Mere exposure to a distracting stimulus: like it or not?

Thesis submitted by

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I declare that this thesis is my own work and has not been submitted in any form for another degree or diploma at any university or other institution of tertiary education.

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STATEMENT ON THE CONTRIBUTION OF OTHERS INCLUDING FINANCIAL AND EDITORIAL HELP

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DECLARATION ON ETHICS

The research presented and reported in this thesis was conducted within the guidelines for research ethics outlined in the *National Statement on Ethical Conduct in Research Involving Humans* (2007), the *Australian Code for the Responsible Conduct of Research* (2007), and the *James Cook University Code for the Responsible Conduct of Research* (2009). The proposed research methodology received clearance from the James Cook University Experimentation Ethics Review Committee (approval numbers H2312, H2763 & H3242).

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ABSTRACT

The increase in liking for a repeatedly presented stimulus is a central theoretical justification for advertisement repetition. Products and brand names are repeatedly presented because it supposedly leads to an increase in liking for the brand or product and therefore more chance a consumer will purchase the product. Recent research suggests that the influence of repeated exposure to a stimulus is not so straightforward. The increase in liking for a stimulus due to repeated exposure is known as the mere exposure effect and is one of the most established and replicated phenomena in experimental psychology. It appears as though the mere exposure effect is most likely the result of increased ease in processing the stimulus, known as processing fluency. In contrast to over 300 experiments corroborating this effect, distracting stimuli viewed during visual selective attention tasks become disliked, in what has become known as the distractor devaluation effect. This effect is based on inhibition associated with ignoring distractors in these tasks and poses a potential inconsistency with the mere exposure effect, which leads to the prediction that the exposure should produce a preference for any exposed stimulus. The aim of the current research is to determine whether the divergent outcomes of exposure to a stimulus observed in these two effects operate via a common set of mechanisms or whether the observations of distractor devaluation studies are due to a different evaluative process. In the reported series of experiments, participants were repeatedly exposed to distracting stimuli for brief periods whilst engaged in visual search tasks. Participants' liking and familiarity for target and distractor stimuli were assessed using self-report and implicit measures. Results indicate that processing fluency is increased due to exposure to the distracting stimulus; however, the processing fluency does not always lead to positive subjective preference ratings for the same stimulus. Results from these experiments instead suggest that negative attitudes towards distractors are related to rejecting the distractors. The negative feelings are related to a hedonic marker that increases efficacy in visual search tasks. The implication of this research is that ignoring a stimulus leads to a short-term negative attitude for the stimulus related to goal attainment that has little long-term consequence for preference formation. The mere exposure effect is the development of a longer term liking of a stimulus based on exposure and, therefore the distractor devaluation effect contributes little to the understanding of the

mechanisms underlying the mere exposure effect and the development of persistent likes and dislikes.

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> *"Millions of items of the outward order are present to my senses which never properly enter into my experience. Why? Because they have no interest for me. My experience is what I agree to attend to. Only those items which I notice shape my mind – without selective interests, experience is utter chaos. Interest alone gives accent and emphasis, light and shade, background and foreground – intelligible perspective, in a word." (James 1890, p. 381)*

Controversy exists within the literature concerning the development of preferences. Specifically, there is uncertainty regarding whether or not exposure to a stimulus reliably leads to a preference for it over novel stimuli. On the one hand is an extensive history of studies on the mere exposure effect (MEE; Zajonc, 1968), which is an increase in liking for a stimulus due to previous exposure to it. On the other hand is the distractor devaluation effect (DDE; Raymond, Fenske & Westoby, 2005), which is a decrease in liking for a stimulus due to exposure when the stimulus is not the focus of attention. At the core of the debate is uncertainty over if and how cognitive processes impact on the development of preferences.

The current research addresses the relevance of the DDE to the understanding of the processes responsible for the development of preference through exposure. As part of this investigation, factors known to be associated with an increase in liking due to exposure, such as familiarity and the interaction of awareness, cognition and emotion, will be examined within this context. The aim of the current research is to reconcile the variation in liking outcomes predicted by theories underlying the MEE and the DDE. The outcome of this investigation is a more parsimonious account of how preferences for new and novel stimuli are developed through repeated exposure.

Preference formation and mere exposure

It has been generally assumed that preferences are either innate or develop through one of a number of learning mechanisms such as evaluative conditioning (Bohner & Wänke, 2002; Martin & Levey, 1978; Zajonc & Markus, 1982). Despite a growing interest in the study of attitudes, the development of preferences is not completely understood (Blanchette & Richards, 2010; Lichtenstein & Slovic, 2006; Naqvi, Shiv & Bechara, 2006). One facet of preference formation that has received some attention within experimental psychology is the relationship between exposure to a stimulus and experiencing a preference for it.

