classic *fan effect* (Anderson, 1974), which refers to the phenomenon that as the number of known facts about a particular concept increases, the length of time to recall any one fact about that concept significantly increases. Research has extended this idea to the realm of contexts effects and memory accuracy, and has indicated that the benefit of context reinstatement is modulated by the fan of the context, where the fan of the context is defined as the number of memories associated with a given context (Diana, Peterson, & Reder, 2004; Park, Arndt, & Reder, 2006; Reder, Donavos, & Erickson, 2002). In terms of “fan”, in the current paradigm, the contexts in the unexpected condition would have high fan, as each face was paired with many different contexts, whereas the contexts in the expected condition would have low fan, as the faces were paired with the same context every time. The

SAC model of memory (e.g., Diana, Reder, Arndt, & Park, 2006; Reder et al., 2002) suggests that the boost in memory seen when context is reinstated is lost when an encoding context is associated with many study episodes. Therefore, in terms of the conditions in Experiment 6, the SAC model predicts an attenuated CR in the unexpected condition (high fan) and a maintained CR in the expected condition (low fan), similar to predictions made by the outshining hypothesis.

5.2 Method

5.2.1 Participants

Thirty-five undergraduate students completed the study (24 females, M age = 20.43, SD = 2.28, Range = 18-27 years). Participants were recruited through the University of Waterloo's SONA system. All students were enrolled in undergraduate Psychology classes and received course credit or token monetary remuneration for their participation.

5.2.2 Materials

Stimuli were identical to those of Experiment 1.

5.2.3 Procedure

The procedure replicated that of Experiment 1's active linking condition, with the exception that all faces and all contexts were viewed 3 times during the study phase, in an inter-mixed, random order, and that half of the faces were paired with the exact same context when viewed each time, and the other half were paired with a different context each time it was presented. This design ensured that all faces and all context scenes were equally familiar (viewed 3 times each). Forty-eight unique face and scenes were presented in the manner described, equaling a total of 144 encoding trials, with 24 faces and scenes in the expected condition and the other 24 in the unexpected condition. Stimuli were presented for 2500 msec during encoding. All participants were asked to make a rating on a scale of 1-6 by pressing a key on the horizontal

numerical keypad on a standard keyboard for how likely it was they thought that the face was somehow associated or related to the scene, thereby encouraging associative linking of the face and context. Later at test, all 48 faces from encoding along with 48 lure faces were presented only once, paired with a same, switched, or new context. Stimuli were presented for a maximum of 5000 msec, however participants were encouraged to make their recognition judgments as “quickly and accurately as possible”. See Figure 9 for sample trials.

