2011

Emotion's Influence on the Evaluation of Familiarity

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Emotion's Influence on the Evaluation of Familiarity

(Spine Title: Emotion and Familiarity)
(Thesis format: Monograph)

by

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Graduate Program in Psychology

A thesis submitted in partial fulfilment of the requirements for the degree of Master of Science

School of Graduate and Postdoctoral Studies
The University of Western Ontario
London, Ontario, Canada
August 2011

THE UNIVERSITY OF WESTERN ONTARIO
SCHOOL OF GRADUATE AND POSTDOCTORAL STUDIES

CERTIFICATE OF EXAMINATION

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The thesis by

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entitled:

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is accepted in partial fulfillment of the
requirements for the degree of

Master of Science

Date__________________________

Chair of the Thesis Examination Board

ABSTRACT AND KEYWORDS

Emotion enhances the encoding and consolidation of memory traces, leading to the salient reliving of emotional experiences. In the recognition memory literature, the induction of somatic arousal and feelings of perceptual fluency during retrieval have been associated with illusory familiarity. Understudied in this literature is an investigation into how one's emotional state, independent of stimulus content, influences recollective and familiarity-based recognition memory retrieval. Two priming paradigms were employed in the current thesis research to contrast the effects of affective priming and identity priming on familiarity and recollection using the Remember/Know procedure. Enhanced familiarity-based discrimination was revealed using affective priming, selective to participants with low overall recognition performance. Identity-priming resulted in a response bias, indicative of an induction of erroneous feelings of familiarity. Both manipulations failed to influence recollection. These results illustrate that a heightened affective state can provide selective benefits to familiarity, dissociating from a confused sense of familiarity induced through increased perceptual fluency.

Keywords: Emotion, Episodic Memory, Affect, Familiarity, Recollection, Amygdala, Arousal, Perceptual Fluency

ACKNOWLEDGEMENTS

I would like to thank the members of the Köhler lab, which includes, Ben Bowles, Ed O'Neil, Chris Martin, and Dr. Stefan Köhler. I would especially like to thank Victoria Barkley and Jordan Rozario for their assistance on much of the scheduling and programming for this thesis research. Dr. Köhler's enthusiastic guidance and training over the past two years has also been extremely influential.

I would also like to thank my mother, father, and sister for their enduring support and love.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1 Introduction

Emotion is a core attribute of subjective reality, effectively painting the internal representation of our multi-dimensional sensory environment in a way that guides behavior and social interaction toward biologically relevant personal goals (Lazarus, 1991). Emotion is known to shape the remembering of past personally experienced episodes and events. When personal events are experienced through an emotional lens, memory for these events can be significantly enhanced, oftentimes leading to a reliving of comparable salience. Determining how the vast spectrum of emotionality contributes to the absorption of moment-to-moment conscious experience for later memory assessment is undoubtedly vital for a comprehensive account of human memory systems. The goal of this thesis research is to advance our current understanding of the influence that a heightened emotional state has on recognition memory retrieval, and further, to investigate the qualitative nature of those memory experiences.

To date, research has dealt primarily with investigating the interactive nature of emotion and episodic memory. Episodic memory is defined as the ability to consciously remember past events, tied to a specific time and place (Tulving, 1972). The majority of studies on memory and emotion have concentrated on the tendency of emotionally arousing experiences to produce vivid subsequent recollections for those events. In other words, this research has consistently shown that the increased emotional salience of an event facilitates the encoding and consolidation of the multi-sensory elements that constitute an episodic occurrence, and allows for these contextual elements to be reinstated more efficiently during retrieval at a later time (Kensinger, 2009). William

James has described that, "An experience may be so exciting emotionally as almost to leave a scar on the cerebral tissue," when attempting to characterize the "burnt-in" effect that emotion seems to have on memory (James, 1890). The highly adaptive benefit of emotional memory enhancement is clear; being able to more efficiently reflect on emotionally and biologically significant past environmental interactions will allow an individual to avoid behaviour that in the past may have been dangerous, or gravitate toward repeating successful and opportunistic behaviours. For example, possessing a perceptually veridical representation of the layout of a dangerous area of town that you had been mugged in at some time would aid in the future avoidance of finding yourself in another possibly deadly situation.

1.1 Emotional Enhancement of Autobiographical and Laboratory Memories

There exists a general consensus in the empirical cognitive and cognitive neuroscience literature that emotional events are more likely to be later remembered as compared to events that are neutral in nature (LaBar & Phelps, 1997). Emotional experiences also tend to be remembered with higher levels of detail, particularly in the case of autobiographical memories that are of a negative valence. An interesting manifestation of emotion's action on event retention is the prevalence of "flashbulb" memories for events associated with strong fear or sadness (Brown & Kulik, 1977). Many individuals possess a detailed moment-to-moment recollection of highly arousing, consequential, and negative events, for example the day of September 11th, 2001. Other autobiographically relevant emotional memories, such as a birth of your first child, or the death of a loved one, are also recalled with extensive repetition and are characterized by an intense emotional reliving (Conway, 2000). Through the individual contributions of emotional valence and arousal, autobiographical and laboratory-created memories are made more durable, increasing the likelihood that an enduring memory trace is created.

1.1.1 Independent Contributions of Arousal and Valence

When defining the term "emotion" and its influence on memory processes, it is important to clarify that "emotion" consists of both an arousal and a valence component. Emotional "arousal" relates to the intensity of an emotional stimulus or event and has also been tied to the level of physiological excitement elicited by an emotion, while valence corresponds to whether an emotion is positive or negative in nature (Kensinger, 2004). Negative emotions such as fear, disgust, or sadness and positive emotions such as happiness, love, or pleasure, have been related to contrasting goal-directed motivational states with differing behavioural outcomes (Levine, 2004), with the later resulting in approach and the former resulting in withdrawal behaviours. Essentially, emotional valence results in changes to behaviour directly beneficial to survival, proving to be a valuable evolutionary tool that shapes the construal of our environment. Similarly, these two independent dimensions of emotion, valence and arousal, also offer highly beneficial, but contrasting, advantages to memory.

1.1.2 The Amygdala and Arousal

A subcortical structure in close proximity to the medial temporal lobe, the amygdala, has specifically been associated with the arousal component of emotional memories produced both in real-life and the laboratory (Gläscher & Adolphs, 2003). Arousal has been tied to the release of glucose and adrenal stress hormones (e.g., Cortisol) during emotionally arousing events, and results in the enhancement of memory encoding, made evident by the successful later recall of information. In non-human animals it has been demonstrated that arousal-mediated enhancement of memory is tied to the activation of β-adrenergic stress hormones within the amygdala (McGaugh, 1990). In humans, it has been found that the administration of a β-adrenergic antagonist (propranolol) prior to the presentation of emotionally arousing versus unemotional stories leads to a decrement in the subsequent recall of details for emotional but not for unemotional stories (Cahill et al., 1995). These studies illustrate the amygdala's critical role in memory enhancement related to emotional arousal.

It has also been observed that emotional arousal results in "focal" memory boosts for "intrinsic" aspects of an event (i.e., enhanced narrowing of encoding for the emotionally-relevant details) regardless of content valence (Kensinger, 2008). A specific example of this "narrowed" enhancement of encoding for the central aspects of an emotional event is the "weapons focus" effect (Loftus et al, 1987). It is a well documented observation that victims of robberies, domestic disturbances, and hijackings can vividly remember the weapon pointed at them, but often have difficulties in remembering details present in the periphery (e.g., facial identification of the perpetrator, details concerning other conspirators). During an emotionally intense experience it is adaptive to direct your attention to survival-relevant details (e.g., a weapon pointed directly at you) at the expense of momentarily insignificant aspects of that experience. While valence and arousal are both inevitably contributing to the emotional influence on memory encoding, valence has its own unique impact.

1.1.3 The Role of Valence

When considering valence independently, it has been shown consistently that emotional stimuli with both negative and positive valence are correctly remembered with a higher likelihood than neutral stimuli in typical study/test memory studies (Hamann, 2001). These types of memory studies involve an initial "study" phase where positive, negative, or neutral stimuli (oftentimes words or scenes) are exposed to a participant, followed by a later "test" phase where participants are to recall "old" words. Interestingly, there seems to be a particular enhancement of "focal" emotionally relevant aspects of an event for negative stimuli (e.g., anger, fear, disgust) (Kensinger, 2009). Interestingly, in the case that both negative valence and high arousal characterize an event or laboratory stimulus, there exists an additive boost in memory for the most emotionally consequential and salient aspects of scene (Kensinger, 2000). This targeted emotional memory enhancement was illustrated in a study by Christianson & Loftus (1991), revealing that the retention of details found within a laboratory presented scene of a car accident will involve more accurate recall of characteristics of the car that was destroyed or the positioning of a victim at the expense of irrelevant peripheral details (e.g., whether there was a stop or yield road sign nearby). If an event is both negative and highly arousing, retention of details will improve in comparison to events that are only negative, or only arousing but not particularly negative.

1.1.4 Enhanced Memory Consolidation

The effects of emotion permeate the boundaries of initial memory encoding, facilitating the off-line consolidation of emotional memories as well. Consolidation refers to the strengthening of memory traces that have been "dropped from consciousness," and can be conceptualized as the "sinking in" of a memory. The memory benefits afforded to emotional information can be particularly pronounced after delays, and is taken as enhanced consolidation (Sharot et al., 2007). Some studies have shown that the enhanced memory for emotional images studied in the laboratory exists a full year after initial learning (Dolcos, 2005). A night of sleep has also been shown to specifically enhance memory for negative emotional scenes relative to non-emotional scenes (Payne, 2008). It is known that emotional arousal induced through pairing a foot shock and an unconditioned stimulus in fear condition experiments in animals results in increased amygdala firing rates for nearly 2 hours after learning (Pelletier, 2005), and that amygdala activity promotes long-term potentiation in the hippocampus (Nakao, 2004). Using fMRI in humans, Ritchey et al. (2008) found that functional connectivity between the amygdala and MTL structures at the time of encoding predicted successful memory to a greater extent after a 1-week delay as compared to a 20-minute delay for emotionally negative images. These findings highlight the tendency for emotionally significant personal occurrences to be made selectively resistant to later forgetting.

1.1.5 Neural Substrates of Emotional Memory

The underlying brain-basis for emotional memory enhancement has been tied to a core emotion processing network consisting of the amygdala and orbitofrontal cortex and its interaction with medial temporal lobe (MTL) structures (Kensinger, 2009). The MTL is known to be vital for the formation and maintenance of episodic memories. When faced with emotionally significant stimuli, coordinated processing in the amygdala and orbitofrontal cortex has been shown to amplify sensory encoding processes taking place in category specific visual regions in the ventral visual stream (e.g., fusiform face area (FFA) and parahippocampal place area (PPA)) (Lim et al, 2009; Vuilleumier, 2007). The amygdala is known to modulate the rapid relational binding of sensory details into an integrated event representation via the hippocampus, a structure found within the MTL.

Evidence for this neural account of enhanced encoding comes from functional magnetic resonance imaging (fMRI) studies that have taken advantage of the "subsequent memory paradigm." The "subsequent memory paradigm" is commonly used in fMRI studies to determine what brain areas are critical for the successful encoding of information into memory. Activity associated with the initial presentation of a stimulus during the study phase of a memory experiment can be sorted subsequently according to whether that stimulus was later remembered or "missed." Using this technique, reliable amygdala and hippocampal coactivation has been reported to be present during the encoding of emotional stimuli that are subsequently successfully remembered as opposed to successfully remembered neutral stimuli (Kensinger & Corkin, 2004). During the retrieval of emotional memories, a similar amygdala-orbitofrontal-hippocampal activation pattern is evident, which is related to the vividness experienced during remembering (Daselaar, 2008).

The amygdala has been identified as a key structure that seems to amplify efficient associative binding encoding operations taking place in the hippocampus during emotional experiences. It is also evident that the amygdala enhances perceptual processing in category-specific ventral visual stream regions, highlighting that emotion specifically increases perceptual processing of stimuli held in attention. The contribution of emotional enhancement of memories through more efficient perceptual and attentional online processing must be considered when characterizing emotion's influence on memory.

1.2 The Facilitatory Effect of Emotion on Attention and Perception

Emotion has been found to increase the attentional demands allocated to stimuli, usually in the context of challenging perceptual tasks (Phelps & Carrasco, 2006; Vuilleumier, 2001). The "attentional blink" is a phenomenon that occurs during rapid serial visual presentation paradigms (RSVP), where individuals make quick identification decisions for target stimuli among many distracter stimuli (Raymond et al, 1992). Typical visual presentation latencies are around 100ms per image in sequence (Lim et al, 2009). There is an initial target stimulus that must be identified (T1 stimulus), followed by a second target of interest (T2 stimulus) that usually goes unnoticed due to attentional resources being consumed by the identification of the T1. When the second target is made emotional, the "attentional blink" is diminished, resulting in an increased ability to identify the second target as compared to neutral T2 stimuli (Anderson & Phelps, 2001). This study included words as stimuli, and compared the ability of participants to identify T2 words that were neutral (e.g., broom, distance) to words that were highly negative (e.g., rape, bastard). Interestingly, when a patient with left amygdala damage was tested on the identical procedure, the attentional benefit gained through making the T2 stimulus negative, disappeared. These findings suggest that there exists an attention selectivity bias for emotionally important environmental information, automatically rendering visual information available in the visual field when it otherwise would not be.

The amygdala has been shown to modulate more efficient attentional processing by both directly "tuning" neural responses to visual stimuli in ventral visual cortex, as well as indirectly through attentional modulation via frontal regions (Lim et al, 2009). After aversively conditioning building or scene stimuli through a pairing of mild electric shock and visual presentation of the stimuli, Lim and colleagues administered the RSVP task during fMRI. The T2 stimulus was either aversively condition or unconditioned and allowed the investigators to determine the activation patterns associated with enhanced attentional selection of aversively conditioned T2 stimuli. Using correlational mediation analyses, it was shown that the amygdala had a causal influence on increased evoked responses in the middle frontal gyrus and parahippocampal gyrus (PHG) related to successful T2 detection. It was interpreted that the amygdala contributed to increased attentional resources devoted to the T2 houses or scenes by enhancing middle frontal gyrus activity, and also amplified perceptual processing of those images directly in the PHG. Before these results were published, it was only known that the amygdala played a crucial role in the emotional enhancement of attention and perception; the use of elegant fMRI mediation analyses allowed Lim et al to show that aversive emotionality modulates attention and perception via the amygdala.

The beneficial effects that emotionality lends to attentional processing have been shown not only with the RSVP paradigm, but with other tasks requiring rapid visual search of emotional versus non-emotional stimuli. In accordance with the findings obtained with the RSVP paradigm, Öhman & Flykt (2001) found that during a visual search task, snake and spider images were detected more rapidly than fear-irrelevant images (e.g., flowers and mushrooms) in a grid array of numerous distracter images. In-line with the findings from RSVP studies, rapid search processes and attention are facilitated when emotionality exists among less emotional visual information.

It is known as well that perceptual processing efficiency is also enhanced for emotionally significant visual stimuli. Phelps & Carrasco (2006) cued sinusoidal gratings that varied in visual contrast and orientation with fearful and neutral faces quickly at 75ms followed by an orientation judgment for the gratings. Judgment accuracy increased as a result of fearful priming, allowing for more accurate orientation judgments at lower levels of visual contrast as compared to neutral face priming. The authors argued that this enhancement of contrast sensitivity may have resulted from an amygdala-based modulation towards more efficient processing in early visual cortex. Given the findings of Lim et al (2009), which displayed a direct influence of amygdala activity on increased evoked responses in ventral visual cortex for aversively condition stimuli, it seems that this conclusion receives direct support from more recent functional neuroimaging investigations.

After having reviewed the line of evidence on the enhancing influence that emotional arousal affords to attention and perceptual processing, it can be seen from a mechanistic perspective how emotion can boost memory encoding processes. The efficient encoding of stimuli in our environment leave an enduring memory trace available to enriched consolidation, until a cue sparks the reliving of a past emotional experience. Another more select domain of episodic memory, recognition memory, also consistently shows influences of emotion that dissociate between the qualitative memory experience that it can subsequently boost (i.e., familiarity versus recollection).

1.3 Recognition Memory

When considering a more specific aspect of episodic memory, recognition memory, an advantage in accurate recognition exists for emotional versus non-emotional stimuli (Ochsner, 2000). Recognition memory is the ability to discriminate between previously encountered and novel stimuli, and can be based on processes of recollection or familiarity assessment. The idea that two independent processes underlie the ability to determine whether a stimulus has been encountered is referred to as the Dual-Process Model of recognition memory (Yonelinas, 2001). More specifically, recollection refers to the ability to consciously bring back to mind a previously encountered stimulus and the context associated with it at initial viewing. This context can include the spatial location, temporal location in relation to other events, metacognitive evaluations, internal states, or other external events associated with a prior stimulus presentation. Familiarity is the recognition of prior occurrence, in the absence of contextual reinstatement. For example, one may get the strong sense they have seen someone before, but have no idea when or where they encountered that person. Recognition memory studies typically involve viewing a series of stimuli (e.g., list of words, objects, or faces) followed by an “old/new” recognition test for those stimuli. The recognition test includes exactly half previously presented and half novel stimuli, forcing participants to endorse items as being old while also rejecting novel lures. Recollection and familiarity are known to be differentially affected by manipulations of affect.

1.3.1 Recollection and Familiarity

To determine whether familiarity or recollective-based recognition is differentially affected by emotionally arousing pictures (e.g., gun held up to someone's neck, a couple kissing); Ochsner (2000) conducted a recognition memory study using the Remember/Know procedure. The Remember/Know procedure is commonly employed to index familiarity and recollective-based recognition memory independently by having participants sort recognition judgments according to a meta-cognitive evaluation of the basis of their recognition experience (Tulving, 1985). The Remember/Know procedure involves participants first making an old/new recognition judgment for a test stimulus, and if a stimulus is identified as "old," a Remember or Know response is given. A "Remember" response is given when the stimulus is recognized with accompanying contextual information and represents that recollection occurred. A "Know" response is given when the stimulus merely seems familiar in the absence of contextual recollection. Ochsner (2000) found that negative emotional images were subsequently "Remembered" (i.e., recollected) to a greater extent than positive images, which were typically "Known" (i.e., based on subjective sense of familiarity). The author argued that the tendency for recollection to be enhanced by emotionally arousing images (particularly negative) as compared to both positive and neutral images, illustrates how the increased distinctiveness, physiological response, and attention devoted to negatively arousing stimuli at first exposure, can increase subsequent contextual recollection. Positive stimuli in contrast were more likely to be "Known" than negative stimuli. Familiarity was affected to a much lower extent as compared to recollection. These findings are consistent with past studies showing increased hippocampal activation during the encoding of later vividly recollected negative emotional stimuli (Kensinger & Corkin, 2004). The hippocampus has been identified as a bottleneck structure vital for contextual retrieval in episodic memory, leaving conscious reliving of past experiences impossible without its integrity (Moscovitch et al, 2006).

1.3.2 Emotional Filtering of Past Experience: Unanswered Questions

The emotional enhancement of memory encoding, and the subsequent recollective nature of retrieved memory content have been emphasized to date in the literature on recognition memory and emotion. Left unanswered though by this research is a clear investigation into what role one's emotional state and level of arousal has on memory access, specifically, emotionality being present only during later recognition and existing independently of the stimulus to be remembered (i.e., a neutral stimulus). We live in a world where many of the faces, objects, and verbal information that we come into contact with is relatively emotionless, while one's personal level of arousal and "emotional mood" is in a state of continuous fluctuation. Manipulations employed by past researchers have typically varied the level of emotionality within the stimulus to be remembered, therefore cannot speak to the "pure" influence of an emotional state on retrieval operations without necessarily having to consider that stimulus encoding processes were also affected by its inherent emotionality. Any memory study that varies the emotional content of the stimuli studied and later remembered, necessarily present that content with emotionality at encoding. In this line of research, emotional arousal is conceptualized as something existing in response to the perception of an emotional stimulus, while the aforementioned stimulus-independent influence occurs in a top-down manner (i.e., emotional arousal “shadowing” environmental stimuli). To determine how emotional arousal may “paint” retrieval processes independently of stimulus property encoding, a manipulation of one’s emotional state during retrieval must be de-coupled from the content to-be-remembered.