In over 300 experiments published since Zajonc's (1968) often cited monograph[1], it has been widely observed that repeated, unreinforced exposures to various stimuli tends to result in those stimuli becoming preferred over novel stimuli. Although this idea had previously been raised by Fechner (1876, cited in Zajonc, 1968), James (1890) and Maslow (1937), Zajonc was the first to provide systematic experimental evidence for the effect he labelled the mere exposure effect. This phenomenon has been observed across a range of stimuli, sensory modalities and testing situations using various rating scales (see Bornstein, 1989; Harrison, 1977; Stang, 1974 for reviews). The MEE has been found using visual (Zajonc, 1968), gustatory (Crandall, 1984), and auditory stimuli (Heingartner & Hall, 1974). The effect is apparent with meaningful or meaningless stimuli (Saegert, Swap & Zajonc, 1973), with stimuli that are initially hedonically liked (Swap, 1977), neutral or disliked (Litvak, 1969) and has been found to occur in both laboratory (Bornstein, Kale & Cornell, 1990; Moreland & Zajonc, 1976; Zajonc, 2001) and

1 A Google Scholar search indicates over 2350 citations

naturalistic settings (Bornstein, Leone & Galley, 1987). The MEE appears to be quite robust, even reliably occurring in animals other than humans (Hill, 1978). The conclusion that can be drawn from all this research is that exposure to a novel stimulus reliably leads to that stimulus becoming liked, despite there apparently being no other positive consequences of the exposure. Topolinksi and Strack (2009) argue that the MEE is one of the "most established facts of modern psychology" (p. 423).

Despite its apparent ubiquity, and perhaps because of it, the MEE has been the topic of widespread debate with implications beyond the development of preferences. Many questions have been raised about the earliest stages of information processing in mere exposure studies, particularly in terms of the processes responsible for initiating the experience of emotions (Bonanno & Stillings, 1986; Lazarus, 1991; Zajonc, 2000). The MEE has been seen as evidence for implicit learning and is often used as categorical confirmation of the very existence of implicit learning and implicit memory (Reingold & Merikle, 1988). Research into the effect has therefore also contributed to understanding processes beyond the exposure/preference domain.

The MEE also has practical implications in marketing where 'any publicity is good publicity', which can be translated to 'any exposure is good exposure'. Many marketing and attitude formation studies have found that mere exposure contributes significantly to consumer choice (Mantonakis, Whittlesea & Yoon, 2008). In other words, being merely exposed to products and brand names reliably induces a preference (Nordhielm, 2002). For instance, Janiszewski (1993) has examined incidental exposure to brand names and product packaging and found such exposures result in reliable increases in preference compared to novel brands and packaging.

In addition to marketing studies, research has examined how the MEE contributes to the formation of attitudes (Bohner & Wänke, 2002; Kruglanski & Stroebe, 2005), in particular how exposure contributes to liking for certain people and in how prejudices against certain groups can be lessened and altered through exposure (Crisp & Turner, 2007; Eagly & Chaiken, 1993). A number of studies have found that more frequent exposure through social interaction generally leads to greater liking and interpersonal attraction (c.f. Berscheid & Reis, 1988). Other studies have found that discrimination against members of minority groups can be lessened through mere exposure (see Zebrowitz, White & Wieneke, 2008). The MEE is therefore not limited to experimental situations but is a phenomenon that has direct practical application in a number of fields. The wide-ranging implications of this seemingly simple phenomenon increase the importance of understanding under what conditions it operates and how it works.

Despite the apparent robust nature of the effect and its practical application for marketers and social psychologists, a parsimonious explanation of how and why the effect occurs remains elusive (see Fang, Singh & Ahluwalia, 2007; Maio & Haddock, 2009; Yagi, Ikoma & Kikuchi, 2009). Although many theories have been forwarded to explain how mere exposure leads to liking, none have been able to adequately explain all the experimental observations. It has become clear that the MEE is not simply a case of exposure to a stimulus leading directly to liking of that stimulus. Complex cognitive and emotional processes impact on the relationship between exposure and preference and these processes are the central focus of the current research.

Processes underpinning the mere exposure effect

Initially it was believed that the MEE was simply a case of exposure leading to familiarity, which then led to a preference. Zajonc's (1968) preliminary investigations of the MEE involved evidence from two main sources, correlational and experimental data. Zajonc noted that there was a strong positive correlation between word frequency and preferences for words. Words with positive valence are used more often and words (and parts thereof) that are seen and used more often are preferred, an effect not unique to English. To support these correlations, Zajonc also reported a series of experiments involving exposure to nonsense words, Chinese characters and pictures of faces. In all cases, repeated, unreinforced exposure to the stimuli led to an increase in positive attitude towards these stimuli compared to novel stimuli. Harrison (1977) later heralded this work as being responsible for the formalisation and revitalisation of the “familiarity-leads-to-liking hypothesis” (p. 40). Although it has become apparent that familiarity is not the sole explanation for the MEE, it is a factor to be considered and will be discussed further in terms of underlying mechanisms.