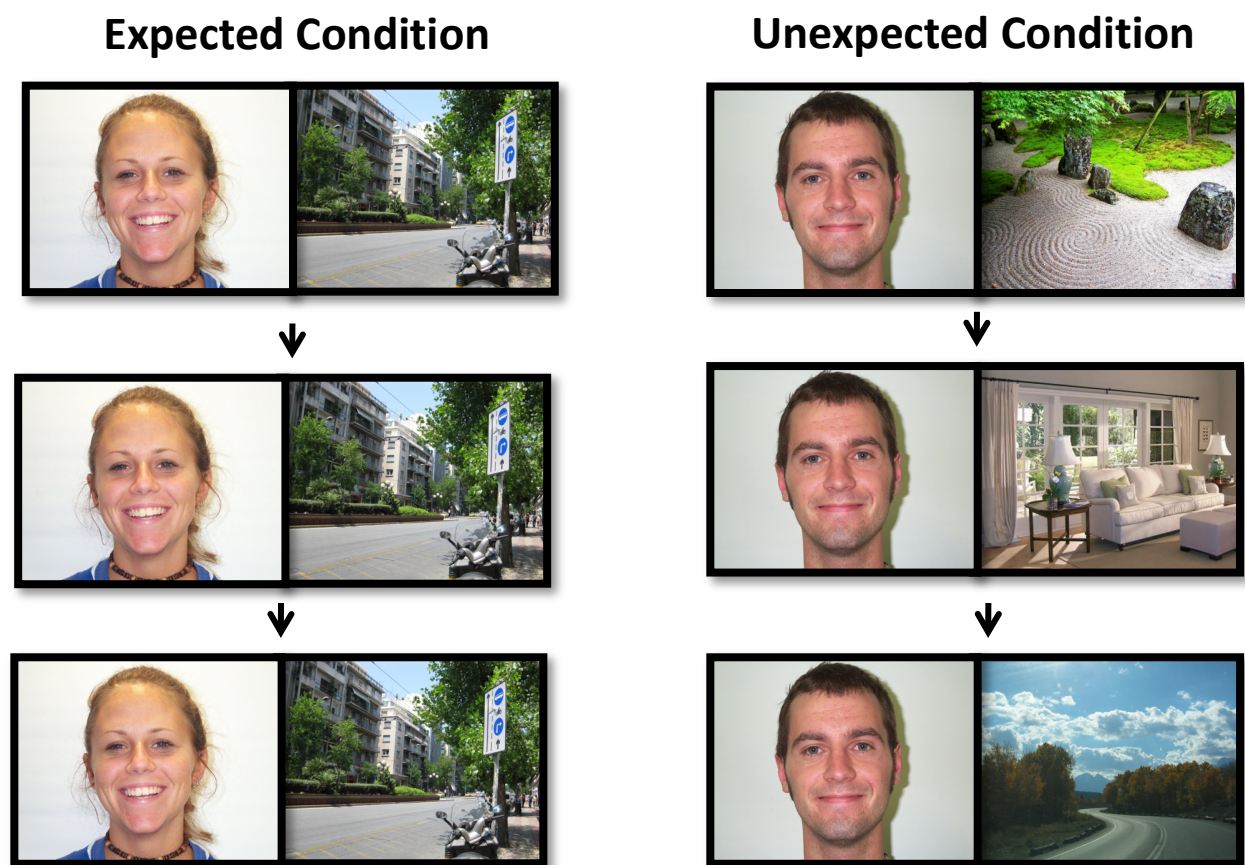


Figure 10. Experiment 6: Depiction of different trial types presented during encoding

5.3 Results

5.3.1 Memory

As in previous experiments, d' was calculated for overall memory scores: we added R + K hits for calculation of proportion hits for each expectancy condition, and R + K false alarms for overall false alarm proportions. The influence of context on d' for overall memory scores was evaluated using a 3 (Context Type) X 2 (Expectancy) repeated measures ANOVA, with Context Type (same, switched, new) and Expectancy (expected - face paired with same context three times, unexpected – face paired with a different context each time) as within-subject factors. Means for d' and hit rates are presented in Table 9. The mean overall false alarm rate was .06 ($SD = .09$).

Table 9. Experiment 6 d' Scores and Hit Rates, with Standard Deviations in Parentheses, as a Function of Expectancy by Context Type at Test

	Expected		Unexpected	
	d'	Hit Rate	d'	Hit Rate
Same	2.94 (.58)	.91 (.10)	2.88 (.63)	.89 (.13)
Switched	2.65 (.69)	.81 (.16)	2.81 (.65)	.87 (.17)
New	2.73 (.66)	.81 (.14)	2.85 (.77)	.84 (.15)

As predicted, a significant main effect of Context Type was found, $F(2, 68) = 3.09$, $MSE = .18$, $p = .05$, with simple effects contrasts revealing that faces paired with same contexts were marginally better remembered than faces paired with new contexts at test, $F(1, 34) = 2.83$, $MSE = .34$, $p = .10$ (trending CR effect), and faces paired with same contexts were better remembered than faces paired with switched contexts at test, $F(1, 34) = 7.73$, $MSE = .27$, $p < .05$ (CS effect). In addition, a significant main effect of Expectancy was found, $F(1, 34) = 4.90$, $MSE = .06$, $p <$

.05, such that, in general, faces in the unexpected condition ($Mean d' = 2.85, SD = .60$) were better remembered than faces in the expected condition ($Mean d' = 2.77, SD = .56$). Unfortunately, the Context Type X Expectancy interaction was non-significant, $F(2, 68) = 1.68, MSE = .15, p > .05$.

However, because we had a priori predictions, means within each Expectancy were further examined, revealing a significant CR effect, $t(34) = 2.45, p < .05$, and significant CS effect, $t(34) = 3.06, p < .005$, in the Expected condition, but non-significant CR effect, $t(34) = .25, p > .05$, and CS effect, $t(34) = .74, p > .05$, in the Unexpected condition.