It has been observed in the memory literature that one’s emotional state or “mood” can bias how one remembers past experiences. For example, in a study by Holmberg and Holmes (1994), individuals whose marriages have become more negative and less desirable interpret the nature of their marriage in the past as less happy than original reports. Also, students who were originally highly anxious about an exam, report that their level of anxiety was lower than it actually was if they performed well on the exam (Levine & Safer, 2002). This memory “filtering” of the emotional status of past experiences shows that one’s emotional “set” or “mood” can influence the nature of content that is retrieved in a top-down way, rather than just having an enhancing effect on memory abilities.

In the domain of recognition memory, only a few studies have manipulated emotionality independent of stimulus content. Sweeny and Paller (2009) subliminally induced positive emotion prior to the presentation of surprised faces, neutral in valence, at encoding in a recognition-memory study. Priming involved the 30ms presentation of a happy faces immediately before surprise faces (presented consciously for 650ms), which were the content to be remembered later (i.e., only surprise faces were consciously studied, and tested for later). Priming resulted in an increase in subsequent accurate recognition, even though the emotional manipulation went completely unnoticed during the experiment. Interestingly, it was also shown in this study that the rated "positivity" of the surprise faces primed by positive affect increased in relation to surprise faces that were primed by neutral faces. This study shows that an emotional state induced prior to the presentation of a memory-test stimulus can "filter" perception and enhance encoding processes. This de-coupled emotion enhancement effect suggests that one's emotional state also has lasting memory effects.

Taken together, it can be seen that emotion effectively biases the content of retrieved memories in a way that is consistent with an individual's current emotional state. Another domain of recognition memory research has shown that manipulated levels of perceived perceptual fluency and somatic arousal can influence familiarity assessment processes during recognition in a completely different way, by creating illusions of familiarity.

1.4 Perceptual Fluency, Arousal, and Illusions of Familiarity

Another line of evidence important in the development of the hypotheses formed in this thesis research, has associated illusions of familiarity during recognition memory retrieval to perceptual fluency and arousal. It is known that familiarity assessment in a study/test recognition memory experiment can be affected by increasing the fluency of perceptual processing of the stimulus being recognized (Jacoby & Whitehouse, 1989; Kleider, 2004). While boosting the ease of perceptual processing of a stimulus is not a manipulation of emotional arousal, it has been shown that this fluency can produce an erroneous sense of familiarity for novel memory test items. In one such study, increased perceptual fluency of verbal test items was obtained through the use of subliminal identity priming (Jacoby & Whitehouse, 1989). When priming test words (at 34ms) with its own identity (e.g., a target word "house" primed by "house"), a bias to respond "old" more often during an old/new recognition test was seen for both hits and false alarms in comparison to test items primed with a different word (e.g., a target word "apple" primed by "wrist"). In a recognition memory study, a "hit" is defined as correctly responding "old" to a previously encountered stimulus presented during a learning phase, and a "false alarm" is an "old" response to a novel test item not previously encountered. The subjective sense of fluency created through identity priming led participants to interpret a "free-standing" sense of fluency as a memory signal for the same stimulus presented consciously. Interestingly, this effect has also been shown with non-verbal, non-meaningful perceptual stimuli as well (Brown & Marsh, 2009).

The perceptual fluency literature has shown that judging familiarity for a stimulus is heavily influenced by one's expected sense of fluency for old and novel test items in a memory experiment, and has been described in the framework of the Discrepancy Attribution Hypothesis (DAH) to account for the illusion of familiarity created through identity-priming (Whittlesea & Williams, 2000) For example, one knows that new test items should likely have a lower level of fluency or familiarity while old test items will "feel" different. In the case of subliminal identity-priming, as used by Jacoby & Whitehouse (1989), novel test words experiencing a feeling of increased perceptual fluency have a discrepant level of fluency in comparison to novel test words not identity-primed. This attribution of discrepancy in the fluency of processing for a novel test stimulus leads one to judge it as familiar instead of new. Further, the subliminal nature of the processing fluency manipulation prevents individuals from attributing a source to this increased fluent processing, leading individuals to interpret it in the context of the current task. Using the Remember/Know procedure, Rajaram (1993) confirmed that the erroneous feelings of familiarity produced by identity priming manifest themselves as familiarity-based but not recollection-based memory decisions. It would be surprising to find that the fleeting feelings of fluency would be interpreted as false recollection experiences due to the fact that recollection involves the conscious retrieval of contextual elements of an initial exposure in relation to the stimulus at hand. There exists a debate in the recognition memory literature as to whether the sense of fluency erroneously interpreted as familiarity is related to an induction of autonomic arousal.

1.4.1 Arousal and Erroneous Familiarity

These studies show that a sense of fluency can be erroneously interpreted as a feeling of familiarity not tied to the reactivation of an actual memory trace. Left unclear by these studies is whether the subjective fluency produced through perceptual identity priming "feels" like an actual familiarity experience that may be elicited by a truly familiar stimulus. Some have suggested that the feeling elicited by increased perceptual fluency may be tied to a spark of arousal similar to those known to occur in response to a stimulus with a truly familiar status. It has been found that familiar stimuli produce increased skin conductance responses as compared to novel stimuli (Morris & Cleary, 2008). Interestingly, Jacoby & Whitehouse (1989) were reluctant to call the subjective sense of fluency as being arousal-based. Important in this regard are studies that have utilized subliminal arousal-based manipulations during recognition memory retrieval to determine whether feelings of arousal administered during retrieval affect familiarity assessment in a similar manner as identity-priming.

In a clever study conducted by Goldinger and Hansen (2005), a covert somatic "buzz" was delivered through the seat of participants' testing chairs during the recognition phase of a memory study. This somatic "buzz" was described by the authors as akin to an induction of arousal. Both overt (i.e., clearly audible buzz that obviously came from the bottom of the chair) and covert (i.e., buzz went unnoticed) conditions were included as a between-subjects manipulation during the presentation of test stimuli that included words and colored photographs of everyday objects. An easy and difficult version of the recognition test was designed where less distinct and imaginable words and pictures (clip art) were used in the difficult task, whereas in the easy task, coloured photographs and easily imaginable words were used. In-line with the Discrepancy Attribution Hypothesis, only covert buzzing resulted in an increased tendency to respond "old" to both old and new test items. This response bias also only occurred when a difficult version of the memory test was used. The authors argued that increased difficulty may have pushed participants to rely more on a subjective sense of familiarity when trying to discriminate between old and new test item, rather than specific contextual recollection, and only under these circumstances was the response bias present. Familiarity and recollection were not measured in this study however, leaving the question open as to whether this response bias was driven by familiarity-based recognition experiences. The authors argued that this effect was present only when the buzz was subliminal because participants were not able to attribute the source of the increased arousal to something other than the test items themselves. The attribution of discrepant arousal felt for novel test items is thought to exist only when the source of the arousal is unknown; otherwise the feeling can be discounted as something that is independent of the test item to be judged as familiar or not. The authors suggest that is "unexplained" arousal may have been the source of the observed response bias.

Although there remains some uncertainty whether the manipulation introduced by Goldinger et al (2005) had its effect specifically via a mechanism of perceived physiological arousal, the findings could suggest that boosted arousal during recognition memory evaluation is interpreted as similar to an actual familiarity signal under some circumstances. The congruency seen between the response bias present in Goldinger & Hansen (2005) and Jacoby & Whitehouse (1989) may lead one to believe that perceptual fluency manipulations embedded into recognition tests produce a similar arousal-based erroneous interpretation. An increase in perceptual fluency always accompanies a second exposure to a familiar stimulus when compared to an un-encountered stimulus due to the fact that unfamiliar stimuli are less perceptually familiar. Since we know already that familiar stimuli produce measurable increases in skin conductance responses, it is imaginable that perceptual fluency may be the root of a familiarity-based arousal response to begin with. In light of such findings, which link feelings of familiarity to increased physiological arousal, it may indeed be the case that an artificially induced sense of arousal, as manipulated by Goldinger and Hansen (2005), produces a feeling very similar to that of "true" familiarity. It is important to note that somatic arousal that is not tied to any particular dimension of valence may not represent a true emotional stimulus. The manipulation used in this study to induce arousal is unusual, and it is not clear whether it is in fact comparable to the arousal associated with valenced emotionality, for example, the feeling elicited in relation to a baby's laughter or images of terrorism.

A real-world phenomenon in the domain of person recognition has been observed in the clinical neurological literature in a condition known as Capgras delusion. This condition highlights the interplay between affective arousal and feelings of familiarity, and has been reported in demented populations as well as in conjunction with focal brain damage (Alexander et al., 1979). Capgras delusion is characterized by the belief that a close family member, usually a spouse, is actually an imposter who has assumed the identity of that person (Hirstein & Ramachandran, 1997). This delusion has been rooted in deficient sense of emotional familiarity that usually accompanies the identification of a loved-one. Hirstein & Ramachandran (1997) demonstrated that a patient with Capgras delusion, DS, did not show the usual increases in skin conductance responses to familiar as compared to unfamiliar stimuli when shown photographs of family members and unknown people. The neurological profile of patients of this type remains unclear but these authors hypothesized that the underlying problem may be in part to a disconnection between face-processing visual areas and emotion related limbic system regions in the temporal lobe. Hirstein and Ramachandran suggested that the delusional nature of this condition may not only result from this limbic "disconnection," but may also result from additional cerebral atrophy in frontal regions that would be important in the evaluation of inappropriate feelings of affective familiarity in response to an individual (Alexander et al., 1979).

After having reviewed the emotion and recognition memory literature highlighting the recollective benefit afforded to emotional stimuli, and the perceptual fluency literature, which as associated illusions of familiarity to fluency and autonomic arousal, it becomes clear that many questions remain open concerning how stimulus-independent affect may influence familiarity assessment. Capgras delusion is an unfortunate but interesting manifestation of the interplay between affect, arousal, and familiarity, and suggests that these dimensions of conscious experience are highly interwoven. The experiments outlined ahead will attempt to clarify the relationship between these two contrasting domains of recognition memory research.

1.5 Goals of the Current Study

The aim of this thesis research is to investigate the relationship between emotional arousal and familiarity assessment with two different priming paradigms, and to examine the resulting findings in the context of the Dual-Process Model of recognition memory. Both experiments will make use of a subliminal priming paradigm during the test phase of a recognition memory task, with the primary difference between both experiments being the nature of the prime stimulus. In Experiment 1, the priming manipulation will involve subliminal presentation of faces with fearful emotional expressions but with a different identity then the test items that are being primed in the context of the recognition decisions. In line with terminology used in the broader literature on emotion, I will refer to this as an affective-priming manipulation. Experiment 2 will incorporate a modified Jacoby & Whitehouse (1989) paradigm, again using faces as stimuli. More specifically, to manipulate perceptual fluency, neutral faces used for the memory task will be primed by that same neutral identity. I will refer to this manipulation as identity priming. The aim of Experiment 2 is to determine to what extent an induction of a sense of perceptual fluency during memory retrieval will affect memory differently than the affective priming manipulation used in Experiment 1. Due to the considerable evidence linking perceptual fluency manipulations to arousal (Morris & Cleary, 2008; Goldinger & Hansen, 2005), it appears promising to contrast the effects of identity priming with an affective priming manipulation characterized by negative valence (i.e., fearful expression faces). Both experiments will take advantage of the Remember/Know procedure to measure the effects of priming on recollective and familiarity-based recognition processes.

Faces will be used as stimuli primarily due to the fact that face recognition is known to rely heavily on familiarity assessment (Aly et al., 2010), and a subliminal influence of affective priming on face processing was shown to be effective as an encoding manipulation in Sweeny & Paller (2009). Experiment 1 will test to what extent an induction of an affective state, occurring below participants' level of awareness at test, will affect familiarity and recollection for neutral memory test stimuli. The goal is to keep presentation of primes subliminal, such that participants will only be consciously exposed to neutral, non-affective faces during the experiment. Fear was chosen as the expression of the prime faces due to the highly arousing nature of fearful faces, and its known association with robust amygdala responses in past research with fMRI by Whalen et al. (1998). Towards this end, amygdala responses have been suggested to be elicited in response to the subliminal presentation of masked fearful faces, as is the nature of the priming manipulation used in Experiment 1.

The choice to use subliminal prime presentation was also motivated by the perceptual fluency literature that has revealed an increased influence of primes not perceived consciously on performance interpreted in the framework of the Discrepancy Attribution Hypothesis (Whittlesea & Williams, 2000). After memory testing, both experiments will also incorporate a forced-choice prime discriminability task to determine the effectiveness of the subliminal presentation mode, and to allow for later evaluation of the impact that prime awareness has on priming effects.

1.5.1 Experiment 1: Hypotheses

The previous review of the literature concerning the interplay of feelings of perceptual fluency and autonomic arousal, gives some perspective on the multi-dimensional nature of familiarity assessment. It remains to be determined, however, exactly how the induction of an affective state (containing both an arousal and valence component) during the time of recognition-memory retrieval may affect familiarity assessment.

One hypothesis, which takes the attention and perceptual enhancement literature into account, is that affective priming will have a facilitatory effect on familiarity assessment. Inducing a negative affective state prior to the presentation of memory test items, may lead to an enhancement of processing of test items, both in terms of increased attentional resource allocation and perceptual-processing efficiency. The negative valence state may lead to heightened attentional vigilance towards the consciously perceived test item, allowing for increased accuracy of memory discriminations. Necessarily, an increase in memory accuracy would include an increased likelihood of endorsing actually familiar stimuli as "old" (increased "hit" rate) while reducing the likelihood of falsely attributing familiarity to novel stimuli (reduction in "false alarms"). It can be predicted as well that familiarity specifically, rather than recollection, will be selectively enhanced. By definition, familiarity involves the recognition of a stimulus independent of its initial contextual associations. Recollection on the other hand is a process that incorporates a retrieval of contextual information in relation to a stimulus. It is predicted that affective priming will affect the processing of the test stimulus specifically, thus familiarity should be selectively enhanced.

An alternative hypothesis concerning how negative affect induced at test may affect recognition memory takes into account the evidence put forth by the Discrepancy Attribution and perceptual fluency literature (Whittlesea & Williams, 2000). A subliminal, affectively arousing prime may induce the typical response bias observed in past experiments that "artificially" shadowed a test stimulus with subjective qualities similar to feelings of "true" familiarity (e.g., Jacoby & Whitehouse, 1989; Goldinger & Hansen, 2005; Sweeny & Paller 2009). If a somatic "buzz" can be interpreted as familiarity, affective arousal produced by a fearful face prime may also be interpreted by participants in a similar way. This would lead to an increase in hit rates and false alarm rates for affectively primed test stimuli, and would likely manifest itself in familiarity-based decisions if one were to use the Remember/Know procedure, considering the findings of Rajaram (1993).

Importantly, it is possible that overall recognition performance should be taken into account when interpreting affective priming effects, given that that the effectiveness of the subliminal "buzz" induced during memory testing in Goldinger & Hansen (2005) occurred only for the difficult version of their task. From this perspective, participants showing an overall lower ability to discriminate between old and new faces may show a more pronounced effect of affective priming.

1.5.2 Experiment 2: Hypotheses

Past experiments have shown that an increased sense of perceptual fluency induced during a recognition-memory test can result in an erroneous sense of familiarity (Whittlesea & Williams, 2000; Jacoby & Whitehouse, 1989), thus it can be predicted that Experiment 2 will also show this pattern. Also predicted, and shown previously in the perceptual fluency literature, is that identity-priming will result in a response bias to respond "old" for novel and old test faces that are identity-primed. It should be noted again, however, that such an effect has not been reported for faces so far and would reflect a novel generalization of the effect in terms of stimulus content. It can also be predicted based on these past experiments (e.g., Jacoby & Whitehouse, 1989), that the effectiveness of identity priming may be critically tied to subliminal prime presentation. In other words, it can be predicted that only individuals with scores in the forced-choice prime discriminability task that are not significantly above chance accuracy, will display a response bias based on identity-priming.

2 Experiment 1: Affective Priming

2. 1 Methods

2.1.1 Participants

Fifty two individuals participated in the study (36 females, 16 males; mean age = 22.15, SD = 4.09). All participants had normal or corrected-to-normal vision and gave their written informed consent before participation. Participants were compensated for their participation or received course credit. The study protocol was approved by the Research Ethics Board at the University of Western Ontario. Three participants were excluded based on chance overall recognition performance. Data was not used for four additional participants based on prime duration errors.

2.1.2 Stimuli

The stimuli presented were high-resolution coloured images of faces taken from the Karolinska Directed Emotional Faces database (KDEF) as well as the NimStim Emotional Face Stimuli database (Lundqvist et al. 1998; Tottenham et al., 2009). Faces with neutral expression and fearful counterparts from the same individuals were used from the databases. All faces were cropped down to a specific oval template, including the forehead, eyes, nose, mouth, and full jaw, while leaving out hair, jewelry, and ears. This was done to create a more homogenous sample of faces and to reduce large variations in hair style and other stylistic qualities across databases. Faces were surrounded by a rectangular background of Gaussian noise. Images from both face databases were intermixed for this study. Overall, 96 faces with neutral expression and with fearful expression were used, allowing for 24 unique neutral faces to be used in each of four lists that were assigned to four within-subjects test conditions. Two different lists were used as targets (at study and test) and two lists served as lures (at test). Both old and new test items were primed by either a fearful or a neutral face, creating a 2 x 2 experimental design (i.e., test status (old or new) x prime condition (fearful or neutral), with one list being employed in each condition. Assignment of lists to conditions was counterbalanced across participants. To create consistency across the memory test conditions, each list had a constant proportion of faces from each database. Also, a constant proportion of males to females was established for each list of targets, being the same between conditions. Due to a limited number of overall face identities, target identities for a given condition were also used as the primes for that condition. Careful attention was paid to matching the number of times an identity, during the course of the test list, appeared as a prime before being presented as a target face to be sure that any differences in recognition could not be attributed to an identity being shown more often before being a target between conditions. Importantly, each target face was paired with a prime of a different identity from that list to avoid any influence of identity-priming.

2.1.3 Procedure

Face images were presented on a CRT computer monitor with the image presentation software E-Prime 1.0 (Psychology Software Tools). Participants were seated at a distance from the screen of approximately 1.5 ft. Face images occupied an area of about 4 in. x 6 in. on the screen.

An initial study phase took place, which included the presentation of 48 neutral face images that were used as target items for the subsequent recognition test (e.g., 24 faces later tested with neutral face primes, and 24 paired later for fearful face priming). An illustration of event timing, image presentation, and trial types can be found in Figure 1. Participants were informed that they would be required to make judgments about faces, followed by a memory test. At study, participants were asked to make likeability judgments. A fixation cross appeared for 1000ms prior to each face, which was presented for 650ms. Immediately after the face disappeared, participants were instructed to judge how much they liked that face using a 6 point scale, with 1 corresponding to "strongly dislike," and 6 corresponding to "strongly like." This judgment of likeability was employed so as to get participants to attend to each face during study. After each rating was made, there was a 1000ms inter-stimulus-interval prior to the next fixation presentation. The faces designated to each prime condition were randomized.

After the completion of the study phase, participants rested for about 1 minute before receiving instructions for the recognition test. Overall, test instructions spanned approximately 5 minutes, creating roughly a 6 minute study-test delay period. Participants were informed that they would then undergo a recognition memory test for the faces presented during the study phase. They were informed that half of the faces in the upcoming test were faces seen during the study phase, and the other half were new faces (i.e., not previously encountered), and also, that the order was randomized.