To reach the preference through increased familiarity hypothesis, Zajonc (1968) conducted a series of experiments including randomised repeated presentations of the target stimuli for a set number of exposures followed closely by a series of attitudinal ratings. This sequence of exposure phase then rating phase became the standard way of conducting experiments examining the MEE (Murphy, 2001). A typical mere exposure experiment using visual stimuli includes an exposure phase where a number of stimuli are presented, often sequentially or within a visual array. Following the exposure phase, an evaluation phase is conducted where exposed stimuli and novel stimuli not included in the exposure phase are rated in terms of how much they are liked. Using this approach, the research reliably results in exposed stimuli being preferred over novel stimuli, with greater numbers of presentations leading to greater preference.

Despite the reliability of the results, the highly standardised procedure for conducting mere exposure research that developed following Zajonc’s (1968) experiments has been criticised. For instance, Stang (1974) voiced concerns about the various types of stimuli used in mere exposure research and about the persistence of the effect beyond the exposure phase, issues that will be discussed further in terms of theoretical approaches attempting to explain the MEE. Regardless of this criticism, in the 10 years following the publication of Zajonc's monograph, there were hundreds of experiments conducted on the effect, often using very similar methods. In a review of the literature, Harrison (1977) argued that despite Stang's concerns there was sufficient accumulated evidence to confirm that exposure to a stimulus under a wide range of conditions leads to a reliable increase in liking. Although there is some argument as to whether it is due to the apparent uniformity in methods, the volume of positive MEE observations under varying research conditions confirms that the MEE is a robust phenomenon.

Harrison (1977) notes that several factors appear to influence the MEE and that these variables pose fundamental problems in developing an elegant explanation of the effect. These factors include procedural elements such as the nature of the presentation sequence. For instance, heterogeneous and homogenous presentation sequences produce different effects, with heterogeneous presentation sequences resulting in greater liking. Additionally, more complex stimuli and longer intervals between exposure and rating (one of the concerns voiced by Stang, 1974) are factors that could lead to a more pronounced MEE. What is clear is that the MEE is not simply based on familiarity as a function of the number of exposures to the stimulus. The results of a meta-analysis conducted by Bornstein (1989) revealed that, in addition to the factors outlined by Harrison, the number and duration of exposures, stimulus type and age of the subject could also impact on the strength of the MEE. Consistent with Harrison's results, Bornstein found that greater complexity, a heterogeneous presentation sequence and a longer delay between the exposure phase and the rating phase all enhanced the effect. These factors suggest alternative explanations for the processes underlying the MEE and therefore need to be considered in any examination of the effects of exposure on preference and will be addressed within the current research.

In addition to supporting Harrison's (1977) observations, Bornstein (1989) also found that shorter display durations (<1 s), a relatively small number of repeated exposures (10-20) and certain types of visual stimuli (particularly photos and polygons as opposed to paintings, drawings and matrices) produced stronger effects. Bornstein further categorised the factors influencing the effect into four groups: stimulus variables, presentation variables, measurement variables and participant variables. In a discussion of the future direction of mere exposure research based on these findings, Bornstein argues that research into the effect had concentrated predominantly on stimulus and presentation variables and not on measurement or participant variables. Thus a complete understanding of the MEE also requires further investigation of these factors.

Bornstein's (1989) analysis has enabled researchers to create situations that maximise a MEE and thus allow examination of other variables that may influence the effect. Foremost amongst these factors are cognitive processes, such as memory storage and retrieval. The techniques and findings of mere exposure experiments are consistent and reliable, but at the same time poorly understood. In effect, the phenomenon has become a central topic for debate over broader theories addressing the development of emotional responses to stimuli (Moors, 2009; Moreland & Topolinski, 2010). One example that illustrates these issues is the question of whether the subjective experience of emotion could be independent of memory, higher executive functioning and conscious awareness. The uncertainties over the independence of emotion have created a point of contention in theories attempting to explain the MEE and are therefore worth considering within the context of the current research.