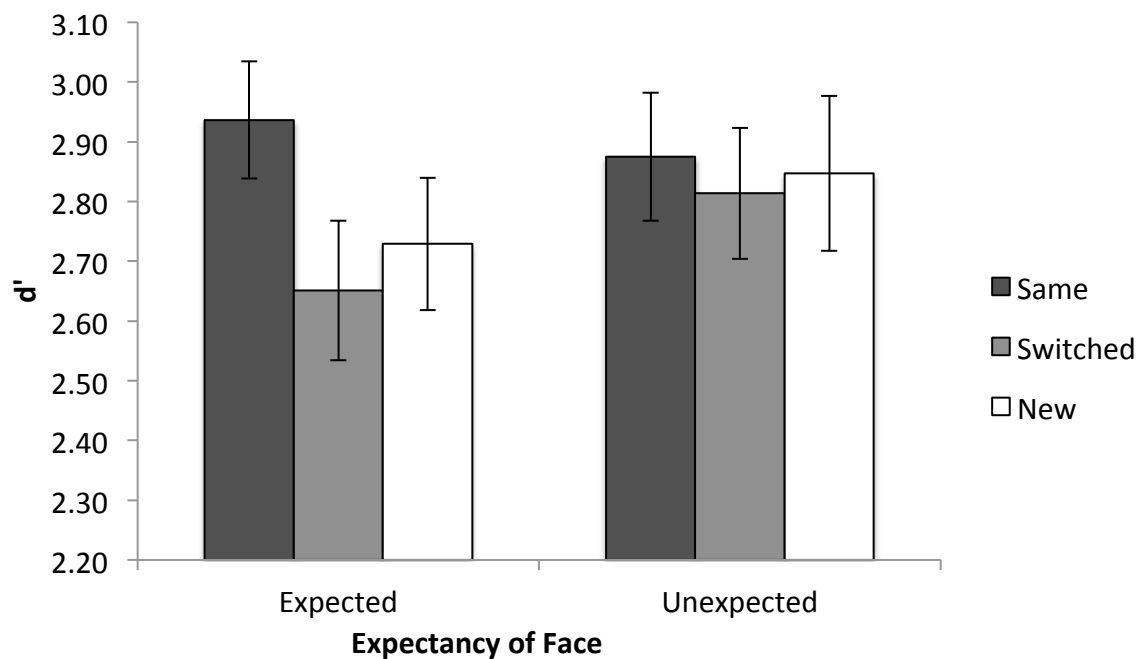


Figure 11. Experiment 6: Recognition memory for faces as measured by d' for expectancy of face by context type at test

5.4 Discussion

5.4.1 Summary of Experiment 6 Results

As predicted, results indicated robust CR and CS effects in the expected condition, but a loss of both effects in the unexpected condition. The outshining hypothesis clearly explains these results, suggesting that with the repeated face + context pairings in the expected condition, the cue association formed between the two stimuli was reinforced, in turn leading to a greater detriment to recognition of the face when the context was changed at test (switched or new). However, when the face was paired with a different context at each presentation during study in the unexpected condition, the cue association was not strongly established between that face and any specific context, as revealed by the finding of no detriment in recognition of the face when context was different from study to test. Additionally, the SAC model also predicted an attenuated CR in the unexpected condition (high fan) and a maintained CR in the expected condition (low fan), because the boost in memory seen when context is reinstated is lost when an encoding context is associated with many study episodes. Future empirical work is necessary to tease apart these theories and further understand the specific mechanism at play behind the different effects found across the expected and unexpected conditions.

5.4.2 Alternate Hypothesis

A curious finding in the current results was that better memory was found for faces in the unexpected condition relative to the expected condition, which lead us to consider a possible alternative explanation. Perhaps as a face is presented each time during encoding with a different context (unexpected condition), the novelty of the pairing lead participants to pay greater attention to the face + context pair, leading to a strengthened representation of the face in memory. If the face had a strong enough signal on its own, memory for that face would be less

likely to be affected by context changes from study to test (as suggested by Experiments 3 and 4). This hypothesis is viable especially considering the finding presented earlier in this thesis that attention may be important for context effects (Experiment 2). On the other hand, for faces presented repeatedly with the same context at encoding (expected condition), these pairs of face + context may have lost novelty to the viewer, therefore reducing the amount of resources, or attention, paid to the pair and in turn leading to a diminished representation of the face in memory. One way to test the validity of this alternate hypothesis would be to examine memory for the contexts as well as memory for the faces. If our prediction about novelty were in fact correct, the memory representation for contexts in the unexpected condition would also be stronger than for those in the expected condition. Unfortunately, data for memory of the contexts were not collected in the current work, nevertheless, this would be quite an intriguing avenue of future research.