At test, a sandwich mask set up was used to backward and forward mask prime face images. This sandwich mask procedure is commonly used in verbal priming studies, and typically use random symbols strings (e.g., #&##&) to mask prime words (Forster, Davis, Schoknecht, & Carter, 1987). In this experiment a scrambled face image was

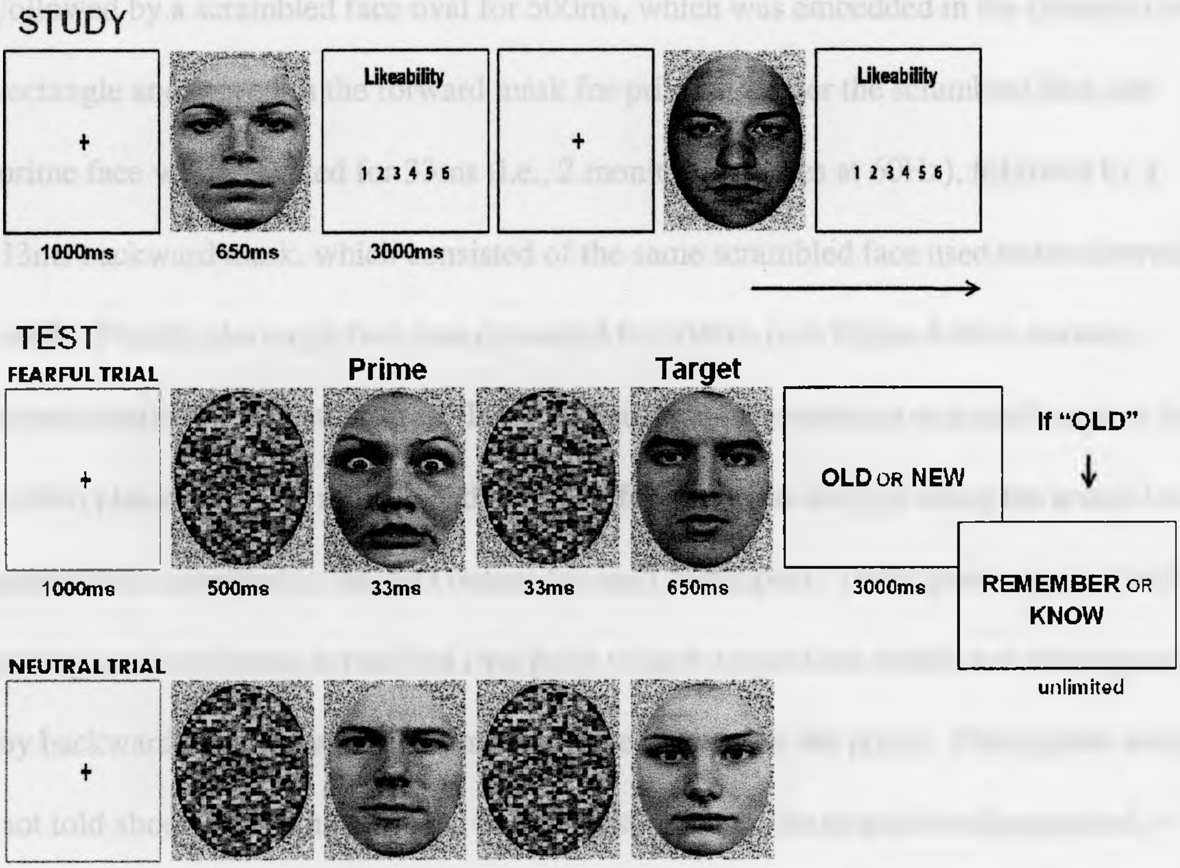

Figure 1. Illustration of events, timing, and priming trial types.

used instead. Each face was preceded by a fixation cross for 1000ms, immediately followed by a scrambled face oval for 500ms, which was embedded in the Gaussian noise rectangle and served as the forward mask for priming. After the scrambled face, the prime face was presented for 33ms (i.e., 2 monitor refreshes at 60Hz), followed by a 33ms backward mask, which consisted of the same scrambled face used as the forward mask. Finally, the target face was presented for 650ms (see Figure 1 for schematic representation of trail structure). Timing of stimulus presentation was confirmed to be within plus or minus 1 millisecond accuracy for the prime images, using the actual image onset times specified in the data output for each participant. Participants reported only seeing one continuous scrambled oval prior to each target face, which was made possible by backward masking with the same scrambled face after the prime. Participants were not told about any priming to take place at test. When the target face disappeared, participants were prompted with "Old" or "New" cues, and offered 3000ms to make their memory decision. If participants claimed that they recognized the face as "old," a Remember/Know judgment was required in a self-paced manner. Participants indicated whether the experience of recognition was characterized merely by a sense of familiarity for the face or by recollection of the face. Participants were told that the "Know" response should be used when the target was only familiar to them, and when they lacked memory for contextual elements of the study experience. Participants were told that a "Remember" response should be used when the face was recognized with the retrieval of a contextual detail (e.g., remembered what they thought about the face when they first saw it during the study phase, recollect a noise present at initial exposure, remembered that they thought a face looked like someone they knew). It was emphasized that the contextual detail had to be specific to that face in order to be sufficient for a "Remember" response, due to the common initially observed tendency of participants to have an unduly liberal criterion for the specifics the prior presentation (e.g., "I think this is a Remember response because I remember noticing that there were only a few attractive males, I'm pretty sure I saw this man, and he is attractive). To ensure that participants completely understood the phenomenological distinction between familiarity and recollection, they were told to appropriately verbally justify the choice of memory experience for their first two "Remember" and "Know" responses. For example, if they believed a recognition experience was sufficient for the "Remember" response, they would describe the nature of the contextual element retrieved (e.g., "I remember, during the study phase, I was thinking that this face looks just like my friend Tanya."). If this contextual distinction was not properly employed, a correction and reiteration of the Remember/Know distinction was offered by the experimenter, and that face was not included as one of the two correct descriptions of each response type.

After the completion of the recognition test, participants were probed in a brief interview to determine whether they were consciously aware of the masked presentation of face primes. They were asked whether they had noticed anything odd about the images presented during the test, maybe that the experimenter had not informed them about. After their response they were fully informed about the nature of the face priming during the test.

Participants were then tested on a prime discriminability task in order to directly measure the conscious awareness of the prime faces. It was necessary to reveal the nature of masked priming in order to give instructions for the prime discriminability task. Every masked prime and target pairs were presented for this task in order to keep all timing and image presentation parameters identical to the memory task. This was necessary because the discriminability task would later be used as a measure of prime awareness during the memory test. Participants were to judge whether the prime presented for 33ms had a neutral or fearful emotional expression. Participants were told that half the faces were primed by a fearful face, and the other half by neutral faces. This forced-choice procedure has been used in other studies to determine prime awareness (Hannula & Cohen, 2005). The same 3000ms response deadline used for the recognition test was again incorporated in this task to keep the pace of the experiment similar to that of the recognition test. During the response period, participants were prompted with the text, "What was the expression on the prime's face?" Participants were then asked to provide a "Fearful" or "Neutral" response.

2.2 Results

Figure 2 displays the proportion of faces recognized as "old" separate for both priming conditions (e.g., Affective versus No Prime (i.e., Neutral face)) and for recognition test status (e.g., Old or New). A 2 x 2 repeated measures ANOVA was conducted, with test status (old or new) and priming condition as factors, so as to determine whether affective as compared to no priming differentially affected the tendency to recognize a face as previously encountered. The ANOVA revealed a

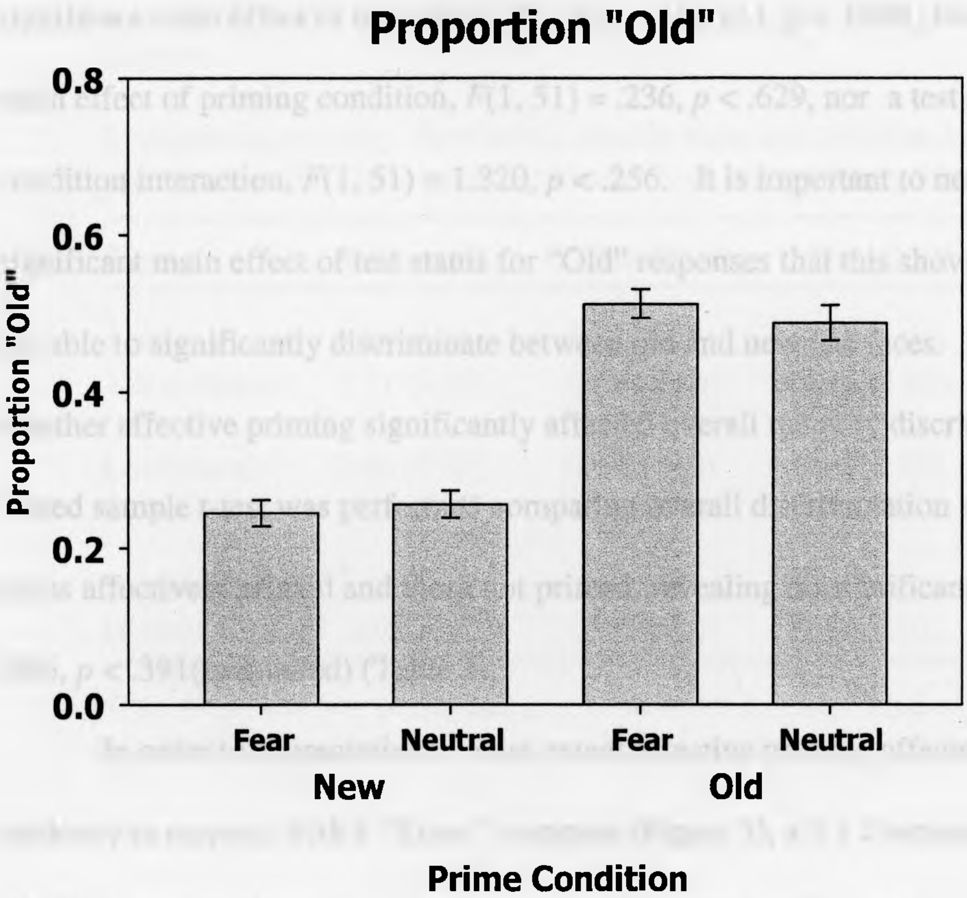

Figure 2. Overall proportion of target faces identified as "Old" as a proportion of the total number of faces in each of the two experimental conditions for old and new items.

significant main effect of test status, $F(1, 51) = 267.121$, $p < .0001$, but no significant main effect of priming condition, $F(1, 51) = .236$, $p < .629$, nor a test status by priming-condition interaction, $F(1, 51) = 1.320$, $p < .256$. It is important to note when reporting a significant main effect of test status for "Old" responses that this shows that participants are able to significantly discriminate between old and new test faces. To determine whether affective priming significantly affected overall memory discrimination (d'), a paired sample t-test was performed comparing overall discrimination associated with items affectively primed and those not primed, revealing no significant change, $t(51) = .866$, $p < .391$(two-tailed) (Table 1).

In order to characterize to what extent affective priming affected the overall tendency to respond with a "Know" response (Figure 3), a 2 x 2 repeated measures ANOVA was conducted, with test status and priming condition as factors, on the proportion of "Know" responses for each condition revealing a main effect of test status, $F(1, 51) = 67.007$, $p < .0001$, no main effect of priming condition, $F(1, 51) = .128$, $p < .722$, and no test status by priming condition interaction, $F(1, 51) = 1.294$, $p < .261$. Figure 3 displays the pattern of proportion "Know" responses for old and new test items, organized according to prime type. To formally measure the effect of affective priming on familiarity-based discrimination, d' measures were calculated separately for both priming conditions using a commonly employed corrected familiarity measure that takes into account a participant's tendency to respond with a "Remember" response (Yonelinas, 2003). Since "Know" responses were to be used only when recollection did not occur, this correction must take place. Familiarity is calculated as the

Table 1

Recognition accuracy, familiarity, recollection, and criterion location (*c*) for participants with high or low level of overall recognition performance

Group	d' Overall	d' Familiarity	Recollection	*c* Familiarity
All(FEAR)	0.78 (0.06)	0.61 (0.07)	0.14 (0.02)	0.68 (0.07)
All(NEUTRAL)	0.71 (0.07)	0.48 (0.08)	0.13 (0.02)	0.65 (0.06)
Low(FEAR)	0.65 (0.07)	0.49 (0.10)	0.13 (0.02)	0.74 (0.09)
Low(NEUTRAL)	0.39 (0.07)	0.12 (0.09)	0.10 (0.02)	0.79 (0.10)
High(FEAR)	0.91 (0.08)	0.73 (0.11)	0.15 (0.03)	0.62 (0.10)
High(NEUTRAL)	1.02 (0.08)	0.83 (0.07)	0.17 (0.02)	0.51 (0.06)

Note: High and low performance groups were defined based on median split in in overall recognition performance. Values represent mean (standard error).

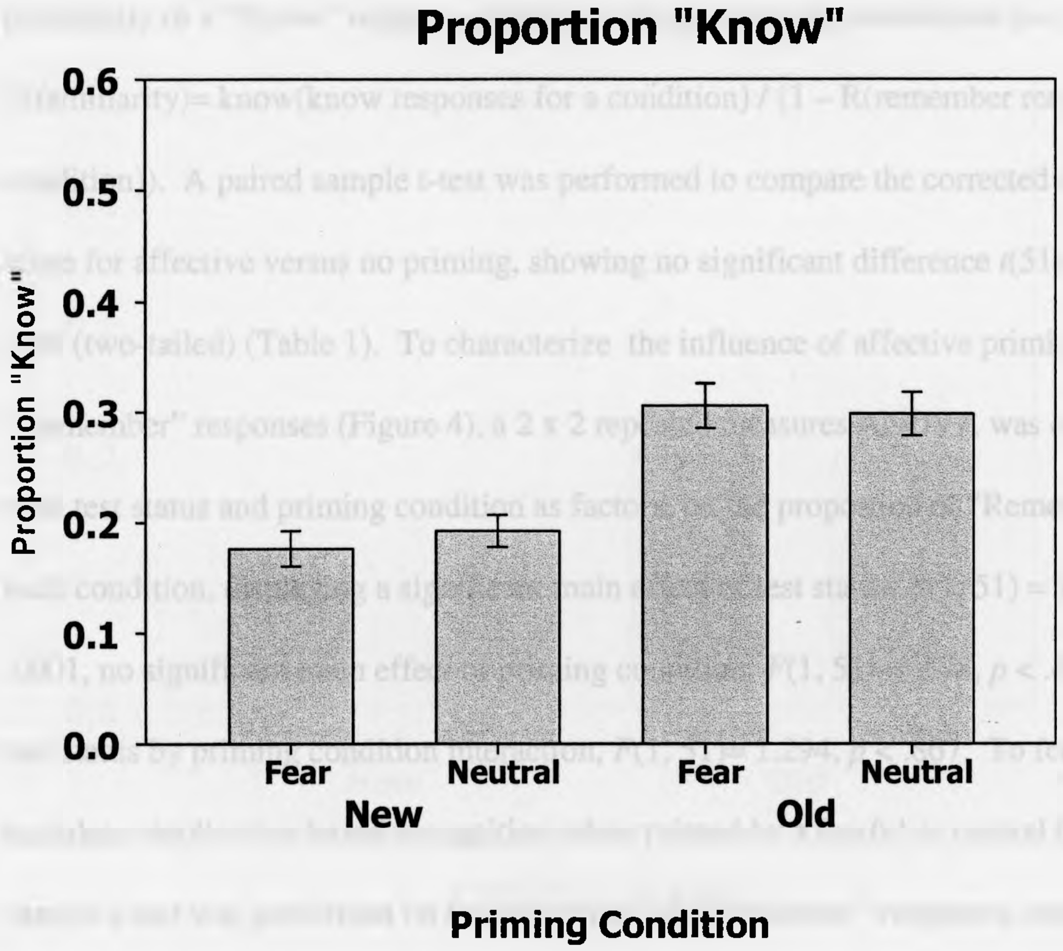

Figure 3. Overall proportion of target faces identified as "Know" as a proportion of the total number of faces in each of the two experimental conditions for old and new items.

probability of a "Know" response given that an item was not recollected (i.e., F(familiarity)= know(know responses for a condition) / (1 – R(remember responses for a condition)). A paired sample t-test was performed to compare the corrected d' familiarity score for affective versus no priming, showing no significant difference $t(51) = 1.283, p < .205$ (two-tailed) (Table 1). To characterize the influence of affective priming on "Remember" responses (Figure 4), a 2 x 2 repeated measures ANOVA was conducted, with test status and priming condition as factors, on the proportion of "Remember" for each condition, displaying a significant main effect of test status, $F(1, 51) = 125.286, p < .0001$, no significant main effect of priming condition, $F(1, 51) = .578, p < .451$, nor a test status by priming condition interaction, $F(1, 51)= 1.294, p < .867$. To formally calculate recollective-based recognition when primed by a fearful or neutral face a paired sample t-test was performed on the proportion of "Remember" responses minus "Remember" false alarms for each prime type, displaying no significant difference, $t(51) = .191, p < .849$ (Table 1).

In an effort to determine whether any potential impact of affective priming was associated with an individual's overall recognition performance (i.e., overall hit rate – false alarm rate, irrespective of proportion of Remember versus Know responses), a median split of the sample based on corrected recognition performance was performed. This effectively split the sample into a low performance group (n =26), and a high performance group (n = 26). A 2 x 2 repeated measures ANOVA was conducted, with test status and priming condition as factors, on the proportion of "old" responses for both

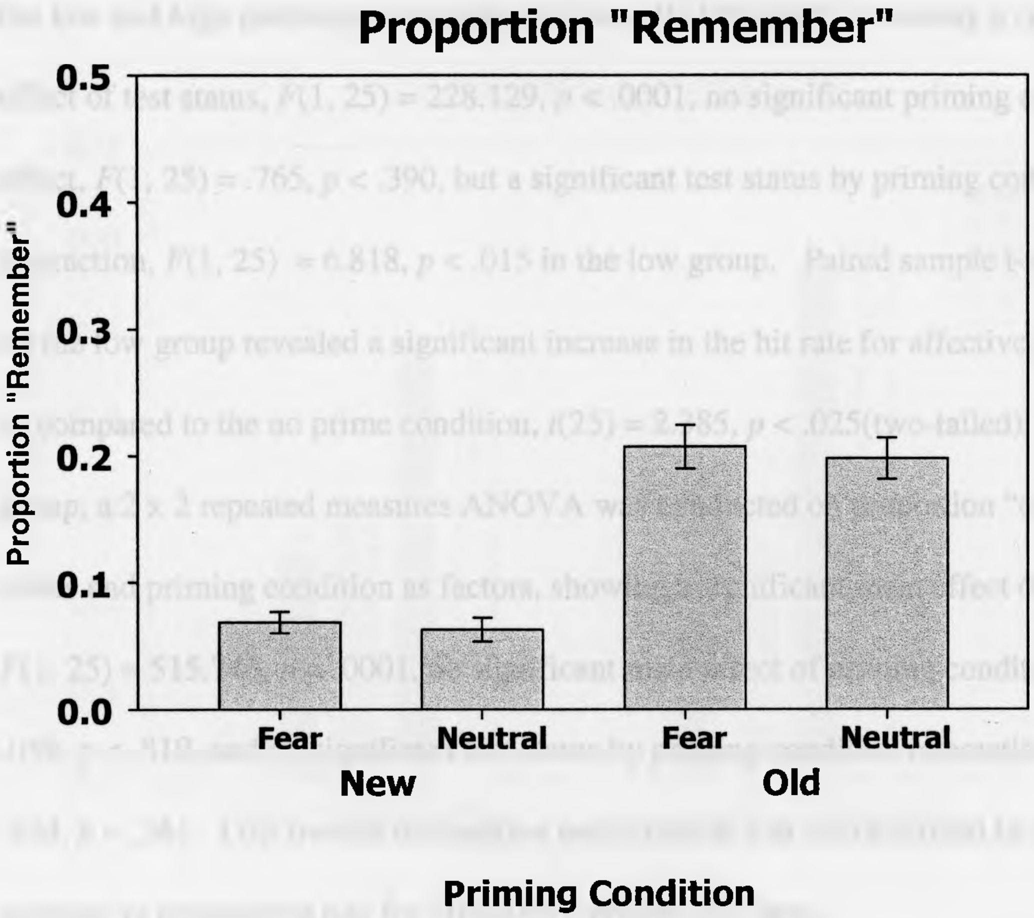

Figure 4. Overall proportion of target faces identified as "Remember" as a proportion of the total number of faces in each of the two experimental conditions for old and new items

the low and high performance groups individually (Figure 5), revealing a significant main effect of test status, $F(1, 25) = 228.129$, $p < .0001$, no significant priming condition main effect, $F(1, 25) = .765$, $p < .390$, but a significant test status by priming condition interaction, $F(1, 25) = 6.818$, $p < .015$ in the low group. Paired sample t-tests performed on the low group revealed a significant increase in the hit rate for affectively-primed faces as compared to the no prime condition, $t(25) = 2.385$, $p < .025$(two-tailed). In the high group, a 2 x 2 repeated measures ANOVA was conducted on proportion "old," with status and priming condition as factors, showing a significant main effect of test status, $F(1, 25) = 515.743$, $p < .0001$, no significant main effect of priming condition, $F(1, 25) = .059$, $p < .810$, and no significant test status by priming condition interaction, $F(1, 25) = .864$, $p < .361$. Low overall recognition performance was characterized by a significant increase in recognition hits for affectively-primed test faces.