The primacy of affect

The relationship between awareness of the stimulus and preference for it, or the relative contribution of cognition and emotion, is the facet of the mere exposure phenomenon that has generated the most debate (see Bornstein & D'Agostino, 1992; Moreland & Zajonc, 1977; Newell & Shanks, 2007). The subliminal MEE is the term used to describe the instances where a preference develops for a stimulus repeatedly presented outside conscious awareness (Kunst-Wilson & Zajonc, 1980). Moreland and Zajonc (1977) suggest that, because recognition is not necessary for the MEE to occur, higher order cognitive processes are not required for the development of persistent preferences. A number of studies conducted directly comparing responses to subliminally and supraliminally exposed stimuli (Bornstein & D'Agostino, 1992; Murphy, Monahan & Zajonc, 1995) demonstrated that subliminal exposures are more effective at inducing a MEE, although greater preferences for subliminal stimuli over recognised stimuli have not been found in all cases (see Fox & Burns, 1993; Newell & Shanks, 2007). These contradictory findings have led to ongoing debate about the role of awareness in the MEE and suggest that a lack of awareness of prior exposure must be accounted for in a complete explanation of the effects of exposure on liking. In other words, a parsimonious account of the MEE must also explain the subliminal MEE.

Given that the majority of studies on the subliminal MEE have found greater preferences for subliminally exposed stimuli compared to supraliminally exposed stimuli, it has been suggested that there is little to no modulation of the MEE by cognitive processes. Winkielman and Cacioppo (2001) argue that it is instead the result of affective systems working independently of higher cognitive functions. A number of studies have attempted to find supporting evidence for this claim. For example, Harmon-Jones and Allen (2001) used facial electromyography (EMG) to measure activity in the zygomaticus major region (i.e. the cheek area), which is linked to positive emotional responses, even emotions experienced without conscious awareness (Tassinary, Cacioppo & Vanman, 2009). Harmon-Jones and Allen found higher activity in the zygomaticus major region in participants repeatedly exposed to visual stimuli. They suggested that their results confirm that the MEE is therefore a purely affective phenomenon. Zajonc (1984) also advanced the idea that preferences can develop independently of conscious or cognitive processes and argued for an ‘affective primacy hypothesis’. Supporting Zajonc’s hypothesis are observations that suggest that emotional appraisal processes occur far more rapidly than do the cognitive processes that lead to conscious awareness (LeDoux, 1996).

Despite the evidence that affect can influence behaviour outside of conscious awareness, there has been ongoing criticism of Zajonc’s (1980) claim that “preferences need no inferences” (p. 151). For example, Lazarus (1982) took up this debate and was adamant that it is cognitive processes that set in motion the emotional experience of humans. Lazarus (1984) maintained that without cognitive appraisal, there would be no experience of emotion. This argument was based on Schacter and Singer’s (1962) contention that the foundation of emotional experience arises from conscious judgements as to the cause of the emotion being experienced. This, in turn, built on James’ (1890) argument that emotion is an interpretation of involuntary physiological responses to stimuli. In this respect, Lazarus (1984) argues that emotion is solely a result of cognitive appraisal and that the subjective experience of emotion does not exist without this appraisal. This argument is in clear contrast to the belief that emotional reactions to stimuli develop independent of and before any cognitive processing (Bornstein, 1989; Zajonc, 1984). Although there is evidence suggesting that very little to no cognitive processing is necessary for emotions to exert influence over behaviour (Winkielman & Berridge, 2004), Zajonc and colleagues (Zajonc, Pietromonaco & Bargh, 1982) concede that cognition is often involved in the subjective experience of emotion, but maintain that it is not always necessary. Ultimately, this argument leads to the conclusion that any investigation of the development of preference must take both into account. A lack of awareness of the exposure does not exclude the possibility that other cognitive processes are influencing the development of preference in an interdependent processing system.

Zajonc (2000) claimed he was "closing the debate over the independence of affect" (p. 31), but it appears that, at least in the case of the MEE, this declaration may have been premature. Whittlesea and Price (2001) argue that the divergence of recognition and preference responses in mere exposure studies is a methodological issue and that it is, in fact, differences in conscious cognitive processing that are responsible for the increase in liking without recognition in the subliminal MEE. This criticism aligns with that of Stang (1974), who suggested that early mere exposure studies were too uniform in their approach and leads to the conclusion that the methods employed in these studies have been too narrow to effectively elucidate the underlying processes. A narrow range of methods and the premature discounting of other cognitive processes due to the flawed assumption that awareness is a necessary condition for cognitive processing means that a number of other underlying mechanisms may have been overlooked in mere exposure studies.

In answering the question of how much cognitive processing is required to experience emotion and guide preference, debate has centred on whether the development of emotional responses can be truly unconscious (De Gelder, 2005). Storbeck and Clore (2007) suggest that there is more than sufficient evidence based on numerous neurological and behavioural studies to categorically eliminate the idea that cognitive processes are divorced from emotions. Fox (2008) summed up the Lazarus/Zajonc debate as being useful for stimulating research into emotion but it became more a debate over semantics and created a false dichotomy that is not supported by contemporary research. The debate, as it was initially framed, is therefore no longer useful in the quest to understand cognition/emotion relationships. The outcome of this broader debate has been the more willing acceptance that cognitive and affective processes are interdependent and, hence, both implicated in the process of developing preferences.