5.4.3 Conclusion

Taking these results in light of Experiments 3 and 4, which suggested that familiarity with a face leads to an immunity against the effects of context change on face memory, the current experiment suggests that expectancy can override the immunity of familiarity. In other words, even though all faces had become familiar to the observer (as they were each viewed 3 times, which in Experiment 4 proved to be enough repetitions to form an immunity against context effects), whether these now familiar faces were paired repeatedly with the exact same context or with a different context during study influenced whether context had an effect on face memory. Interestingly, when a face was expected to be paired with a specific context, the effects of changing the context at test are robust.

Relating this finding back to the example provided earlier of my encounter with my previous landlord, results of the current experiment suggest that my failure to recognize her face was due to the fact that I had repeatedly been exposed to her in the same context during all previous encounters. Therefore, when I encountered her in the supermarket (an unexpected context), I was no longer able to use the office as a memory cue, leading to memory failure when attempting to recognize her face.

Chapter 6

General Discussion

6.1 Summary

How does context information influence memory, and what factors modulate this effect? The effect of context on memory was the central focus of the current PhD thesis and was examined across six experiments. In the current experiments, memory for faces was examined in conditions modeled after those experienced in everyday life. Specifically, faces were presented at study paired with a variety of indoor and outdoor context scenes (e.g., park, supermarket, swimming pool) and a recognition memory test ensued in which faces were paired with either the same contexts (exact same context the face was paired with at encoding), switched contexts (a context that was presented at study, but not presented with that particular face), or new contexts (a context never before seen), relative to encoding. The inclusion of such trial types on a recognition test allowed for the examination of factors affecting the well-established *context reinstatement effect* - the boost in memory observed for target items re-presented with the same context at both study and test, as well as our newly coined *context specificity effect* – the boost in memory when a familiar, though not identical, context from study is re-presented with a target item. The use of unfamiliar faces paired with unfamiliar context scenes allowed for the examination of episodic memory while avoiding problems of using verbal information as stimuli, which hold considerable pre-existing semantic content, potentially biasing performance (Tulving, 1972).

In Experiment 1, the importance of instructions at encoding – specifically, actively, or passively linking the target (face) and context (environmental scene) – was examined. Maintaining the same context at retrieval as at encoding reliably enhanced overall detection, and

recollection, of studied faces relative to when memory was assessed within a new context, replicating the known context reinstatement effect. Notably there was also a reliable memory benefit when faces were paired at test with the exact same, relative to a familiar, though switched context, indicating a context specificity effect on memory. Encoding instructions to either actively link or passively view face-context pairs during encoding did not influence the presence or magnitude of the CR or CS effect. In Experiment 2, we showed that dividing attention did not influence CR, but eliminated the CS effect on overall memory. Findings suggest that the general boost to memory, from reinstating the same relative to a totally new context at test, is robust, though linking specific contexts to targets is hampered when attention is limited during encoding.

In Experiments 3 and 4, we showed that familiarity of the face to the observer interacts with these context effects. In Experiment 3, face familiarity was manipulated by presenting famous and non-famous faces during encoding. The CR effect was reduced for famous relative to non-famous (unfamiliar) faces, though the CS effect remained. In Experiment 4, degree of familiarity was controlled by pre-exposing the completely unfamiliar study faces 0, 1, 3, or 10 times without an accompanying context before encoding. We showed that after just one pre-exposure to an unfamiliar face, the CR and CS effects were reduced. Results suggest that the effect of context reinstatement on memory must be qualified such that the effect only applies to novel faces; once a face becomes familiar, other factors, such as strength of the memory signal, seem to guide performance. The aim of Experiment 5 was to explore in another way whether familiarity of faces influenced the CR and CS effects.