To determine the relationship between recognition performance, affective priming, and the tendency to respond "Know," A 2 x 2 repeated measures ANOVA was conducted, with test status and priming condition as factors, on the proportion of "Know" responses for each condition in the low group (Figure 6). In the low group a main effect of test status, $F(1, 25) = 13.566$, $p < .001$, no main effect of priming condition, $F(1, 25) = .162$, $p < .691$, and a significant test status by priming condition interaction, $F(1, 25) = 4.877$, $p < .037$, was found. To pursue this interaction further, paired sample t-tests were performed comparing affective priming for new test items against no priming, $t(25) = -1.121$, $p < .273$, as well as affective priming for old items against no priming, $t(25) = -1.569$, $p < .129$. While t-tests failed to reveal select differences between affective

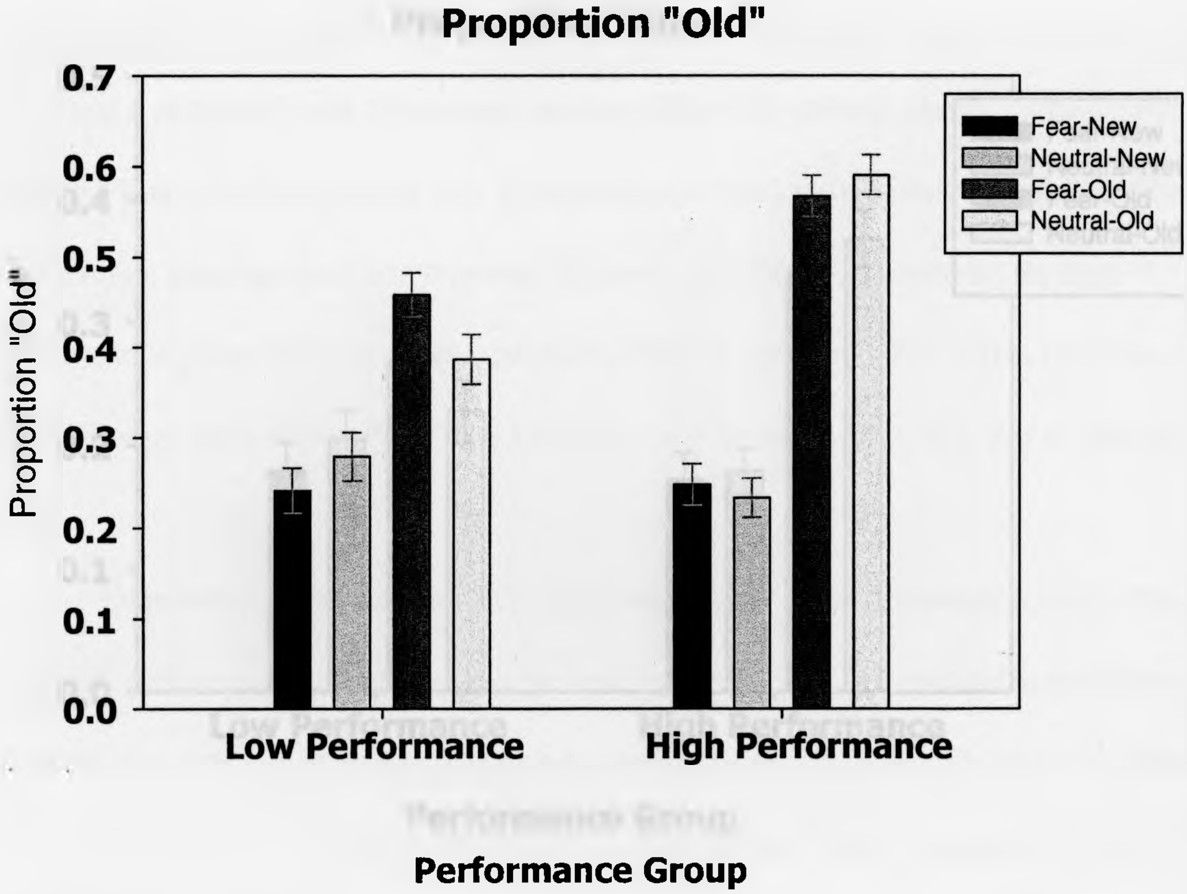

Figure 5. Overall proportion of target faces identified as "Old" as a proportion of the total number of faces in each of the two experimental conditions for old and new items as a function of priming condition (Fearful versus Neutral) and overall recognition performance group.

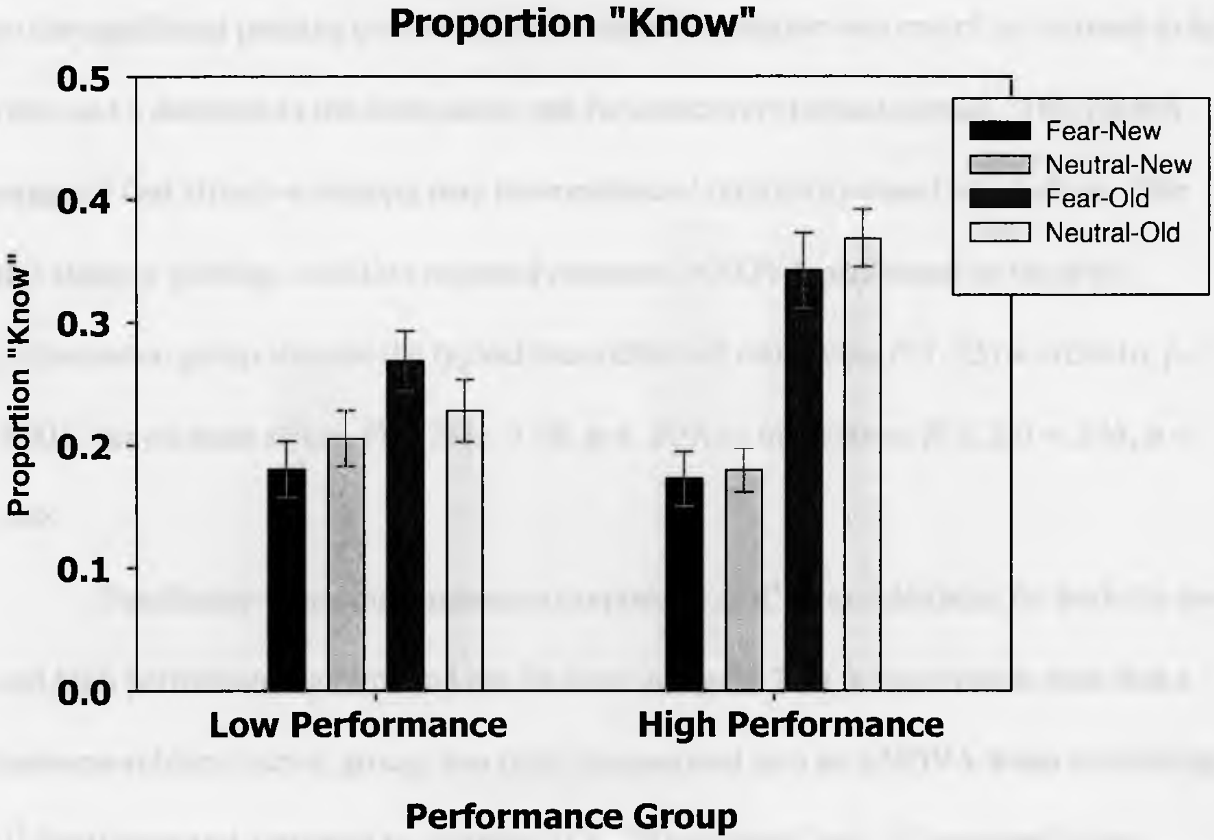

Figure 6. Overall proportion of target faces identified as "Know" as a proportion of the total number of faces in each of the two experimental conditions for old and new items as a function of priming condition (Fearful versus Neutral) and overall recognition performance group.

priming and no priming for old and new items individually, the pattern of results leading to the significant priming condition by test status interaction was one of an increase in hit rates and a decrease in the false alarm rate for affectively primed stimuli. This pattern suggests that affective priming may have enhanced familiarity-based recognition. The test status x priming condition repeated measures ANOVA performed on the high performance group showed the typical main effect of test status, $F(1, 25) = 105.616, p < .0001$, but no main effect, $F(1, 25) = 1.08, p < .309$, or interaction, $F(1, 25) = .544, p < .468$.

Familiarity-based discrimination (expressed as d') was calculated for both the low and high performance groups and can be seen in Figure 7. It is important to note that a between-subjects factor, group, was only incorporated into an ANOVA when considering d' familiarity and corrected recollection (i.e., "Remember" hits- "Remember" false alarms) because these measures are corrected for independence and incorporate both old and new recognition test responses. A 2 x 2 repeated measures ANOVA was performed, with priming condition and performance group as factors, on d' familiarity revealing a significant interaction, $F(1, 50)= 5.914, p < .019$. Follow-up paired sample t-tests in the low group revealed that affective priming produced significantly higher d' values as compared to no priming, $t(25) = 2.494, p < .020$ (two-tailed). As discussed above, affective priming boosted familiarity-based discrimination in the low performance group. Importantly, one-sample t-tests were performed on the d' familiarity means for affective and no priming individually against 0 to determine if familiarity-based discrimination was above chance in the low performance group. For no priming, d' familiarity was not

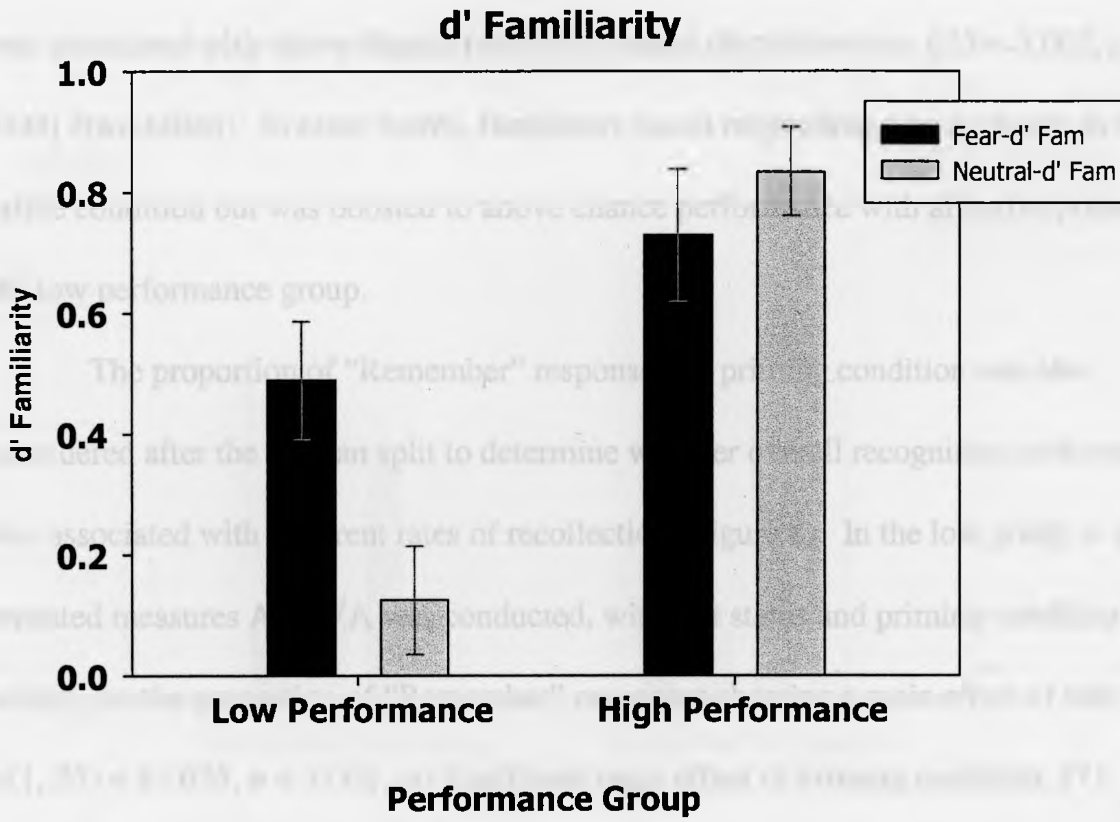

Figure 7. Familiarity expressed as d' for each of the two experimental conditions as a function of priming condition (Fearful versus Neutral) and overall recognition performance group.

significantly above chance, $t(25) = 1.390$, $p < .177$ (two-tailed), while affective priming was associated with above chance familiarity-based discrimination, $t(25) = 5.002$, $p < .0001$ (two-tailed). In other words, familiarity-based responding was at chance in the no prime condition but was boosted to above chance performance with affective primes for the low performance group.

The proportion of "Remember" responses by priming condition was also considered after the median split to determine whether overall recognition performance was associated with different rates of recollection (Figure 8). In the low group, a 2 x 2 repeated measures ANOVA was conducted, with test status and priming condition as factors, on the proportion of "Remember" responses showing a main effect of test status, $F(1, 25) = 81.635$, $p < .0001$, no significant main effect of priming condition, $F(1, 25) = .056$, $p < .815$, nor an interaction between test status and condition for the low performance group, $F(1, 25) = .750$, $p < .395$. In the high performance group, also, a significant main effect of test status was discovered, $F(1, 25) = 61.107$, $p < .0001$, no main effect of priming condition, $F(1, 25) = .567$, $p < .458$, nor an interaction was found, $F(1, 25) = .382$, $p < .542$. While no apparent relationship between priming and the tendency to respond "Remember" was found, it is possible that the formal analysis of recollection (e.g., "Remember" hit rate – false alarm rate) would reveal an influence of priming on recollection. As was performed on d' familiarity, a 2 x 2 repeated measures ANOVA was conducted, with priming condition and performance group as factors, on recollection scores for each priming condition. No significant main effect of priming condition was found, $F(1,50) = .037$, $p < .849$, as well as no significant priming condition

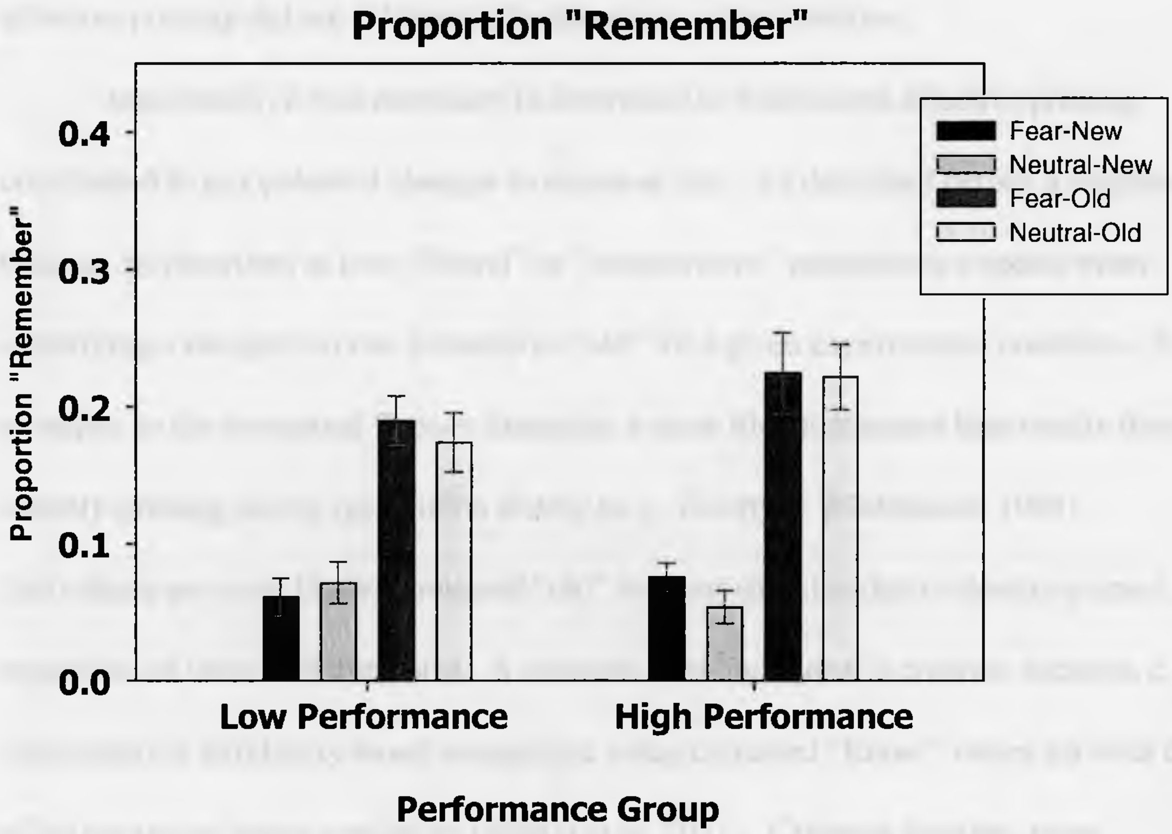

Figure 8. Overall proportion of target faces identified as "Remember" as a proportion of the total number of faces in each of the two experimental conditions for old and new items as a function of priming condition (Fearful versus Neutral) and overall recognition performance group.

by performance group interaction, $F(1, 50) = 1.149, p < .289$. Unlike for familiarity, affective priming did not differentially affect rates of recollection.

Importantly, it was necessary to determine to what extent affective priming contributed to any potential changes in response bias. As described before, a response bias can be described as how "liberal" or "conservative" participants respond when identifying a recognition test stimulus as "old" for a given experimental condition. For example, in the perceptual fluency literature, a more liberal response bias results from identity-priming during recognition testing (e.g., Jacoby & Whitehouse, 1989). Individuals are more likely to respond "old" to a test stimulus that is identity-primed, regardless of the actual test status. A measure of an individual's criterion location, *c*, was calculated for familiarity-based recognition using corrected "Know" values for both the affective and no prime conditions (Martin et al, 2011). Criterion location, more specifically, represents the point at which participants decide to set their decision boundary between responding "New" and "Know." A 2 x 2 repeated measures ANOVA was conducted, with priming condition and performance group as factors, on *c*, revealing no significant main effect, $F(1,50) = .381, p < .540$, as well as no priming by performance group interaction, $F(1,50) = 2.254, p < .140$. Affective priming did not significantly affect familiarity-based response biases (Table 1).