Despite the two mental functions being very closely linked, it is still unclear what the exact relationship between emotional and cognitive processing is (LeDoux, 1994; Panksepp, 1994; Pessoa, 2008) and this poses a fundamental problem for understanding how preferences develop in the MEE. The interdependence of these processes is evident in the multitude of physiological observations linking the brain structures involved in cognition and emotion (e.g. Bush, Luu & Posner, 2000; Pessoa, 2008). Although there are clear neurological correlates between cognitive and emotional functions, the role played by cognitive processes in the formation of emotions is still contentious (Gendron & Barrett, 2009; Moors, 2009). As it is still unclear exactly how emotional and cognitive processes work independently and interdependently, it remains unclear as to how cognitive processes influence the MEE (Yagi et al., 2009). This ongoing uncertainty about the interaction between emotion and cognition leads to the conclusion that, just because a preference can develop through exposure outside conscious awareness, it does not mean that cognition is not involved in the MEE. Although there is uncertainty over the exact influence each has on each other, there is little doubt that cognition can and does influence liking due to exposure, despite a lack of awareness.

The subliminal mere exposure effect, familiarity and implicit memory

The observation that liking can be altered in the absence of awareness is not only a point of contention for theories attempting to explain the subjective experience of emotion, it has also raised issues concerning memory processing. The subliminal MEE has been replicated many times (see Bornstein, 1992; Zajonc, 2001 for reviews) and is an often-cited example of implicit learning and implicit memory (Manza & Bornstein, 1995). Evidence that the MEE does not require explicit recognition of the stimulus comes not only from the subliminal presentations but also from studies involving patients with severe memory deficits. For example, Greve and Bauer (1990) found a preference for repeatedly exposed faces in a prosopagnosic patient despite the fact that the patient had no recollection of having seen the faces before. Willems and colleagues (Willems, Adam & Van der Linden, 2002; Willems, Salmon & Van der Linden, 2008) have also replicated this finding with patients with impaired memory due to Alzheimer's disease. The evidence that a persistent change in attitude can occur without a corresponding change in responses to a direct measure (i.e. recognition) in subliminal mere exposure experiments has been taken as "strong evidence for unconscious memory" (Reingold & Merikle, 1990, p. 23). In the context of the current research, the role of implicit memory is an important consideration because the development of preference in the absence of awareness has been a difficult observation to account for in theories attempting to explain the MEE.

A number of studies have set out to directly examine the role of implicit memory in the MEE. For instance, Seamon et al. (1995) found that the global representation of figures that is sufficient to determine if a figure is possible or impossible takes several seconds, but a preference can develop for either type of stimulus in apparently far less time. In other words, an overall structural impression of the stimulus can be encoded into memory very rapidly, but the more detailed encoding required to make an accurate recognition decision about the stimulus requires greater exposure duration. This difference is supposedly the boundary between what is implicitly and explicitly processed (Seamon et al., 1995). Seamon et al. argue that this disparity between recognition and preference judgements for possible and impossible objects fulfils Cooper and Schacter's (1992) criteria for separate systems of mental representations of visual objects, i.e. explicit and implicit memory. Based on the results of their experiments, Seamon et al. went as far as to say that explicit memory is completely uninvolved in the MEE and that the effect could be wholly explained as an implicit memory phenomenon.

For the most part, implicit memory studies of this type have relied on an artificial grammar language in which series of letter strings conform to a complex set of rules (see Reber, 1967). Pothos (2007) describes artificial grammar as a language created to allow sequences of symbols or letters to meet or violate the grammatical rules. Typically, participants are presented with a series of letters conforming to the grammar in a training phase and then asked to discriminate between grammatical and non-grammatical sequences in a test phase. The subliminal MEE has also been investigated using this methodology. Gordon and Hollyoak (1983) examined the MEE using an artificial grammar language of letter strings and proposed a 'structural' mere exposure effect, which can occur when greater preference for repeatedly exposed stimuli generalises to novel stimuli that conform to an implicitly learnt rule. Later studies aimed at understanding the possible influence of implicit learning of an artificial grammar based on familiar and unfamiliar symbols produced inconclusive results, suggesting that the 'structural' MEE might or might not be based on stimulus familiarity (Zizak & Reber, 2004). These studies lead to the conclusion that familiarity contributes more to the development of preference due to exposure than a discrepancy between explicit and implicit memory systems.