In Experiment 5, we examined whether distinctiveness of a face, to the participant, influenced the effects. Based on results from Experiments 3 and 4, it was predicted that we

should see the presence of both CR and CS for out-group faces (Caucasian faces for Asian participants and Asian faces for Caucasian participants), as these are akin to unfamiliar faces, but we should see a reduction in both CR and CS for in-group faces (Caucasian faces for Caucasian participants and Asian faces for Asian participants), as these are akin to familiar faces. Results indicated no difference in CR nor CS across the conditions, suggesting that distinctiveness, as defined by in-group or out-group status of the faces to the participant, did not influence CR or CS effects. Interestingly, from the results of Experiment 5, we were able to conclude that context effects may be robust and culturally universal.

In the final experiment, the relative expectancies of face-scene pairings were manipulated. From experience, we know that even though a face is familiar, we may still experience difficulty in recognizing that face when there is a change in context. In Experiment 6, how the expectancy of a face + context pairing influenced CR and CS effects was examined when all target faces were equally familiar. We found robust CR and CS effects for faces in an ‘expected condition’ (faces repeatedly paired with the same context during study), but a loss of both effects in an ‘unexpected condition’ (faces paired with varying contexts during study).

What can be generally concluded from the series of experiments presented in this thesis is that memory for to-be-remembered items is indeed influenced by context. Moreover, specific factors modulate such context effects, and these include attentional resources during encoding, the level of familiarity of the target to the observer, and lastly, the expectancy of seeing a specific face + context paired together.

6.2 Theoretical Implications

To date, there have been some opposing opinions about how target and context information interact in memory. The current data help to shed light on this controversial issue.

Older global activation models (Murnane & Phelps, 1993, 1994, 1995) suggest that memory representations contain both context and item information, and that memory is activated depending on the degree of match between the information in the cue and in memory, as well as the summed activation from all activated memory representations. This account predicts no CS effect (Murnane & Phelps, 1994), no differences in response times across same, switched, and new conditions, and no differences in the magnitudes of CR and CS effects, regardless of whether memory is for familiar or for unfamiliar target items.

The outshining hypothesis (Smith, 1988; 1994; Smith & Vela, 2001), alternatively, suggests that the target and the context act as cues for one another: When the strength of the target item is weak relative to the strength of the context cue, a benefit of reinstating context will be observed. The outshining hypothesis predicts a CS effect, as well as similarly fast RTs for correct responses to targets paired with the same and new contexts, and slowest response times for switched contexts, as well as a reduction in both CR and CS effects when target items are familiar relative to unfamiliar to an observer.

Tulving (1974) had also proposed a theory for how context could influence memory, in which he similarly described target and context information as acting as cues for one another. One part of Tulving's (1974) cue-dependent forgetting theory suggests that the environmental setting or the physical surroundings in which information is encoded acts as a cue at test when the same environment is reinstated. Tulving (1974) described cue-dependent forgetting as the phenomenon that information stored in long-term memory may not be accessible because there is no suitable retrieval cue from the environment to trigger the memory. Like the outshining hypothesis, this theory suggests a relative benefit when a specific context cues a specific target

face (as in our same trial types) compared to when the context cue is familiar despite never having been directly paired with the target during encoding (similar to our switched trial types).

Results from Experiments 1 through 6 have each supported predictions made by the outshining hypothesis and the cue-dependent forgetting theory, and fit agreeably within the parameters outlined by these theories. As previously noted, Nairne (2002) and Goh and Lu (2012) have suggested that the degree of match alone may not be the key factor determining what is ultimately remembered, and that what may actually be critical is the diagnostic value of retrieval cues, which can be defined as the degree to which retrieval cues provide diagnostic information about the target. Our study echoes this idea in that we showed that it is not only the familiarity one has with a particular context that aids memory, but also whether the context information presented at test acts as a cue that uniquely specifies a particular face.