To assess the relationship between prime discriminability and affective familiarity enhancement, a regression analysis was conducted assessing the relationship between priming and d' discriminability in the entire sample of participants (Figure 9). Priming was calculated for each participant by subtracting the d' familiarity score for the no prime

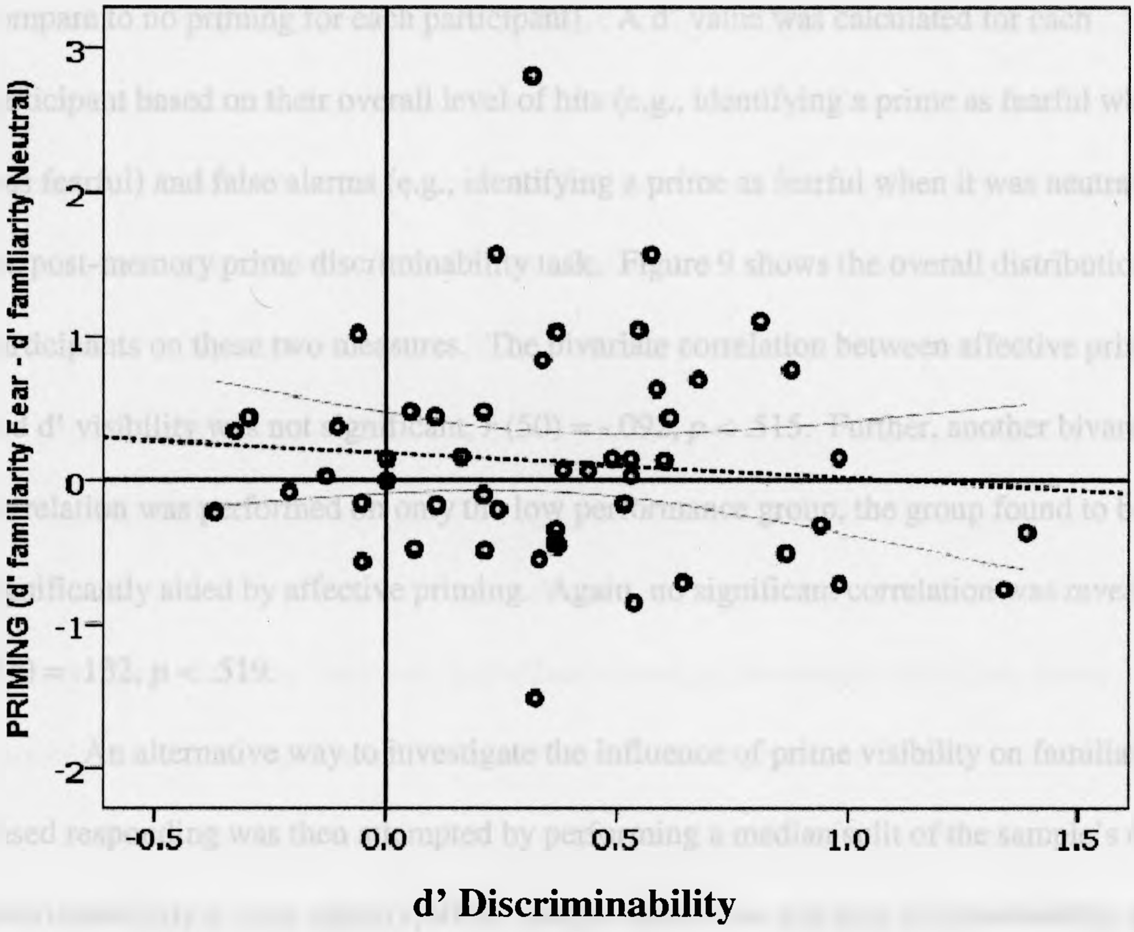

Figure 9. Relationship between affective priming in recognition memory and discriminability on the forced-choice perceptual discrimination task. Data points pertain to individual participants. Regression line and 95% confidence interval are shown.

condition from the d' familiarity score for the affective priming condition (i.e., calculating to what extent affective priming increased familiarity-based discrimination as compare to no priming for each participant). A d' value was calculated for each participant based on their overall level of hits (e.g., identifying a prime as fearful when it was fearful) and false alarms (e.g., identifying a prime as fearful when it was neutral) on the post-memory prime discriminability task. Figure 9 shows the overall distribution of participants on these two measures. The bivariate correlation between affective priming and d' visibility was not significant, r (50) = -.092, $p < .515$. Further, another bivariate correlation was performed on only the low performance group, the group found to be significantly aided by affective priming. Again, no significant correlation was revealed, r (24) = .132, $p < .519$.

An alternative way to investigate the influence of prime visibility on familiarity-based responding was then attempted by performing a median split of the sample's d' discriminability scores, which split the sample into a low and high discriminability group. Within the low discriminability sample, a 2 x 2 repeated measures ANOVA was conducted, with test status and priming condition, on the proportion of "Know" responses, revealing no main effect of priming condition, $F(1,24) = 1.385$, $p < .251$, nor a status by priming condition interaction, $F(1,24) = 1.423$, $p < .245$. In the high discriminability group, no main effect of priming condition, $F(1,26) = .654$, $p < .426$, nor a test status by priming condition interaction was found, $F(1,26) = .314$, $p < .580$. In order to specifically assess the influence of prime discriminability on d' familiarity selectively, A 2 x 2 repeated measures ANOVA was then performed on d' familiarity, with prime condition and discriminability group as factors, revealing no main effect of condition, $F(1, 50) = 1.674$, $p < .202$, nor a significant prime condition by discriminability group interaction, $F(1, 50) = .284$, $p < .596$. No relationship was found between prime discriminability and the tendency to respond "Know," which would also determine whether affective priming was associated with a change in response bias when the sample is split according to prime awareness rather than overall recognition performance. No relationship was found between familiarity-based discrimination (d') and prime awareness as well.

2.3 Discussion

The current experiment employed an affective priming paradigm to induce a fleeting emotional state below an individual's level of awareness while they made attributions of past experience for faces with neutral expressions. Towards this end, we used the Remember/Know procedure to determine whether affective priming differentially affected familiarity-based recognition memory or recollective-based recognition memory.

The results of this study reveal that subliminal affective priming can act to enhance the ability to recognize whether someone's face has been previously encountered, specifically, this heightened emotionality selectively enhances familiarity-based recognition of these faces. These results are in line with predictions derived from the literature on the effects of affective priming on perceptual decisions (Phelps & Carrasco, 2006) and attention (Anderson & Phelps, 2001; Lim et al, 2009). It was also shown that only participants with an overall lower ability to discriminate between old and new faces showed the enhancing effect of affective priming on familiarity-based recognition memory. In other words, if participants could efficiently rely on sufficiently rich memory representations of the faces studied initially, affective priming did not particularly affect familiarity-based performance. Another possible explanation is that individuals in the low group may have been less vigilant in their attention toward test faces, allowing affective priming to initiate a vigilant attentional state. Participants who performed poorly on the test were significantly aided by an induction of emotional arousal, essentially boosting access to a familiarity signal that was not significantly different from chance in this group when no emotional induction occurred. Interestingly, the influence of affective priming was not determined by the level of awareness of fear present in the primes, as measured by a forced-choice discriminability task. Neither a regression approach, which has been extensively used to determine prime visibility on behavioural performance on a variety of tasks (Hannula & Cohen, 2006), nor a median-split approach revealed any significant influence of the level of prime discriminability on priming effects during recognition.

An alternative hypothesis that affective priming may result in participants erroneously attributing a feeling of heightened arousal to familiarity can be ruled out given that measures of response bias were unaffected by priming. Even though past recognition memory experiments have shown that administering a subliminal “buzz” during recognition can result in such a response bias, without any improvement in discrimination (Goldinger & Hansen, 2005), we observed a decreased tendency to false alarm to novel faces and an increased tendency to recognize previously encountered faces as old. While Goldinger & Hansen (2005) compared their somatic "buzz" manipulation to arousal, it seems that emotional stimuli with confirmed negative valence can produce a different pattern of results.

As stated before, an enhancing effect of subliminal affective arousal on familiarity-based recognition is in line with the abundant existing literature showing that increased stimulus emotionality results in an increased allocation of attention and perceptual processing. It can be argued that affective priming led to superior attention of the target faces as compared faces primed with a neutral face. It is entirely possible that the features of the target faces were examined in a way that led to an increased capacity to compare those perceptual features with already established memory representations. Interestingly, the perirhinal cortex (PrC) has been implicated in sub serving both the accurate recognition of faces from memory as well as accuracy in a perceptual oddball task (O'Neil et al., 2009). Activation of the PrC during stimulus encoding has been associated with later familiarity-based recognition (Diana et al, 2007), and patients with surgical removal of the PrC for treatment of epilepsy can show selective familiarity deficits (Bowles et al., 2007). This past research showing a close-knit relationship between familiarity-based recognition and perceptual analysis strongly corroborates the claim that the emotional enhancement occurring in this study may have been mediated through a perceptual mechanism. Increased attentional devotion to the perceptual features of a face, in combination with more efficient visual processing, perhaps even over and above the attentional benefits, may explain the memory benefits discovered in this study. This combined perceptual/attentional mechanism of enhancement for emotionally conditioned stimuli has already been shown in a recent fMRI study (Lim et al., 2009), which revealed that the amygdala modulates efficient processing in occipitotemporal cortex and the prefrontal cortex during the processing of stimuli that were previously aversively conditioned. Left unanswered by this memory study, is whether the amygdala may also directly modulates more efficient memory processing in the PrC.

It was observed also that the influence of affective priming was not associated with prime visibility in a forced-choice visibility task. It appears to be the case that subliminal prime presentation is not critical in order to see the enhancing effects of affective priming on familiarity-based discrimination. Interestingly, an emerging view of affective processing and amygdala function have recently discussed that amygdala responses are more robust to consciously presented affective stimuli rather than through a subliminal presentation, and that many studies, most notably Whalen et al. (1998), did not effectively measure the subliminal nature of masked priming (Pessoa & Adolphs, 2010).

When considering the relevance of these findings to the Dual-Process Model of recognition memory, it is important to note that affective priming selectively enhanced familiarity-based recognition. Recollection was not significantly affected by affective priming in this study. Importantly, familiarity-based recognition memory has been tied closely with item memory, and it has been shown recently that if details of a stimulus are encoded as an item (e.g., unifying the details “pink” and “elephant” into an item by imagining a pink elephant), these details can be retrieved via familiarity through the PrC (Staresina & Davachi, 2010). If the emotional manipulation employed in this study influences enhanced recognition through increased perceptual analysis of the target faces, one may be able to explain why the manipulation did not also lead to a reinstatement of contextual elements of the initial exposure to the face (e.g., if the participant liked/disliked the face upon initial viewing, if they heard a noise in the testing room, etc.). In such an account the memory benefits would be restricted to the information perceptually analyzed at retrieval, and in this situation the face itself is an item.

While the mechanistic interpretation of these results are highly supported by the past literature on the facilitatory affect that emotion has on attention and perception, it will be important in the future to determine the exact role that the amygdala plays in this enhancing effect. Of particular interest would be the coordination of the amygdala and PrC due to the fact that it has been strongly implicated in familiarity-based recognition. Also, the simultaneous coordination of the amygdala, PrC, and Fusiform Face Area (FFA) would be of interest due to the possibility that the amygdala may independently "tune" efficient processing in both the PrC and FFA when faces are the stimuli to be remembered. From an attentional perspective, it would be necessary to determine the synchronous profile of fronto-parietal regions during the post-prime examination of test faces. It is possible that if increased attentional devotion occurred for fearfully-primed faces, increased fronto-parietal coactivation could be discovered. While an fMRI investigation into the effects of affective priming on memory would be highly informative, it would be challenging to conduct, given the large sample of participants required to reveal the priming effect in the present behavioural study. In another experiment, we aimed to determine whether the use of a perceptual fluency manipulation via priming would affect familiarity-based recognition the same way as affective priming found in this experiment.

3 Experiment 2: Identity Priming

3.1 Methods

3.1.1 Participants

Forty participants participated in the study (25 females, 15 males; mean age= 22.35, SD = 2.97). All participants had normal or corrected-to- normal vision and gave their written informed consent before participation. One participant was excluded from analyses based on chance overall recognition performance. Data from four additional participants were not included based on prime duration errors. Participants were all compensated, or received course credit for their participation. The study protocol was approved by the Research Ethics Board at the University of Western Ontario.

3.1.2 Stimuli

The stimuli presented were high-resolution coloured images of faces taken from the Karolinska Directed Emotional Faces database (KDEF), the NimStim Emotional Face Stimuli database, and the RadBoud Faces Database (Lundqvist et al. 1998; Tottenham et al., 2009, Langner et al., 2010). Only faces with neutral expression were used from these databases for this experiment. Stimulus preparation was done as in Experiment 1 (i.e., face cropping). Overall, 152 neutral faces were used, split into 8 unique sets with 19 faces per set. To create consistency, each set of faces had a constant proportion of items from each database. Also, a constant proportion of males to females was established for each group of targets, being the same between condition sets. This gender matching was also introduced with respect to each of the specific databases from which faces were sampled.

Again, different sets of faces were used to be used as targets (old test items) and novel lures. For each set of old and new items, 3 priming conditions were introduced that corresponded to, (i) non-identity primes, (ii) identity primes, and (iii) primes of scrambled ovals without any identity (i.e., a scrambled oval in place where a face prime would usually be). Having three prime types for both old and new items resulted in a 2 (test status: old or new) x 3 (prime condition) all within-subjects design. Six sets of 19 faces were used as target faces because both old and new items had three prime types as stated above. One set of 19 faces had to be used as novel non-identity primes for old items, and the final set of 19 unique faces were used as the novel non-identity primes for the new test items. A complete 8-list counterbalance scheme was created with this grouping, having each set of 19 faces present in all 8 positions once.

For the subsequent forced-choice prime discriminability task, a pseudo random sample of 20 non-identity primed items (half target and lures), and 20 identity-primed items (half targets and lures) were selected. These items were randomized to create the task list. All 8 counterbalancing versions of the experiment had a unique, list-specific, arrangement of items for the discriminability task.

3.1.3 Procedure

Image presentation (i.e., monitor used, presentation software) was identical to Experiment 1. All procedures and image presentation parameters were the same as in

Experiment 1, with one exception being that faces were presented for 1,500ms rather than 650ms at study and test. This change was introduce in order to be in-line with the presentation parameters previously used in other recognition-memory experiments on perceptual fluency (Jacoby & Whitehouse, 1989; Rajaram, 1993). Primes were again presented at 33ms duration, verified by image onset time for every participant. Procedure and priming setup with timing as well as different trial types are shown in Figure 10.

After the recognition-memory test, participants were again probed for prime awareness and fully debriefed concerning the nature of the priming manipulation during the memory experiment. A prime discriminability task was administered, forcing participants to judge for pairs whether the prime presented was the same identity as the target face, or not. As the primary contrast of interest concerned identity versus non-identity primes, we considered this the primary discriminability factor of interest. Participants were told that half the faces were primed by the same face as the target, and the other half by novel faces. All image presentation parameters were the same as in the recognition memory test. After the target face disappeared in any given trial, participants were prompted with the text, "Was the prime identity the same as the target identity?" and were required to provide a "yes" or "no" response.

3.2 Results

Figure 11 displays the proportion of faces recognized as "old" as a function of priming condition (e.g., Non-Identity, Identity, and No Face) and recognition-test status (e.g., Old or New). A 2 x 2 repeated measures ANOVA was conducted, with test status and priming condition as factors, on the proportion identified as "old" to determine

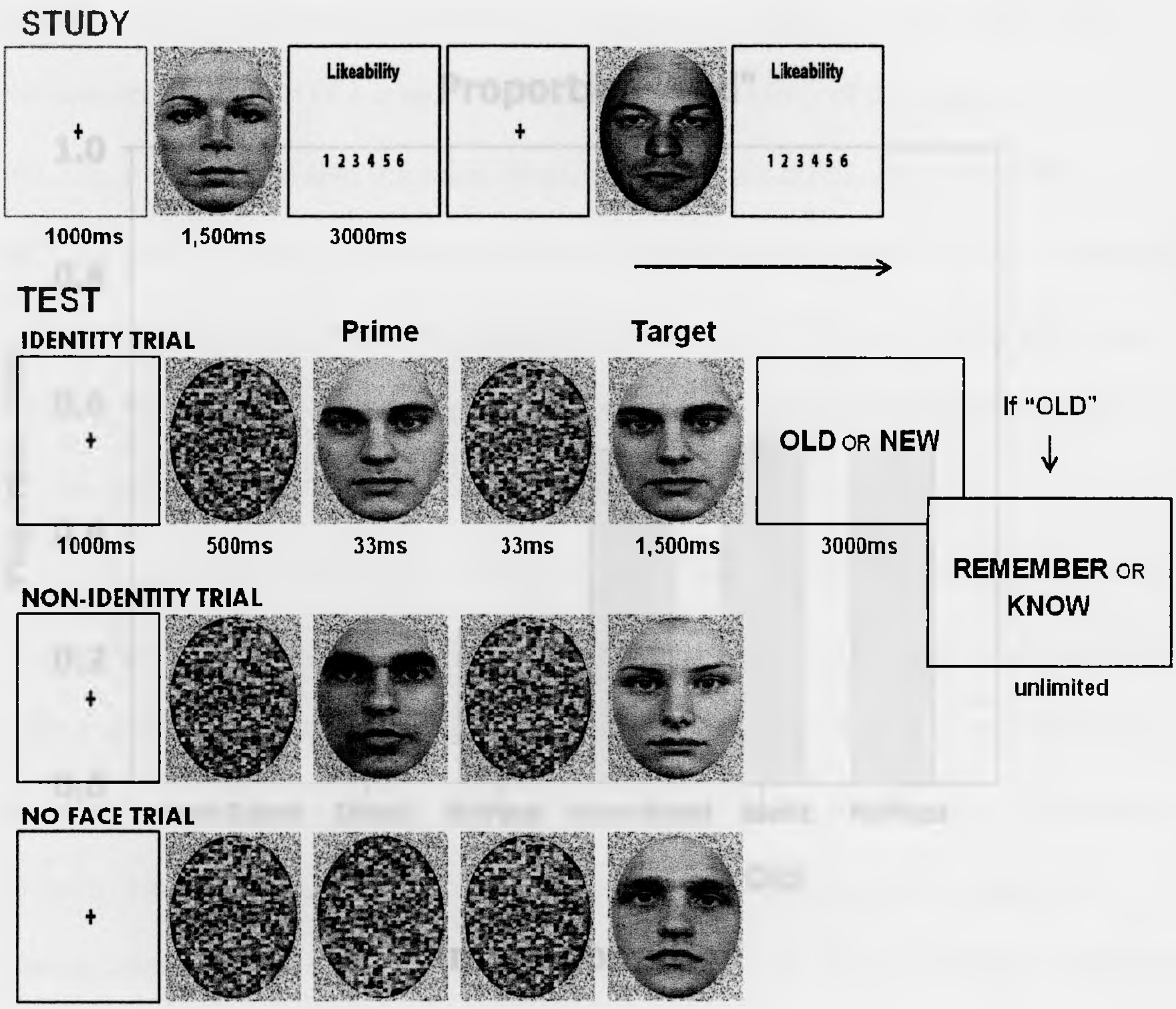

Figure 10. Illustration of events, timing, and priming trial types.