Whether it is the result of unconscious processes or not, familiarity has been established as an important factor in the MEE (Cox & Cox, 1988). Zajonc (1968) initially argued that the effect is the result of familiarity alone, however the involvement of familiarity in the effect is not so explicit. In aiming to examine the contributions of awareness and familiarity on the effect, Ye and van Raaij (1997) investigated the roles of recognition and familiarity independently by using a divided attention technique. Their results suggest that familiarity is a more fundamental consideration than implicit memory in understanding the MEE. Moreover, Zizak and Reber (2004) argue that the subliminal MEE relies primarily on an increase in familiarity for the exposed stimulus. In other words, they suggest that the effect is attenuated when there is no accompanying familiarity for the stimulus. Although familiarity is not solely responsible for increases in liking due to previous exposure, it does appear to be intricately linked to preference formation.

To further investigate the role of familiarity in the MEE, Hansen and Wänke (2009) tested the influence of conscious recognition on the effect using a process-dissociation procedure developed by Jacoby (1991) to separate automatic and intentional memory processes. Jacoby argues that recognition responses rely on both familiarity and conscious recognition and that the recognition task should be designed to separate these influences. Using this approach, Hansen and Wänke found that liking depends on 'unconscious familiarity' and not on different levels of conscious recognition, further eroding the case for the phenomenon being solely the result of implicit memory. Although there is some support for the suggestion that implicit memory is involved in the subliminal MEE, the evidence is not entirely convincing, particularly when considering that familiarity might be a more important factor than recognition.

To summarise the investigations on the role of implicit memory in the MEE, research supporting the existence of implicit learning and implicit memory has often used the subliminal MEE both to test hypotheses concerning implicit learning and as a way of confirming the existence of implicit memory (Manza, Zizak & Reber, 1998). As the broader debate about cognition and emotion has carried on, mere exposure research has focused more on the influence of memory on the effect because of the difficulty in explaining the subliminal MEE. In this vein, these studies have revealed mediating factors such as familiarity that may influence the MEE. Apart from the disagreement about conscious and unconscious processes and the role of familiarity in the subliminal MEE, implicit learning in general is not completely accepted as a testable and reliable phenomenon due to limitations in the understanding and measurement of awareness (Stadler & Roediger, 1998). Shanks (2004; 2010) argues that it is still uncertain that learning can occur both unconsciously and unintentionally. Consequently, an explanation for the MEE based on implicit learning does not stand on solid theoretical foundations. Overall, claims that enhanced positive attitudes towards exposed stimuli, as in the subliminal MEE, are entirely the result of processes outside awareness are unsubstantiated. Despite this, research on the role of implicit memory in the MEE has highlighted the importance of familiarity in the development of preference without awareness. Although theories attempting to explain the MEE have moved away from familiarity as being the sole explanation for the effect, it remains a central element.

What the discussion of studies examining the MEE so far suggests is that, although it is a relatively simple and robust phenomenon, there are a number of conditions known to modulate the effect and a number of observations that are particularly difficult to explain. Prominent is the subliminal MEE, but equally important for any model of the effects of exposure on preference is the influence of familiarity on liking. Before considering the implications of the DDE for explanations of the effect of exposure on preference, it is essential to understand how these conditions and observations have been incorporated into theoretical models of the MEE to date.

Explanations of the mere exposure effect

Despite extensive research into the MEE and subliminal MEE, the mechanisms underlying these effects are not completely understood (Kellogg, 2007; Moreland & Topolinski, 2010). There are however, 12 distinct explanations of how being 'merely' exposed to a stimulus leads to a preference for it. Some of these approaches are not supported by observations from empirical research and a number have been abandoned

(Bornstein & Craver-Lemley, 2004). As established, any complete theoretical model of the MEE must take into account the growing number of variables known to influence the effect, such as affective and cognitive processes, familiarity and, in particular, the subliminal MEE.

In order to understand the mechanisms underlying the MEE and develop a viable explanation, Zajonc (1968) originally argued that stimuli become preferred simply due to increased familiarity. This argument is based on long standing principles forwarded by Fechner (1876, cited in Zajonc, 1968) and James (1890), that familiarity does not necessarily breed contempt, but rather that familiarity breeds content. This proposition was sustained by a wealth of research linking the unfamiliar with aversive and avoidant responses (see Frijda, 1986). Observations from mere exposure studies made it readily apparent that this approach was overly simplistic and a number of competing explanations were developed.