In addition, although the results of this thesis were not in line with predictions made from older global matching models, the results do offer some support for Murnane and colleagues' (1999) newer item, context, ensemble (ICE) theory, which is a built-upon version of the global matching models. This model is less concerned with the degree of match between test probe and memory, and is focused more on describing the way in which items and contexts are stored in memory. The ICE theory purports that three types of information are used when recognizing an item: the item, the context, and the ensemble (ensemble = item + context information). They argue that context becomes integrated with target information during encoding to form an ensemble, which later improves recognition performance when context is reinstated. Within this theory, it is suggested that results may vary depending on whether hit rates, false alarm rates, or d' are examined. Specifically, the model advocates that if memory representations for the item and the context are stored separately, then no differences should be found between context

conditions at test (no CR and no CS) when looking at d' . This is because according to ICE theory, both hit rates and false alarm rates should increase when context is reinstated, leading to no changes in d' . However, if there is an ensemble memory, reliable differences between the various context conditions at test would be revealed in d' , since hit rate should increase but false alarm rate should not. Therefore, when considering the ICE theory, results of the current thesis support the idea that target and context information may be stored as an ensemble, as we showed changes in d' depending on context condition at test.

In sum, from the line of research presented in this thesis, it can be concluded that context provides important diagnostic information regarding the target item, which guides memory performance, and the target and context may be stored as an ensemble in memory.

6.3 Limitations

Limitations of the current design specific to each experiment have been outlined within each chapter. However, there is an important general limitation of the current line of research that is imperative to note. This issue arises from the use of static photographs, reducing the ecological validity of the stimulus set. In the real world, humans are not still figures within still scenes, but are rather constantly in fluid motion and interacting with the surrounding context. For example, when you see a woman in a supermarket, you would see her pushing a cart down the aisle, or reading the ingredients on a jar of pasta sauce. A more generalizable set of stimuli for a memory task involving a target and context at both study and test would involve video clips of different people in different context scenes. However, such stimuli would introduce a massive set of additional problems, including the difficulty of equalizing the degree of movement of all objects across each trial, as excessive movement within one aspect of the scene may draw away attention from more stationary aspects of the scene. Moreover, different interactions of the to-be-

remembered person with the environment could bias results – for example, a man jumping off a high diving board into a swimming pool (significant interaction between the person and the context) may be more memorable than a man idly sitting in a library reading a book (little interaction between the person and the context). These issues with video stimuli are primarily why the current stimulus types were chosen for this research as a first look into the effect of context on memory for faces and the factors that are involved.

Additionally, there is a notable limitation of the current interpretation of results, such that in all of the outlined experiments the poor performance on the new context trials at test relative to performance on the same context trials may have been due simply to novelty effects. That is, the novelty of a new context presented during the test phase may have attracted attention to this context and away from the face, leading to the poorer performance on those trials relative to the same context trial types. This would suggest that reinstating the same context did not boost memory, but rather, memory was impaired in the new context trials, accounting for the CR effect. However, if the difference between same and new contexts at test was due solely to novelty effects rather than to a boost in memory by reinstatement of same contexts, there should have been no CS effect, since switched and same context trials were equally familiar (both were presented in the study phase). If the CR effect was simply due to novelty effects in new context trial types, we should not have seen an increase in memory performance in same relative to switched context trials (no CS effect), as there were no novelty difference between these trials. The existence of a CS effect supports the conclusion that within the CR effect, memory is being boosted by reinstatement of a same context.

6.4 Application

A highly applicable extension for this research is in eyewitness identification. Many studies have indicated that eyewitness reports can be highly unreliable (Loftus, 1974; 1976; 1979; Loftus & Palmer, 1974; Loftus & Zanni, 1975). Wong and Read (2011) demonstrated just how important context is in the correct identification of a criminal by an eyewitness. They had participants watch a video of a crime and then asked them to come back one week later to identify the perpetrator from a lineup, as well as to recall the event. Half of their participants were tested in the same physical environment in which they originally viewed the video, while the other half were tested in a different physical environment. Results suggested that participants were more willing to identify someone in the lineup in the reinstated relative to new context. Moreover, reinstating the study context led to more accurate recall of both central and peripheral details of the crime, as well as more accurate cued recall of peripheral details. The current results support Wong and Read's (2011) work in suggesting that context is crucial in accurate recognition of a face and that it would be beneficial to have lineups held at the scene of the crime as opposed to at the police station. Our research indicates that reinstating the context would significantly improve accurate recognition of a perpetrator.