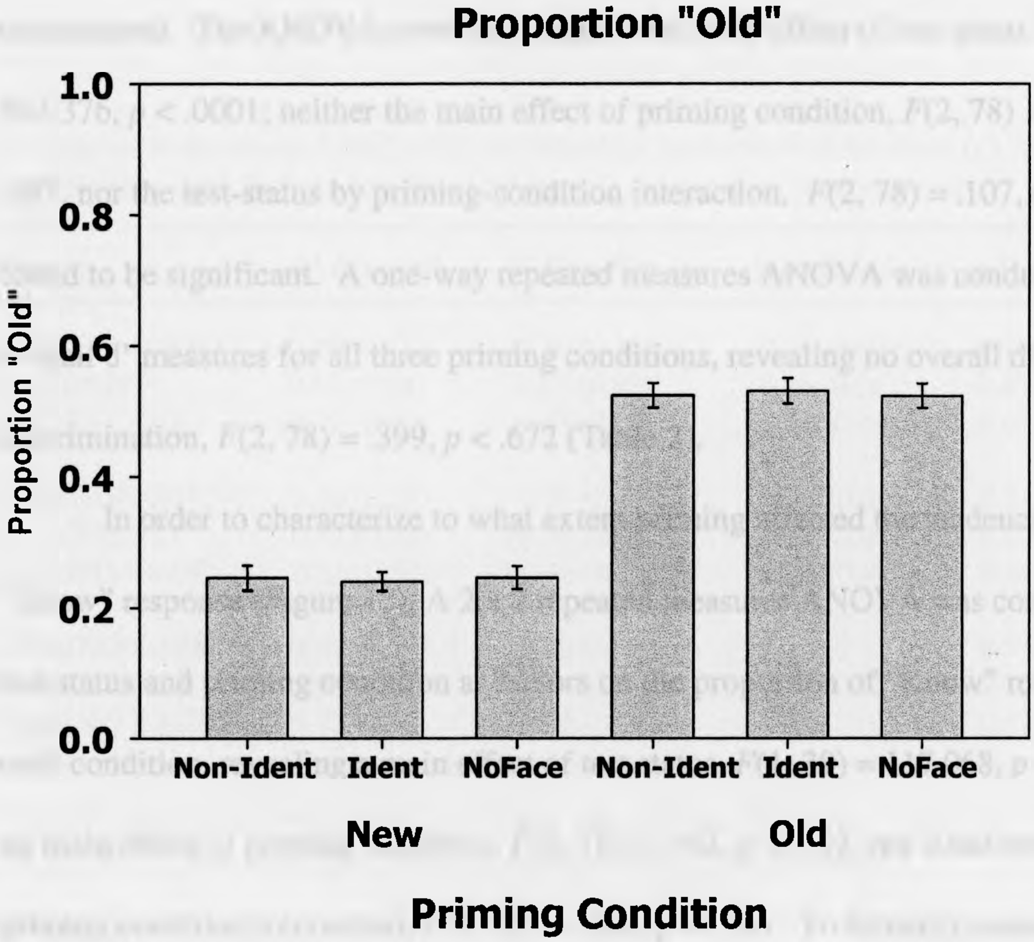

Figure 11. Overall proportion of target faces identified as "Old" as a proportion of the total number of faces in each of the three experimental conditions for old and new items.

whether priming differential affected the tendency to recognize a face as previously encountered. The ANOVA revealed a significant main effect of test status, $F(1, 39) = 362.376, p < .0001$; neither the main effect of priming condition, $F(2, 78) = .003, p < .997$, nor the test-status by priming-condition interaction, $F(2, 78) = .107, p < .899$ were found to be significant. A one-way repeated measures ANOVA was conducted on the overall d' measures for all three priming conditions, revealing no overall difference in discrimination, $F(2, 78) = .399, p < .672$ (Table 2).

In order to characterize to what extent priming affected the tendency to provide a "Know" response (Figure 12), A 2 x 2 repeated measures ANOVA was conducted, with test status and priming condition as factors on the proportion of "Know" responses for each condition, revealing a main effect of test status, $F(1, 39) = 117.068, p < .0001$, but no main effect of priming condition, $F(2, 78) = .462, p < .632$, nor a test-status by priming condition interaction, $F(2, 78) = .308, p < .736$. To formally measure the effect of prime type on familiarity-based responding, d' measures were calculated separately for each prime type (Table 2). As in Experiment 1, this measure was calculated using the correction for independence suggested by Yonelinas (2002). A one-way repeated measures ANOVA was performed to compare the corrected d' familiarity score for all prime types, showing no significant differences in familiarity-based responses by prime type, $F(2, 78) = .129, p < .879$.

To characterize the influence of priming on "Remember" responses (Figure 13), a 2 x 2 repeated measures ANOVA was conducted, with test status and priming condition as factors on the proportion of "Remember" response for each condition. It revealed a

Table 2

Recognition accuracy, familiarity, recollection, and criterion location (*c*) for participants with high or low level of overall recognition performance

Group	d' Overall	d' Familiarity	Recollection	*c* Familiarity
All(NON-IDENT)	0.89 (0.11)	0.70 (0.11)	0.16 (0.02)	0.72 (0.07)
All(IDENT)	0.85 (0.08)	0.65 (0.08)	0.16 (0.02)	0.65 (0.07)
All(NO FACE)	0.79 (0.08)	0.64 (0.08)	0.14 (0.02)	0.63 (0.06)
Low(NON-IDENT)	0.78 (0.17)	0.59 (0.16)	0.14 (0.04)	0.69 (0.10)
Low(IDENT)	0.74 (0.08)	0.56 (0.09)	0.13 (0.03)	0.52 (0.06)
Low(NO FACE)	0.81 (0.12)	0.66 (0.11)	0.13 (0.04)	0.66 (0.08)
High(NON-IDENT)	0.97 (0.15)	0.78 (0.16)	0.18 (0.02)	0.74 (0.11)
High(IDENT)	0.93 (0.11)	0.71 (0.13)	0.18 (0.02)	0.75 (0.10)
High(NO FACE)	0.77 (0.10)	0.63 (0.11)	0.15 (0.02)	0.61 (0.06)

Note: High and low performance groups were defined based on a split at d' 0.15 on prime discriminability. Values represent mean (standard error).

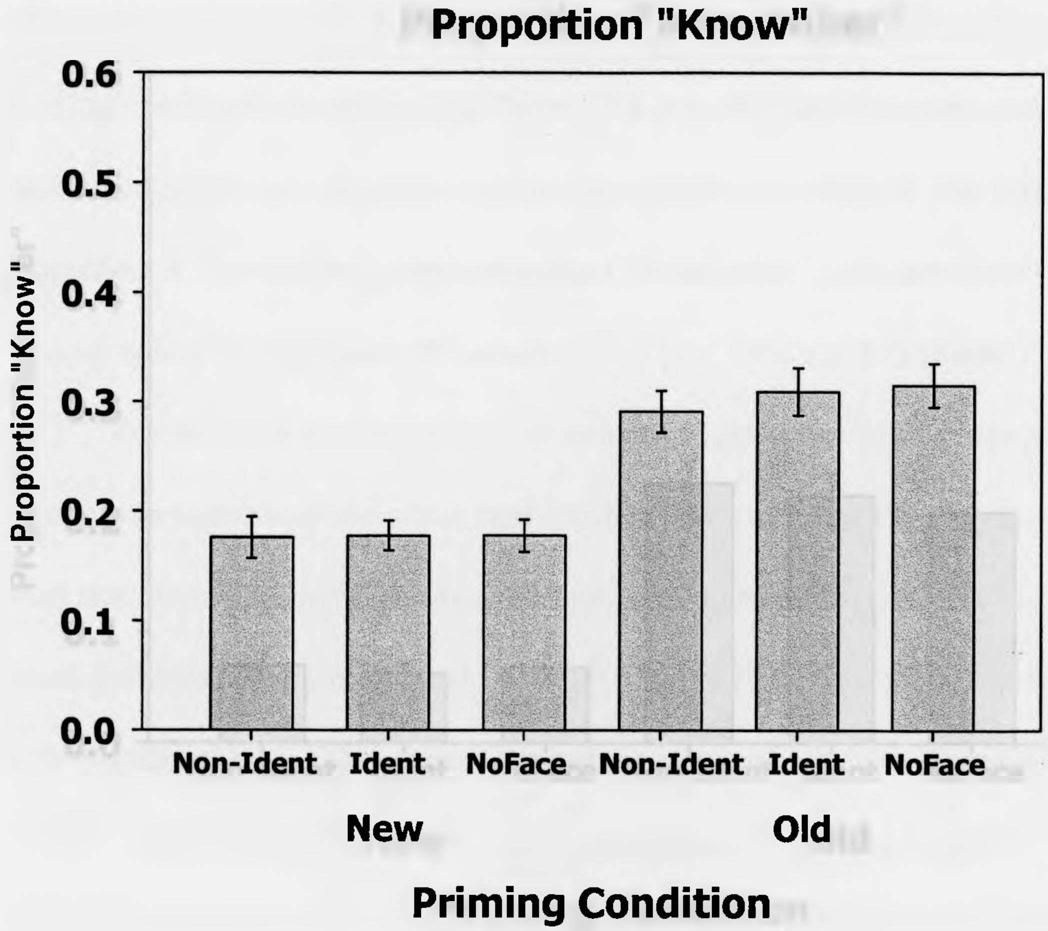

Figure 12. Overall proportion of target faces identified as "Know" as a proportion of the total number of faces in each of the three experimental conditions for old and new items.

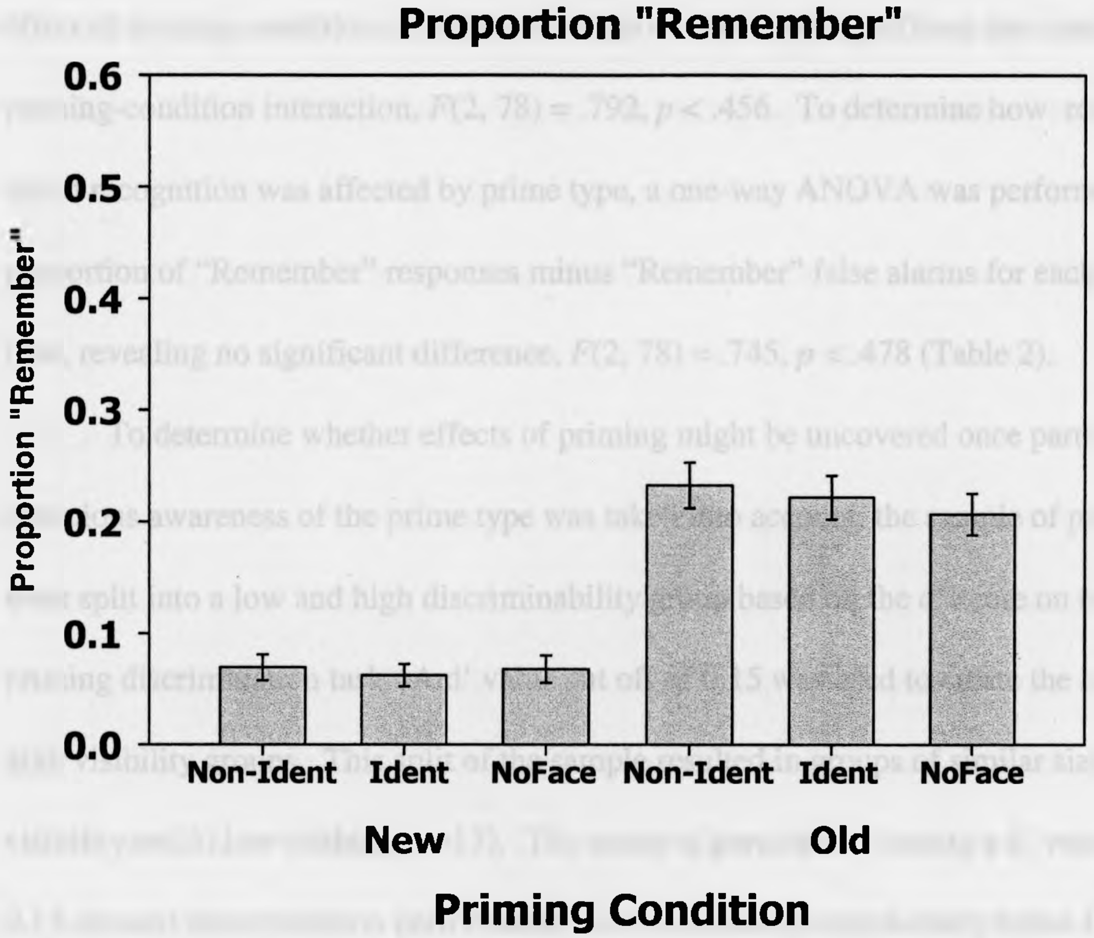

Figure 13. Overall proportion of target faces identified as "Remember" as a proportion of the total number of faces in each of the three experimental conditions for old and new items.

significant main effect of test status, $F(1, 39) = 126.012, p < .0001$, no significant main effect of priming condition, $F(2, 78) = .918, p < .404$, nor a significant test-status by priming-condition interaction, $F(2, 78) = .792, p < .456$. To determine how recollective-based recognition was affected by prime type, a one-way ANOVA was performed on the proportion of "Remember" responses minus "Remember" false alarms for each prime type, revealing no significant difference, $F(2, 78) = .745, p < .478$ (Table 2).

To determine whether effects of priming might be uncovered once participants' conscious awareness of the prime type was taken into account, the sample of participants were split into a low and high discriminability group based on the d' score on the identity-priming discrimination task. A d' value cut off of 0.15 was used to create the low and high visibility groups. This split of the sample resulted in groups of similar size (high visibility n=23; low visibility n=17). The group of participants having a d' value under 0.15 showed discrimination performance that was actually significantly below 0, $t(16) = -2.533$, p < .022, as determined with a one-sample t-test. It is important to note that the group mean for d' discriminability was -0.14. Since a d' value of below 0 represents no accurate prime discrimination, it isn't meaningful to say that the low group performed significantly worse than chance. This value is taken to show that the group did not discriminate between affective and non-affective primes in the prime discriminability task. The high discriminability group did discriminate significantly above chance on the task, $t(22) = 8.557$, p < .0001.

A 2 x 3 repeated measures ANOVA was performed, with test status and priming condition as factors, on the proportion identified "old," revealing a significant main effect of test status, $F(1, 16) = 119.964$, $p < .0001$, no significant priming condition main effect, $F(2, 32) = .554$, $p < .580$, nor a significant test status by priming condition interaction, $F(2, 32) = .322$, $p < .727$ in the low group. In the high group, the same repeated measures ANOVA was conducted showing a significant main effect of test status, $F(1, 22) = 249.841$, $p < .0001$, no significant main effect of priming condition, $F(2, 44) = .341$, $p < .713$, and no significant test status by priming condition interaction, $F(2, 44) = .357$, $p < .702$.

Given the prior hypothesis that identity-priming may result in an increased tendency to respond "old" for old and new test items (shown for overall recognition in Jacoby & Whitehouse, 1989) in the low discriminability group, planned contrasts were performed for identity-primed new items compared to both non-identity and no face priming baseline conditions, revealing no significant increase in the proportion "old" responses given, $F(1,16) = .408$, $p < .532$. For old test faces, a similar planned contrast was performed revealing no significant increase in the overall proportion of test faces identified as "old" for identity-primed faces when compared to both baseline conditions, $F(1,16) = .821$, $p < .378$.

When investigating the influence of priming on "Know" responses, a 2 x 3 repeated measures ANOVA was performed, with test status and priming condition as factors, on the proportion of "Know" responses for each condition first in the low discriminability group (Figure 14). A significant main effect of test status was revealed, $F(1, 16) = 35.788$, $p < .0001$. The main effect of priming condition was not significant, $F(2, 32) = 2.615$, $p < .089$. Also, there was no significant priming condition by test status

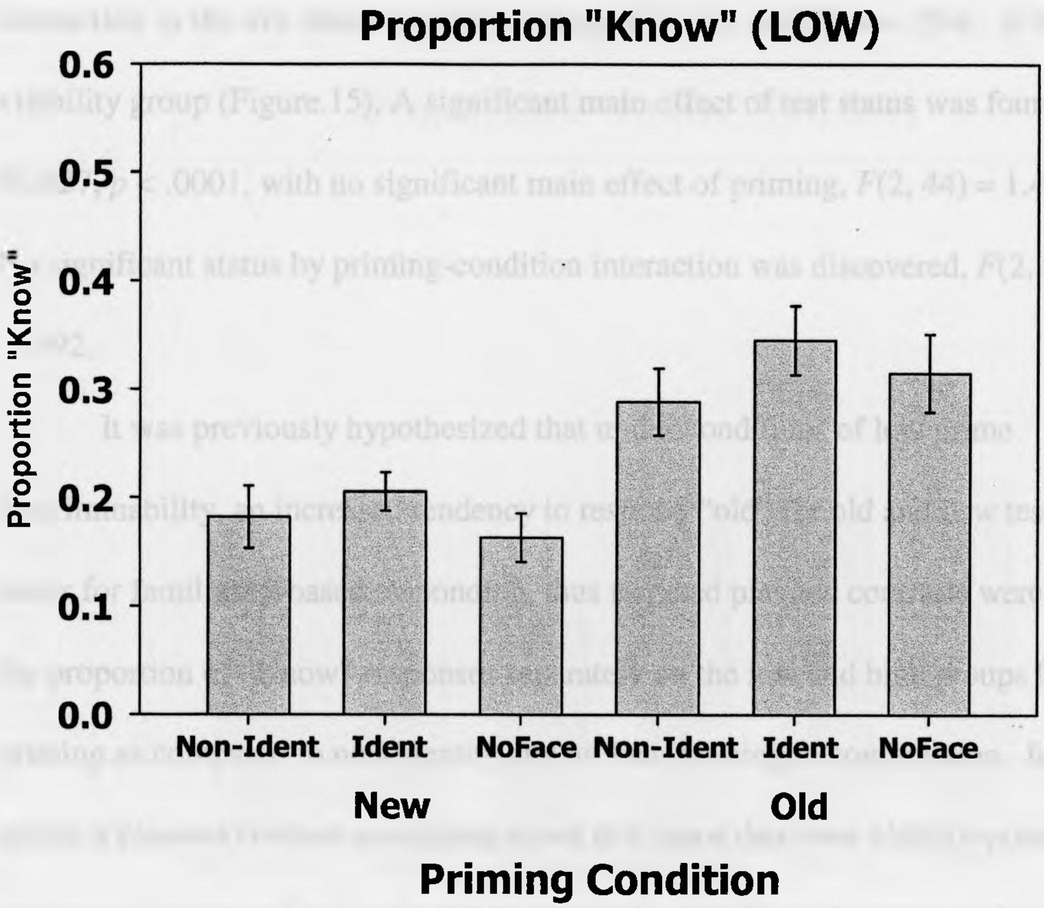

Figure 14. Overall proportion of target faces identified as "Know" as a proportion of the total number of faces in each of the three experimental conditions for old and new items in the low discriminability group.

interaction in the low discriminability group, $F(2, 32) = .659, p < .524$. In the high visibility group (Figure 15), A significant main effect of test status was found, $F(1, 22) = 93.627, p < .0001$, with no significant main effect of priming, $F(2, 44) = 1.405, p < .256$. No significant status by priming-condition interaction was discovered, $F(2, 44) = .008, p < .992$.

It was previously hypothesized that under conditions of low prime discriminability, an increased tendency to respond "old" for old and new test items may occur for familiarity-based responding, thus targeted planned contrasts were performed on the proportion of "Know" responses separately on the low and high groups for identity-priming as compared to non-identity and no face priming in combination. In the low group, a planned contrast comparing novel test items that were identity-primed against both non-identity and no face priming revealed a significant increase in the proportion of "Know" responses for identity-priming, $F(1, 16) = 3.163, p < .047$ (one-tailed). For old items in the low group, another planned contrast was performed, revealing a significant trend of an increase in the proportion of "Know" responses given for the identity-priming condition as compared to the non-identity and no face baseline conditions in combination, $F(1,16) = 3.006, p < .051$ (one-tailed). In order to confirm that this increase in familiarity-based responding for the low discriminability group was isolated to this group, planned contrasts were performed for identity-priming compared to both non-identity and no face baseline conditions for new test items in the high group, $F(1,22) = .997, p < .329$, and old items, $F(1,22) = .587, p < .452$, revealing that the increase in the proportion of "Know" responses for identity-primed test face was restricted to the low group.