Other theories that attempt to explain the mere exposure phenomenon include response competition (Harrison, 1968), two factor learning/satiation theory (Berlyne, 1970), evaluative conditioning (Burgess & Sales, 1971), transfer appropriate processing (Newell & Bright, 2001), an arousal model (Crandall, 1970) and the perceptual fluency/attributional theory (Bornstein & D'Agostino, 1992). These explanations for the MEE were developed to explain why previously exposed stimuli are preferred, to explain boundary conditions of the effect, why this effect occurs without conscious awareness and whether or not the effect is based simply on familiarity. A brief survey of these theories has been included here as a precursor to a discussion of observations that necessitate a rethink of the effect of exposure on preferences.

Early theories

One of the earliest theories to explain the MEE was the response competition theory (Harrison, 1968). This theory is based on a proposed tension state that results from exposure to a novel stimulus and this tension state is hypothetically related to exploratory behaviour. Harrison argued that the individual does not know how to respond to a novel stimulus and thus response competition arises from conflict between approach and avoidance tendencies. These conflicting response tendencies in turn lead to the negative experience of cognitive dissonance. The MEE is the result of repeated exposures reducing the tension state by allowing one response tendency to dominate and thus reduce the negative affect induced by the cognitive dissonance (Brickman, Redfield, Harrison & Crandall, 1972). In other words, this decrease in negative affect presents as more favourable ratings of the stimulus. The response competition theory explains the MEE as being the result of learning how to respond to a stimulus the more times it is encountered.

Like the response competition theory, the two factor theory (Berlyne, 1970; Stang, 1974) argues that the MEE arises from the struggle between two incompatible tendencies. Rather than being cognitive dissonance, the two factor theory assumes that a negative boredom state opposes a positive familiarity state (which Berlyne describes as positive-habituation) and varies according to stimulus complexity (Berlyne, 1970). Stang (1974) describes the relationship between exposure and preference in terms of an inverted ‘U’ function. This idea is based on the observation that a presented stimulus is rated more positively until tedium (satiation) sets in, after this, further exposures lead to a drop in preference ratings. The two factor theory leads to the prediction that complex stimuli will not induce boredom as quickly as simple stimuli. Bornstein, Kale and Cornell (1990) found evidence that boredom-prone participants and relatively simple stimuli result in an attenuated MEE which supports the two factor approach.

Although the response competition and two factor approaches had appeal for evolutionary explanations of how the MEE developed, they had difficulty explaining some fundamental observations. For example, these theories do not explain the subliminal MEE as they lead to the prediction that conscious recognition and familiarity are required for the creation of exposure effects or at least that recognition and familiarity should enhance the MEE. This is not what is observed in experiments with subliminal presentations. These theories also predict that the behaviour is instinctual and evident from birth and therefore have difficulty explaining developmental differences in the MEE. Children generally display a negative exposure effect (i.e. they prefer novel stimuli over previously encountered stimuli), which is not consistent with the response competition or two factor theories (see Bornstein, 1989). Bornstein suggests that the two factor theory needs considerable modification to be able to completely explain the results of mere exposure experiments.

Burgess and Sales (1971) proposed an alternate theory based on positive contextual features being affectively conditioned to the merely exposed target stimulus through a process akin to evaluative conditioning. Evaluative conditioning involves pairing a hedonically neutral stimulus (in this case the merely exposed target) with an emotionally relevant stimulus (positive or negative). With repeated pairings of these stimuli, the once neutral stimulus becomes hedonically valued based on its association with the emotionally relevant stimulus (see de Houwer, Thomas & Baeyens, 2001 for a review of evaluative conditioning). Critically, it appears that evaluative conditioning can occur without conscious awareness (de Houwer, Hendrickx & Baeyens, 1997; Field, 2000), which gives this theory an advantage over the response competition and two factor theories as it can account for the subliminal MEE. Zajonc (2001) gave unequivocal support for a conditioning based theory, highlighting its ability to explain increases in preference without accompanying recognition. Zajonc argued that the effect of repeated exposure is nonspecific and leads to positive affect through simply being paired with the absence of aversive consequences, even when this pairing occurs outside conscious awareness. The problem with this argument is that the MEE is based on a premise that the stimulus is 'merely' exposed, meaning that it could be argued that explanations of the effect relying on conditioning are outside the scope of the examination of the effect as it has been defined.

To address the possibility that the MEE is not just the result of being 'merely' exposed, Harrison (1977) examined the evidence from a number of studies. These studies looked exclusively at whether or not some aspect of the research situation is an unconditioned stimulus that becomes associated with exposed stimuli to cause the increase in positive responses through evaluative conditioning. Harrison found that there was very little evidence that the MEE is an experimental artefact of an affective quality becoming attached to the stimulus through associative learning. However, Harrison's argument relied heavily on Moreland and Zajonc's (1977) observation that recognition and higher order processing is not required for the MEE. Harrison proposed that this lack of awareness also meant that learning was unlikely to be involved. A recent meta-analysis of studies on evaluative conditioning (Hofmann, de Houwer, Perugini, Baeyens & Crombez, 2010) found little to no evidence that evaluative conditioning occurs outside awareness which tends to support Harrison's conclusion. The accumulation of research examining environmental circumstances as a possible cause for the MEE did not lead to unequivocal conclusions. Evaluative conditioning cannot therefore be completely discounted as being involved in the MEE.