6.5 Future Directions

As mentioned in Chapter 2, older adults would be an interesting group to consider when investigating context effects, especially since it has been shown that they may not spontaneously link target and context information in the same manner as younger adults (Bastin & Van der Linden, 2006; Bower & Karlin, 1974; Castel, 2005; Craik, 1982; Craik & Byrd, 1982; Naveh-Benjamin, 2000; Naveh-Benjamin & Craik, 1995; Naveh-Benjamin et al., 2004; Rhodes et al., 2008; Winograd & Rivers- Bulkeley, 1977; Underwood, 1969; Watkins et al., 1976).

In a study that investigated associative memory in aging, Castel and Craik (2003) had younger and older adults study unrelated word pairs, working under full-attention conditions (both age groups) or under divided-attention conditions (younger adults only). Memory for item information was measured by later recognition of the second word in the pair in the absence of the first word (no context), and associative memory was measured by recognition of the entire pair. Older adults in the full-attention condition and younger adults in the divided-attention condition performed more poorly than younger adults in the full-attention condition, demonstrating a deficit in both item and associative memory, but with the deficit in associative memory being greater. Others have shown that older adults who have been shown to have attention deficits have a difficult time associating target stimuli with context (e.g., Buchler, Faunce, Light, Gottfredson, & Reder, 2010). These researchers have concluded, from their research with older adults, that attention is important for the influence of context on memory, and suggest that deficits in associative memory may be due to the need, during encoding, for attention to link target and context information. However, these studies have only investigated CR.

The research conducted in this thesis suggests that in young participants, depleting attentional resources during encoding significantly reduces CS but not CR. Re-evaluating the literature in light of the current research, it seems that perhaps older adults' deficits in associative memory for target + context may not be wholly due to a reduction in attentional resources, since they reliably show deficits in CR whereas our young in our divided attention condition did not. It therefore seems critical to further examine the effects of context in an aging population and include conditions that allow for both CR and CS effects to be examined.

6.6 Conclusion

The aim of the current thesis was to examine the role that context plays in memory for to-be-remembered items. Specifically, memory for faces was examined in contexts akin to real-life situations (such as faces presented with images of supermarkets or parks). Experiments 1 through 6 demonstrated that context does indeed change how well a face is recognized. Maintaining the same context at retrieval as at encoding reliably enhanced memory for studied faces relative to when memory was assessed with a new context, replicating the known CR effect. We also showed a reliable memory benefit when faces were paired at test with the exact same, relative to a familiar (though switched) context, indicating a CS effect.

From the current research, it can further be concluded that particular factors significantly influence CR and CS. Specifically, significant CR and CS effects were found for both encoding instructions to actively link, or passively view, face-context pairs during encoding, suggesting that this linking may occur spontaneously. Furthermore, attention was found to be important for the CS effect, whereas the CR effect was immune to divided attentional resources during encoding. Familiarity of the face to the observer was also found to be an important factor that interacted with context effects, such that CR and CS were both attenuated when faces were familiar. It remains unclear how distinctiveness of a face may influence the context effects in question, as it was determined that memory for both in-group and out-group faces were affected by context changes from study to test. Finally, the relative expectancies of face-scene pairings was revealed to be critical, with robust CR and CS effects for faces repeatedly paired with the same context during study, but a loss of both effects when faces were paired with varying contexts during study. This may explain why we sometimes still experience difficulty in recognizing even a familiar face when there is a change in context.

So next time you meet someone for the first time, to improve later correct recognition of that face be sure to 1) make a connection between the person and the context, such as imagining someone you meet at a skating arena is a very good skater (as long as your next encounter will be in the same context; Experiment 1), 2) pay attention to the encounter (Experiment 2), 3) encounter him/her multiple times if possible (Experiment 3 and 4) and 4) try to always meet that face in the same context to boost memory for that face (Experiment 6).

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Appendix

Race Exposure Questionnaire

Please answer the following questions with a percentage score ranging from 1% - 100%.

Please note that your answers are anonymous and confidential, and you may choose not to answer one or all of the questions.

1. At the current moment, what percentage of your friends would you say are Caucasian?
2. At the current moment, what percentage of your friends would you say are Asian?
3. Over your lifetime, what percentage of your friends would you say have been Caucasian?
4. Over your lifetime, what percentage of your friends would you say have been Asian?