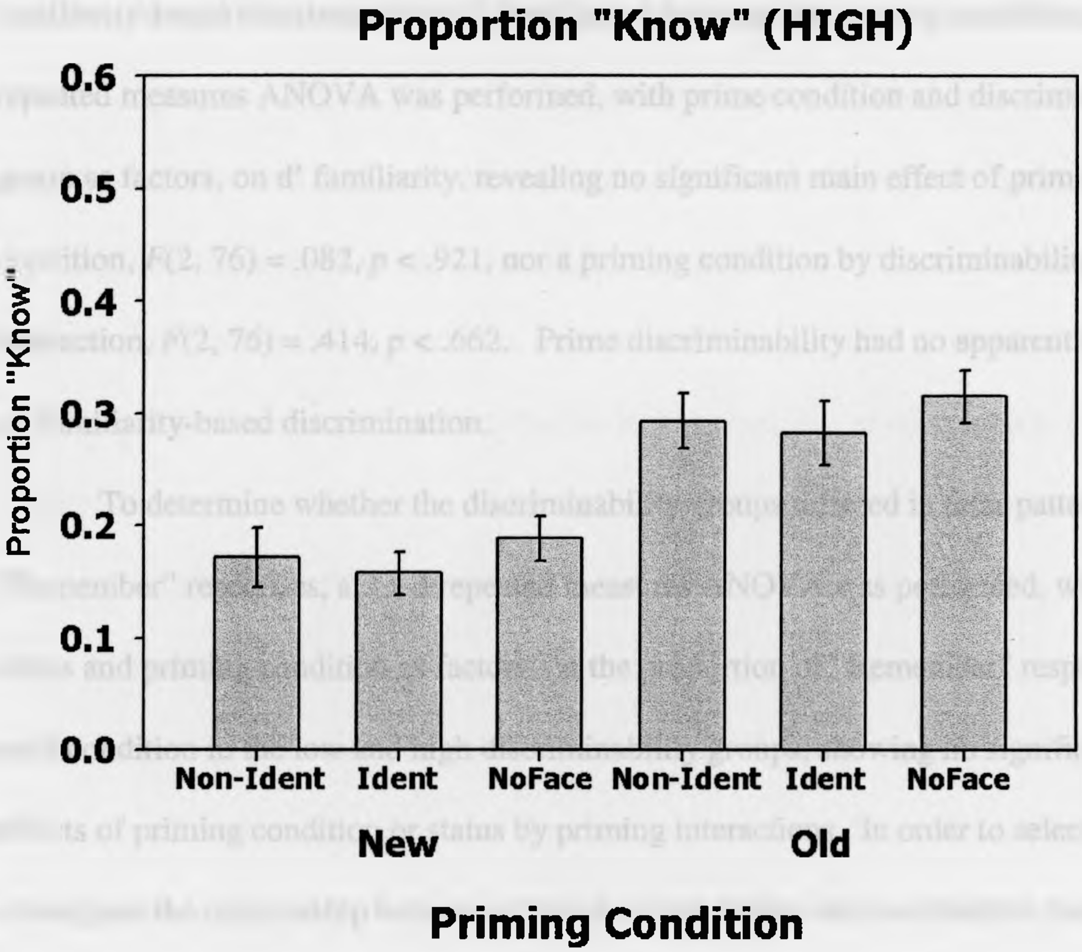

Figure 15. Overall proportion of target faces identified as "Know" as a proportion of the total number of faces in each of the three experimental conditions for old and new items in the high discriminability group.

To assess whether prime discriminability was associated with differences familiarity-based discrimination (d' familiarity) between the priming conditions, a 3 x 2 repeated measures ANOVA was performed, with prime condition and discriminability group as factors, on d' familiarity, revealing no significant main effect of priming condition, $F(2, 76) = .082, p < .921$, nor a priming condition by discriminability group interaction, $F(2, 76) = .414, p < .662$. Prime discriminability had no apparent influence on familiarity-based discrimination.

To determine whether the discriminability groups differed in their pattern of "Remember" responses, a 2 x 3 repeated measures ANOVA was performed, with test status and priming condition as factors, on the proportion of "Remember" responses for each condition in the low and high discriminability groups, showing no significant main effects of priming condition or status by priming interactions. In order to selectively investigate the relationship between prime discriminability and recollection formally, a 3 x 2 repeated measures ANOVA was performed, with priming condition and discriminability group as factors, on recollection ("Remember" hits – "Remember" false alarms), revealing no significant main effect of priming condition, $F(2,76) = .583, p < .561$, as well as no significant priming condition by discriminability group interaction, $F(2,76) = .340, p < .713$.

Of particular interest in this study was the analysis of response bias for familiarity-based responses. An increase in hit and false alarms for test faces that are identity-primed as compared to both the non-identity and no face priming baseline conditions would be indicative of a shift in response bias, as it shows an increased tendency to call items "old" regardless of the item test status (i.e., old or new items). A measure of response bias, *c*, was calculated with corrected familiarity scores from each prime condition; the resulting data are displayed in Figure 16. A 3 x 2 repeated measures ANOVA was conducted, with priming condition and discriminability group as factors, on the response bias, *c*, revealing no significant main effect of condition, $F(2, 76) = 1.050$, $p < .355$, nor a interaction between group and priming condition, $F(2, 76) = 2.313$, $p < .106$. To further investigate whether a shift in response bias occurred for identity-priming as compared to both non-identity and no face priming in combination, a planned contrast was performed in the low group, revealing a significant decrease in *c* for identity-priming, $F(1,16) = 6.223$, $p < .024$. A significant decrease in *c* indicates that identity-priming was associated with a more liberal response criterion, which would indicate that participants in the low group were more liberally responding "old" for identity-primed test faces. To determine whether this decrease in *c* was isolated to the low discriminability group, a planned contrast was performed in the high discriminability group comparing identity-priming to both of the baseline priming conditions, revealing no significant shift in response bias, $F(1,22) = .773$, $p < .389$. Identity-priming was associated with a more liberal response criterion as compared to both baseline priming conditions in the low, but not the high discriminability group.

To be sure identity-priming did not affect familiarity-based discrimination the same way that affective priming did in Experiment 1, a one-way repeated measures ANOVA was performed on d' familiarity for participants in the bottom half of overall

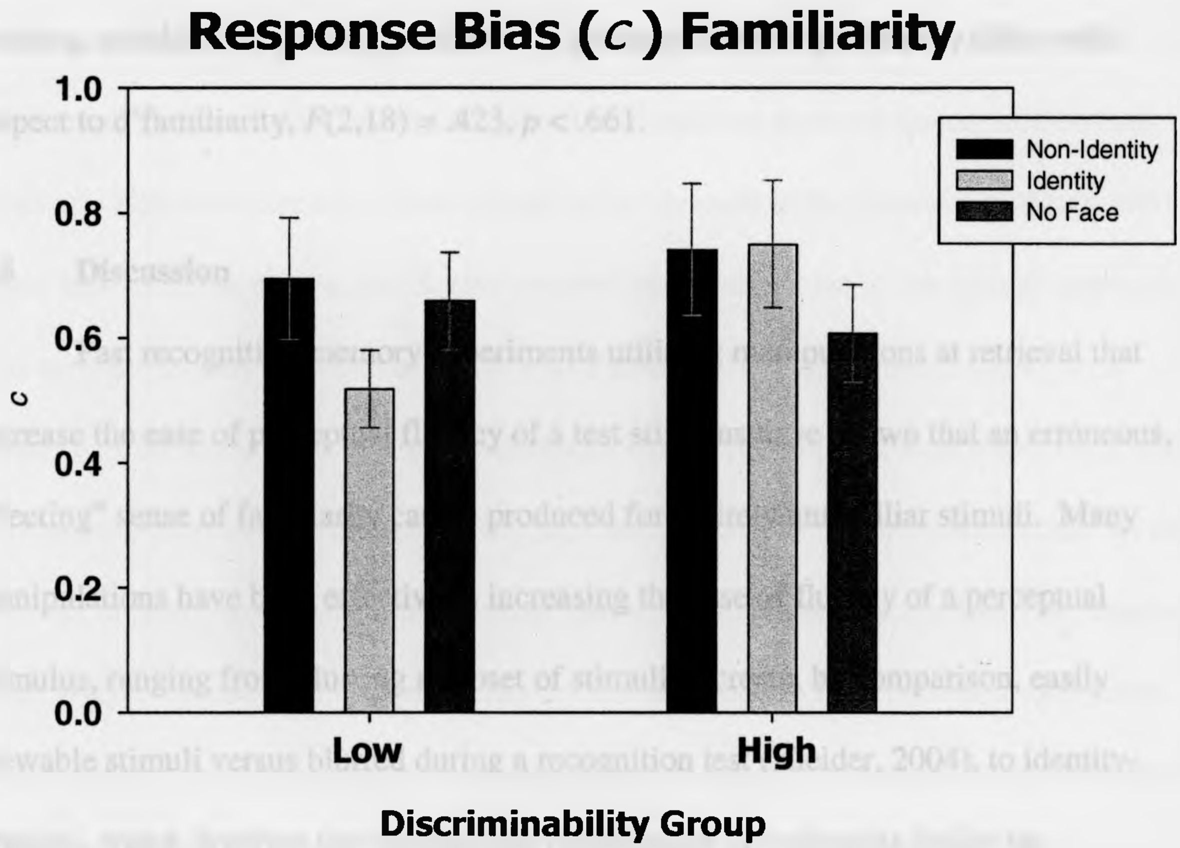

Figure 16. Criterion location (*c*) for familiarity-based responding as a function of prime condition and discriminability group.

recognition. This is the group in Experiment 1 that showed affective priming. Identity-priming, non-identity priming, and no face priming did not significantly differ with respect to d'familiarity, $F(2,18) = .423$, $p < .661$.

3.3 Discussion

Past recognition memory experiments utilizing manipulations at retrieval that increase the ease of perceptual fluency of a test stimulus have shown that an erroneous, "fleeting" sense of familiarity can be produced for entirely unfamiliar stimuli. Many manipulations have been effective in increasing the ease of fluency of a perceptual stimulus, ranging from blurring a subset of stimuli to create, by comparison, easily viewable stimuli versus blurred during a recognition test (Kleider, 2004), to identity-priming, which involves the unconscious presentation of a stimulus before the presentation of itself (Jacoby & Whitehouse, 1989; Rajaram, 1993). In the current study, identity-priming was used as a manipulation to determine whether the Jacoby Whitehouse Effect (i.e., a response bias involving increased proportion of familiarity-based Know responses for identity-primed stimuli) could be shown with faces and whether the effect would be different in its pattern from the effect of affective priming on familiarity-based discriminability in Experiment 1. The results obtained hint that the Jacoby Whitehouse effect can be revealed with faces specifically under low prime visibility conditions.

Overall recognition displayed no differences as a result of prime type (i.e., Identity, Non-Identity, and No Face). This was unsurprising given past findings that have shown the typical bias to respond "old" for novel and familiar test items, occurs under low prime visibility condition and manifests particularly for familiarity-based "Know" responses (Rajaram, 1993). When distinguishing groups based on participants' ability to discriminate between identity and no-identity primes in a separate discrimination task, a trend was observed that was characterized by an increase in the proportion of familiarity based hits and false alarms for identity-primed items, indicative of the typical response bias seen in the past perceptual fluency experiments. The significant change in *c*, a measure of response bias, which was calculated using familiarity-based responding only, revealed the increased liberal nature of responding when Identity-priming occurs. In the low visibility group, Identity-primed items had a more liberal response bias (i.e., responds "old" with a "Know" response more readily) as compared to both non-identity priming and no face priming, showing how this change in response bias is significant and robust against varying baseline conditions. Also in line with Rajaram (1993) was the finding that Identity priming did not have any observable effect on recollection.

This is the first study to show the Jacoby Whitehouse Effect with faces. Until now, only verbal stimuli and non-sense perceptual symbols (Brown & Marsh, 2009) have shown this response bias pattern of results. Consistent with the one other study in which the Remember/Know procedure was employed with verbal identity priming (Rajaram, 1993), priming selectively boosted an artificial sense of "oldness" that was interpreted by participants as a familiarity experience, rather than an experience of recollection. Experientially it seems reasonable that a subjective sense of fluency would be interpreted as familiarity rather than recollection, since recollection involves contextual recollection of details not present in the stimulus itself.

4 General Discussion

Through the use of two different priming paradigms, it was shown that a perceptual fluency manipulation does not affect familiarity-based recognition memory the same way as priming with an affective stimulus. Importantly, affective priming significantly boosted familiarity-based discrimination rather than contextual recollection in Experiment 1; increasing perceptual fluency using identity-priming in Experiment 2 led to an induction of a response bias in familiarity-based responding indicative of a creation of erroneous feelings of familiarity. The pattern of results obtained in both experiments were limited to familiarity, and these two different priming manipulations essentially affected the ability to discriminate between old and new faces accurately in highly divergent ways. The boundary conditions defining the circumstances, in which affective priming and identity-priming affected familiarity-based responding, were different as well. Only when participants were split according to levels of overall memory performance in Experiment 1 did affective priming display familiarity-enhancing effects. By contrast interindividual differences in identity-prime discrimination determined to what extent a response bias could be observed in Experiment 2. Specifically, affective enhancement occurred when participants performed relatively poorly in overall memory discrimination, while the effect of identity priming could be revealed only under low prime-discriminability conditions.

The findings from Experiment 1 are the first to show that a manipulation aimed at heightening a state of emotional arousal during recognition that exists independent of the emotionality of the stimulus judged in the memory decision, (i) can improve recognition abilities, and (ii) has an enhancing effect that is specific to familiarity-based recognition. Experiment 2 is the first study to show the classic Jacoby/Whitehouse Effect with facial stimuli, a highly socially relevant stimulus type. Contrasting affective priming and identity priming in two experiments satisfy to some extent the uncertainty as to whether illusions of familiarity produced by identity-priming and somatic arousal in past recognition memory studies (Jacoby & Whitehouse, 1989; Rajaram, 1993; Goldinger & Hansen, 2005) can be interpreted as acting through the same mechanism. The present data suggest that the mechanisms at work may indeed be different. Also, in regards to the findings of Goldinger & Hansen (2005), the present findings suggest that the somatic "arousal" induced through externally administered buzzers may not be the same as that induced through presentation of arousing stimuli with negative valence. It is important to note however, that arousal was not measured through the measurement of skin conductance responses in any of these experiments, including those in the current thesis research. The fearful faces used in the current experiment were collected from normative databases that were confirmed to produce significant levels of arousal though. SCR's have only been associated with the presentation of familiar versus novel stimuli, and suggests that illusory feelings of familiarity may be associated with a sense of autonomic arousal (Morris & Cleary, 2008). It is possible that an induction of "arousal" via negative valence stimuli may produce a cascade of neural events, possibly originating in the amygdala, promoting attentional and perceptual benefits, while feelings of perceptual fluency that lack valence do not produce the same benefits, and are left subject to erroneous interpretation.

The affective enhancement of familiarity shown in Experiment 1 is most easily explained by relating it to the existing literature on attentional and perceptual processing benefits afforded to emotional stimuli (□hman & Flykt, 2001; Phelps & Carrasco, 2006; Anderson & Phelps; 2001). When trying to fully understand how an affective prime might enhance familiarity, it can be suggested that an induction of a transient vigilant state resulting from fear in the prime faces led participants to attend more efficiently to the target faces, rendering those targets to a more devoted perceptual analysis not occurring for faces that were not affectively primed. This mechanistic account is corroborated by the finding that only participants who performed relatively poorly on overall recognition display this effect. Low performing participants may have had a lower baseline-level of attentiveness as compared to those who performed well on this task and, as a result, were the only ones who benefitted from the extra boost in attentional vigilance induced by the flash of a fearful face during recognition. Such enhanced vigilance during the recognition test is entirely in line with the findings reported by Lim et al (2009) and Anderson & Phelps (2001). These studies have shown that affective stimuli are more likely made available to consciousness in rapid serial presentation tasks, while under the same circumstances, neutral stimuli are usually unperceivable due to rapid presentation and distraction. Affective priming in Experiment 1 may have influence attentional processing in a similar way, by increasing the likelihood of effective target analysis. Lim et al (2009) revealed through mediation analyses performed on fMRI data that the amygdala causally influenced processing in visual cortex (PHG) as well as independently in the middle frontal gyrus, claiming that the amygdala boosts attention and perceptual processing independently. Interestingly, Phelps and Carrasco (2006) showed that contrast sensitivity enhancements were mediated through attentional vigilance. These two studies highlight that affective priming in Experiment 1 may have independently enhanced attention and perceptual processing of target faces during the recognition-test, while possibly leading to an interaction of the two as well.

However, other explanations relating to overall memory capacity differences cannot be ruled out. It is possible, considering the known enhancement of perceptual processing efficiency granted to stimuli that are affectively primed (Phelps & Carrasco, 2006), that affective familiarity enhancement could have also occurred as a result of more efficient perceptual processing in brain regions associated with both familiarity-based recognition memory and perceptual analysis, perhaps in perirhinal cortex (O'Neil et al. 2009), without any mediating role of attentional mechanisms supported by other cortical regions.

An individual's prime discriminability, as measured by a separate forced-choice discriminability task, did not show any observable relationship with the affective prime enhancement effect in Experiment 1. Even though participants reported having not noticed the face primes during recognition, a stringent assessment of prime discriminability measured by the prime discriminability task revealed that priming may not have been truly subliminal. Both the low and high recognition performance groups performed above chance on the prime discriminability task. Some participants reported, in both Experiment 1 and 2, that they noticed a "flicker" of light as the visible scrambled oval switched to the target memory face, suggesting that even though participants didn't know that a face was being presented, some visual information from the prime (e.g., luminance) reached conscious awareness. This highlights the importance of the stringent post-test prime discriminability task, which directly measured participants' ability to consciously appreciate the primes. Regardless, affective priming led to an enhancing influence on familiarity-based recognition.

The pattern of results observed in Experiment 1 is in direct contrast to the findings of Experiment 2, which revealed that identity-priming only produced an illusion of familiarity when participants performed at chance on a similar prime discriminability task. The importance of truly subliminal prime presentation is typically emphasized in the perceptual fluency literature, and can be related to the explanation of the Jacoby & Whitehouse effect in the framework of the Discrepancy Attribution Hypothesis (DAH). The DAH maintains the position that individuals interpret an increased sense of perceptual fluency induced by identity-priming as familiarity under subliminal prime conditions due to the fact that the actual source of fluency cannot be consciously attributed to the identity-prime. Considering that above chance prime discriminability was observed in both the low and high recognition performance groups, and no change in response bias occurred with affective priming, the DAH cannot account for the findings of affective familiarity enhancement in Experiment 1. The DAH was developed as a model to account for the erroneous feelings of familiarity resulting from identity priming and was also referenced in the interpretation offered by Goldinger & Hansen (2005), who induced peripheral somatic arousal during recognition testing. In past studies investigating how emotional arousal affects perceptual processing (e.g., Phelps &

Carrasco, 2006); emotional arousal has typically been introduced at the level of conscious awareness, highlighting that affective influences on cognition do not require subliminal presentation. While the current thesis research did not manipulate to what extent consciously presented fearful faces might induce the same familiarity enhancement effect as subliminal primes, it would be a worthy endeavour in the future to test if the effect would still be present. The observation of no noticeable relationship between prime discriminability and the affective familiarity enhancement effect would suggest that this effect should be evident with consciously presented primes.

In Experiment 2, individuals who were unable to perform above chance on the identity-prime discrimination task showed a pattern of results consistent with the response bias seen in past studies that have manipulated perceptual fluency. Consistent with the DAH, participants who did not significantly perform above chance at detecting identity-priming were more likely to confuse novel test faces that were primed by their own identity, as familiar. Importantly, overall memory performance did not predict whether participants would show the response bias. Aside from the fact that affective priming showed a pattern of results different from that for identity-priming, the findings in Experiment 2 are noteworthy as they appear to be the first to show that identity-priming can create an illusion of familiarity for faces as stimuli. Until now, only verbal (Jacoby & Whitehouse, 1989) and abstract symbols (Brown & Marsh, 2009) have been associated with an erroneous sense of familiarity resulting from identity priming.

4.1 Implications for the Dual-Process Model

The findings from both Experiments 1 and 2 are particularly relevant in regards to the Dual-Process Model of recognition memory that assumes that two independent processes serve the ability to determine whether a stimulus has been previously encountered (i.e., familiarity and recollection). The selective enhancement of familiarity through affective priming at retrieval that was observed in Experiment 1 provides support for the Dual-Process Model given that recollection was not found to be influenced by the manipulation. The pattern of results in Experiment 2 obtained with identity-priming, a manipulation of the perceptual fluency of recognition faces, also supports the Dual-Process Model through its selective effect on familiarity. If recollection and familiarity were not independently organized, an induction of affective arousal or fluency could be predicted to influence recognition regardless of whether the experience pertained to "Remember" or "Know" responses. The finding that familiarity rather than recollection is influenced by affective priming is especially exciting given that emotional influences on memory, in the past, have been almost entirely been selective to recollection. This past literature has narrowed its investigation of the interaction of emotion and recognition memory on circumstances where the stimuli to be remembered are emotional, and therefore have always incorporated enhanced encoding processing of stimuli before the memory test (Ochsner, 2000; Kensinger & Corkin, 2004). It is likely given the findings presented here that the recollective enhancement associated with emotional memories in the past can be attributed, to a large extent, to encoding processing rather than retrieval processing on its own. This possibility may be true considering that any study incorporating emotionality within the stimulus to-be-remembered, necessarily present those stimuli at encoding. The fact that another stimulus content (i.e., faces) shows the Jacoby/Whitehouse Effect pattern of results provides increasingly stronger support that manipulating perceptual fluency of stimuli during recognition memory retrieval affects familiarity-based recognition selectively.

4.2 Implications for an Adaptive Mechanism

Given that emotions have been characterized evolutionarily as discrete states that promote behaviour adaptive for survival (Levine, 2004), it is plausible that there would be a memory system in place in humans that enables one's current emotional state to enhance recognition abilities under conditions of a reduced ability to attend (e.g., crisis situations characterized by intense fear). Being able to identify who is familiar or unfamiliar in a situation that requires rapid assessment of many visual stimuli acting as distracters would surely prove to be beneficial. If one were to try and imagine the experience of hand-to-hand combat, a situation imbued with fear, threats to survival, and distraction, it would be highly beneficial to be able to dissociate familiar faces that are likely less of a threat to survival from unfamiliar faces not in your squadron (e.g., the enemy). When considering that familiarity specifically may be enhanced in these types of situations rather than recollective abilities, it could be argued that being able to quickly and fluidly determine familiarity for stimuli in the environment may be more efficient for guiding behaviour than recollection in some circumstances. It might not be particularly helpful in situations that require rapid decision making to have full vivid contextual recollections of past experiences for familiar individuals, which might actually serve as a distraction. Situations characterized by intense emotional arousal may be more efficiently dealt with by making rapid assessments of familiarity in the absence of effects on recollection.

4.4 Future Directions

It will be important in the future to determine the neural basis of the affective priming enhancement effect in functional neuroimaging research. Accepting the interpretation that the underlying mechanism for this effect is attentional in nature, it may be predicted that the amygdala initiates more efficient frontal-cortex processing related to increased attentional resources for the target faces that are affectively primed. It may also be predicted, based on the considerable evidence linking perirhinal cortex (PrC) processing to both familiarity-based discrimination and perceptual appreciation of faces (Bowles et al, 2007; O'Neil et al, 2009), that the amygdala may modulate more efficient familiarity assessment computations directly within the PrC. Alternatively, the amygdala may modulate increased perceptual processing of faces in the fusiform face area, which then may feed visual information forward to the PrC located in anterior portions of the temporal lobe.

The large sample needed in Experiment 1 to uncover the affective enhancement effect makes it not particularly feasible for an fMRI investigation at the moment. An attempt to boost the effectiveness of affective priming could be attempted that takes advantage of a longer prime duration or an increase in the level of arousal induced by the prime. This may prevent having to search for less attending participants by performing an overall median split on recognition performance as was performed in Experiment 1. Another possible route to an fMRI investigation into this effect would be to incorporate a direct manipulation of attentional distraction during recognition testing given that it may be the case that low performing participants only showed the affective enhancement effect due to their lesser degree of attentiveness during the recognition task. To determine the brain-basis for this enhancing effect that a heightened state of affective arousal has on familiarity-based retrieval, modifications to the effectiveness of manipulation of affect will be needed.

Another future consideration is an incorporation of a measure of autonomic arousal elicited by affective primes. Collecting skin conductance responses while individuals perform the recognition test might be helpful when trying to show that affective primes did indeed exert their effect through a change in autonomic arousal. This strategy might also allow for the separation of trials associated with a "successful" induction of autonomic arousal resulting from priming, which could be expected to show the effect of affective arousal on familiarity assessment most clearly. It is likely that affective priming did not significantly affect familiarity-based enhancement on every trial, but merely increased the likelihood of more accurate discrimination when averaged across a large number of trials. Regardless, the present study has shown that familiarity-based recognition abilities can be selectively enhanced by an induction of affective arousal.

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Appendix A

Ethics

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Western

Use of Human Subjects - Ethics Approval Notice

Review Number	09 11 08	**Approval Date**	0911 13
Principal Investigator	Stefan Kohler/Devin Duke	**End Date**	10 04 30
Protocol Title	Memory for faces		
Sponsor	n/a		

This is to notify you that The University of Western Ontario Department of Psychology Research Ethics Board (PREB) has granted expedited ethics approval to the above named research study on the date noted above.

The PREB is a sub-REB of The University of Western Ontario's Research Ethics Board for Non-Medical Research Involving Human Subjects (NMREB) which is organized and operates according to the Tri-Council Policy Statement and the applicable laws and regulations of Ontario. (See Office of Research Ethics web site: http://www.uwo.ca/research/ethics/)

This approval shall remain valid until end date noted above assuming timely and acceptable responses to the University's periodic requests for surveillance and monitoring information.

During the course of the research. no deviations from, or changes to, the protocol or consent form may be initiated without prior written approval from the PREB except when necessary to eliminate immediate hazards to the subject or when the change(s) involve only logistical or administrative aspects of the study (e.g. change of research assistant, telephone number etc). Subjects must receive a copy of the information/consent documentation.

Investigators must promptly also report to the PREB:
a) changes increasing the risk to the participant(s) and/or affecting significantly the conduct of the study;
b) all adverse and unexpected experiences or events that are both serious and unexpected:
c) new information that may adversely affect the safety of the subjects or the conduct of the study.

If these changes/adverse events require a change to the information/consent documentation, and/or recruitment advertisement, the newly revised information/consent documentation, and/or advertisement, must be submitted to the PREB for approval.

Members of the PREB who are named as investigators in research studies, or declare a conflict of interest, do not participate in discussion related to, nor vote on, such studies when they are presented to the PREB.

Clive Seligman Ph.D.

Chair, Psychology Expedited Research Ethics Board (PREB)

The other members of the 2009-2010 PREB are: David Dozois, Bill Fisher, Riley Hinson and Steve Lupker

CC: UWO Office of Research Ethics

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PSYCHOLOGY EXPEDITED REB SUBMISSION FORM (VERSION – AUG 2005) Page 1

SECTION 1: PROJECT REGISTRATION

1.1	Project Title- Memory for faces

1.2a	Anticipated Project dates	Start Date	Nov 17, 2009
		Completion Date	April 30, 2010

1.3a	Principal or Lead Investigator, or Sponsor of Student/Post-Doc/Visiting Scholar Investigator(s).	
Name	Dr. Stefan Köhler	
Telephone	Phone 661-2111 x 86364	Email stefank@uwo.ca

1.3b	If this is a project of a student(s), Post-Doc(s), or Visiting Scholar(s), please provide names and contact information.	
Name	Devin Duke	
Telephone		

1.4a	Signature of Local Principal Investigator or Sponsor of Student/Post-Doc/Visiting Scholar attesting that:

a) all co-investigators have reviewed the protocol contents and are in agreement with the protocol as submitted;
b) all investigators have read the Tri-Council Policy Statement: Ethical Conduct of Research Involving Humans (1998) and the UWO Guidelines on Non-Medical Research Involving Human Subjects and agree to abide by the guidelines therein;
c) the investigator(s) will adhere to the Protocol and Consent Form as approved by the REB; and
d) the Principal Investigator will notify the REB of any changes or adverse events/experiences in a timely manner;
e) the study, if funded by an external sponsor, will not start until the contract/ agreement has been approved by the appropriate university, hospital or research institute official.
f) the research poses no more than minimal risk

Signature ____________ Date Nov 13, 2009

1.4b	Signature(s) of Student(s), Post-Doc. or Visiting Scholar attesting that they:

a) have read the Tri-Council Policy Statement and the UWO Guidelines on Non-Medical Research Involving Human Subjects and agree to abide by the guidelines therein;
b) will adhere to the Protocol and Consent Form as approved by the REB; and
c) will notify their supervisor and the REB of any changes or adverse events/experiences in a timely manner;

Signature(s) ____________ Date Nov 13, 2009

SECTION 2: PROJECT INFORMATON

2.1	**Objectives and Hypotheses**: Provide a clear statement of the purpose and objectives of the project. (1 page maximum)

This study involves two experiments exploring episodic memory. This study will explore the contribution of affect, specifically the emotion expression of faces, to familiarity assessment of studied and unstudied neutral faces. Also of interest is the role of processing fluency on familiarity assessment in recognition memory. Both experiments will incorporate Tulving's (1989) remember/know paradigm, widely used in studies involving episodic memory. The remember/know procedure will be used to detect whether face discrimination occurred as a result of a contribution of familiarity or recollection.

Tulving's paradigm allows participants to make two types of responses. The first, a "Remember" response, involves having a sense of familiarity as well as a specific detailed memory relating to a stimulus and its previous occurrence. The second type of response, a "Know" response, involves having only a sense of familiarity without being able to identify the source of that familiarity (i.e. having a specific and detailed memory of a previous event). This procedure will be used to determine whether affective face priming selectively will contribute to an increase in "Know" responses (indicating a response based on a sense of familiarity) independent of processing fluency manipulations. A boost in "Know" responses when the perceived ease of fluency of a test item in a recognition test is increased has been observed in past research Rajaram (1993).

We aim to look at effects of subliminal affective face priming (experiment 1) as well as subliminally presented identity primes (i.e., priming a test face with the identical face) (experiment 2) on both false alarm and hit rates in an old/new recognition paradigm, as well as the respective contributions of familiarity processes or recollective processes on this recognition decision. The experimental manipulation of interest (e.g., subliminal face primes) will consist of a 30ms presentation of either an affective face presented immediately prior to the target face (experiment 1) or a combination of affective and identity face primes presented subliminally immediately prior to test faces (experiment 2). Dependent measures used will include recognition accuracy measures (i.e., the ability to correctly discriminate between old and new faces) and answers to a follow- up question asking participants if they "remember" the previous neutral face or simply "know" that the neutral face was presented.

In experiment 1, we hypothesize that subliminal affective face primes will increase false alarm rates for novel neutral test faces, resulting from an increase in a sense of familiarity stemming from covert arousal produced by the fearful face primes. Past research has shown that covertly presented arousal signals at the time of test in a recognition memory study result in an "illusion" of familiarity Goldinger & Hansen (2005). In experiment 2, in which both affective priming as well as identity priming occurs during the memory testing session, we hypothesize that there will be an additive effect of presenting both affective and identity primes on the resulting hit and false alarm rates. This behavioural effect would result from combining both a manipulation that increases processing fluency for novel and old test faces, as well as a manipulation that provides an independent source of emotional arousal due to subliminally presented emotional faces.

2.2	**Research Participants**: If you are requesting to use the **department's subject pool**, please indicate the number of credits per participant __1____ and the total number of credits for the study__100____. Briefly describe the sample, number of participants, and any exclusionary criteria, e.g., exclude non-English speaking participants. 100 participants will be required with normal, or corrected to normal vision. Describe the **method of recruiting participants**, and any **compensation** offered. Participants will be signed up using the psychology undergraduate subject pool. Participants will be compensated 1 research credit for participating in the experiment. Include one copy of the **sign-up poster** or advertisements if used. Include one copy of the **letter of information** and one copy of the **informed consent** sheet. Include one copy of your **debriefing sheet**. If the research will not be conducted in the Social Science Centre, please indicate the location: ______________________________

2.3	**Methodology** – Describe the **study design** and **procedure**, i.e., what participants will be asked to do at each stage of the research, e.g. **manipulations**. (2 page maximum)

There are two memory experiments that each involve a study, delay and test session. Both experiments will have identical testing procedures and will only differ in the subliminal content of the primes during the recognition memory test session.

Affect Primes Study- After informed consent is obtained, participants will read a set of instructions on the computer screen explaining that they will be judging how likeable (on a scale from 1-6, 1 being totally unlikeable and 6 being the highest level of likeability) the neutral faces that appear on the computer screen are. Participants with be instructed to press a button on the keypad to make the relevant likeability judgment. Each neutral face will be presented for 2 seconds, with a 1 second inter-stimulus interval. All participants will be given 10 practice trials in order to become familiarized with the study process. Once the practice trials are completed, the participant will be informed that the actual faces will be viewed and the experimenter will answer any remaining questions about the procedure. Stimuli in the study phase will be randomized so that each participant views the stimuli in a different order. The study phase will contain approximately 50 neutral faces.

Affect/Identity Primes Study- All procedures as well as instructions for this experiment will be identical to the Affect Primes Study seen above. The number of stimuli in the study phase of this experiment will increase to about 100 faces due to the fact that a 2 x 2 design incorporating both affective and identity primes will be tested.

Affect Primes Test- Participants will be informed that a memory test will take place. Participants will then be presented with the faces that were originally presented during the study session, as well as with 50 new faces that were never presented during the study session. During presentation of each face, participants will be asked to indicate whether the face is "old" (was presented during the study session) or "new" (new to the test session). If the participant makes an "old" recognition decision, a follow-up question will appear on the computer screen asking participants whether they "remembered" the face they said was "old," or merely "knew" that the face they identified as "old" had been previously presented to them. Also at the time of test, the same likeability rating will take place for items identified as both "old" and "new."

Affect/Identity Primes Test- The test procedure for this experiment is identical to the Affect Primes Test session. The only difference is that there will be an increased number of test items as compared to the Affect Primes Test due to an inclusion of identity primes in combination with affective face primes.

Following the memory test, participants will be debriefed about the nature of the study and thanked for their participation.

Include one copy of all **measures**, e.g., questionnaires, scales. Indicate if sensitive questions are being asked, e.g., sexual behavior, religious beliefs, suicide ideation, and the like.
A copy of the number grid task is included

Does your research involve **deception**? If so, please describe the deception and the reasons for it, and indicate how the participants will be debriefed.
Participants are not informed they will be required to make judgments regarding the position of the object, or it's its original color. If participants were aware of the memory task, they would attempt to actively memorize the stimuli, disrupting our measures of episodic memory.

Describe any **risks and/or discomforts** to the participants and how you would deal with them.
There are no known risks to this experiment

Describe the procedures to be used to ensure **confidentiality** of participants and for preserving the confidentiality of data during the research, storage, disposition and in the release of the findings.
Data files will be coded so that there is no personally identifiable information associated with the computer files. Data will be stored on a secure drive.

Memory for Faces Letter of Information

Investigators: Devin Duke (Master's Student) & Dr. Stefan Köhler

This study is entitled "Memory for Faces" and is being conducted by Devin Duke. The procedure will involve viewing a series of faces on a computer screen and making judgments about these faces, as well as a subsequent memory test for the same faces. All ratings will be made using a computer key pad.

All data collected will be kept confidential and be used for research purposes only. The experiment will take less than one hour to complete, and participants will receive compensation of one research credit for their participation. Participants are free to refuse response to any questions and are free to withdraw from the experiment at any time without loss of promised credit. There are no known risks associated with this study.

Upon completion of the study, the participant will receive written feedback and will have a chance to have any questions regarding the study answered.

Memory for Faces Sign-Up poster

This study will involve making judgments about different faces that are presented on a computer screen. Also, participants will take part in a memory test for these faces as well. This study will take less than 1 hour to complete and each participant will receive 1 experimental credit for his or her participation. The study will be conducted in room 7250 of the Social Science Centre. If you are interested in participating in this study please sign up using the Psychology research participation pool.

If you have any questions please contact: Devin Duke dduke@uwo.ca 661-2111 ext. 86299

Memory for Faces Informed Consent form

I have read the Letter of Information, have had the nature of this study explained to me, and I agree to participate. All questions have been answered to my satisfaction.

Name: ____

Signature: ____

Date: ____

Experimenter: ____

Signature: ____

Date: ____

Debriefing Form

Project Title: Memory for Faces
Investigators Devin Duke (Masc. candidate); Dr. Stefan Köhler

The purpose of this study is to examine the contribution of subliminal affective face priming as well as identity priming on familiarity assessment in a recognition memory test. The interplay of implicit emotional influences on explicit face recognition has been largely underexplored. We are interested particularly in the interaction of affective primes with identity primes due to an extensive past literature displaying a close relationship of processing fluency manipulations during a memory test and an increase subjective sense of familiarity for novel, never experienced stimuli. By testing both affective primes and identity primes (processing fluency manipulation), we will be able to determine whether an alternative subliminal affective arousal signal given at the time of test will result in an additive level of false familiarity for faces, or interactive relationship.

Previous research in recognition memory suggests that covert arousal, not related or induced by the study stimuli itself, results in a false sense of familiarity for novel and old stimuli at the time of memory testing (Goldinger and Hansen, 2005). These findings indicate that a sense of "free standing" arousal can be interpreted by an individual as familiar past experience, even when processing fluency hasn't been manipulated. Left unanswered by this past literature is how subliminal affective primes may contribute to familiarity assessment during a recognition memory test.

Whalen (1998) showed that subliminal priming of fearful faces led to an increased response of the amygdala when participants were consciously shown neutral faces as compared to neutral faces that were primed with non-emotional faces. This affective response made by the amygdala may represent or mirror the "free standing" arousal signal that has been shown in other studies, to be perceived as familiar experience. If a clear behavioural effect of subliminal affective priming takes place, this past perceptual literature will provide clear imaging hypothesis if the study is adapted for fMRI.

By participating in this study, you have provided us with data to explore the interaction between affect and familiarity assessment. Your responses will be combined with the responses of others to determine whether subliminal emotional arousal will result in feelings of false familiarity. These findings will contribute to our understanding of the underlying mechanisms of memory systems.

For further information on this topic, you may wish to read the following articles:

Whalen, P. J. (1998). Fear, vigilance, and ambiguity: Initial neuroimaging studies of the human amygdala. Current Directions in Psychological Science, 7,177–188.

Goldinger SD, Hansen WA. Remembering by the seat of your pants. Psychol Sci. 2005 Jul;16(7):525-9.

Do you mean Devin Duke?

If you have any questions or concerns regarding this study, please feel free to contact:
Edward O'Neil, Graduate student dduke@uwo.ca or
Dr. Stefan Köhler – Dept. of Psychology.

If you have questions about your rights as a research subject, you should contact The Director of the Office of Research Ethics at ethics@uwo.ca or 661-3036.