Rather than an example of evaluative conditioning as proposed by Zajonc (2001), Bornstein (1994) argued that the subliminal MEE could instead be a form of generalised implicit learning. Bornstein and Craver-Lemley (2004) suggest that the reduction in preference after more than 20 exposures is strong evidence of habituation, and the involvement of implicit learning in the MEE. The generalised implicit learning approach is based on transfer appropriate processing, in which an overlap between how memories are encoded and how they are later retrieved, influences recall (Morris, Bransford & Franks, 1977). Recall is thus seen as relying on cueing the same pattern of cognitive processing as when the encoding took place (Roediger & McDermott, 1993). Similarly, Graf and Ryan (1990) found that focussing on the analysis of features and patterns during memory encoding alters implicit and explicit memory test performance via transfer appropriate processing. Bornstein argued that differences in memory encoding conditions that favour explicit or implicit memory could explain the divergence in preference and recollection responses in mere exposure studies. The results of experiments by Newell and Bright (2001, 2003), utilising brief masked exposures to letter strings constructed using an artificial grammar, did not support Bornstein's proposal because there was no evidence of generalisation of subliminal MEEs to structurally similar stimuli. This kind of generalisation would be expected if the subliminal MEE were a form of implicit learning as it is evident in other forms of learning with supraliminal stimuli (Bornstein, 1994). Just as it is uncertain if the MEE is an example of implicit memory, it also remains uncertain whether implicit learning is partly responsible for the effect. Some researchers have failed to find a subliminal MEE at all when examining the effect using methods common in implicit learning and memory research (e.g., Fox & Burns, 1993; Newell & Shanks, 2007).

In summary, it appears that learning processes could influence the MEE despite suggestions to the contrary and despite the fact that the effect is so often given as a prototypical example of non-associative learning (Kruglanski & Stroebe, 2005;

Schimmack & Crites, 2005). Because it has been deemed to be outside the definitional scope of ‘mere’ exposure, the influence of environmental factors on the MEE remain unclear. Whether there is something in the experimental situation, such as the absence of aversive consequences, that is contributing to the effect or not, it does appear that learning processes could influence the MEE. With more recent research concentrating on other factors, the contribution of associative learning processes to the MEE effect remains uncertain, as do explanations of the effect based on these processes.

Spreading activation and misattribution

Alternative explanations of the MEE link the effect to cognitive processing mechanisms beyond implicit memory. For example, Mandler, Nakamura and Van Zandt (1987) proposed a model of the MEE based on spreading activation. The idea is that a representation of the exposed stimulus is formed during memory encoding, which is activated upon being presented with the stimulus again for a preference rating. This activation has diffuse effects including a feeling of familiarity and an associated increase in liking compared to novel stimuli. The premise that a subjective experience is induced through spreading activation after exposure to a stimulus is supported by evidence that participants report exposed stimuli to be brighter than novel stimuli despite being presented at equal luminance (Mandler et al., 1987). The distorted perception of brightness is assumed to be one of the diffuse effects of spreading activation. Mandler and colleagues argued that the activation of the mental representation necessary for any judgement task, be it liking or brightness, showed that activation spreads beyond the associations formed with the context of the initial encoding experience. Moreover, Craver-Lemley and Bornstein (2006) suggest that the evidence of spreading activation influencing various judgement tasks indicates that the MEE is not simply due to the implicit or basic encoding of stimuli, but that more complex cognitive processing is involved. Although there is merit in the Craver-Lemley and Bornstein argument, there is insufficient concrete evidence of the effect of spreading activation on preference for it to be a viable explanation of the MEE.

In terms of more complex cognitive processes, the MEE has similarly been explained by differences in memory encoding (Butler & Berry, 2004; Seamon et al., 1995). This idea reflects an approach first forwarded by Zajonc (1980) as support for the independence of cognitive and affective processes. Zajonc argued for separate memory processing systems where affective judgements are based on ‘preferenda’, which are indistinct stimulus features that are insufficient for recognition, and that recognition is based on specific identifiable stimulus features or ‘discriminada’. Liking supposedly increases due to the increased familiarity with preferenda that occurs independently of memory for discriminada. In this way, Zajonc was able to account for factors associated with recognition processes whilst also maintaining the affective primacy hypothesis by upholding that preference (i.e. emotional) and recognition (i.e. cognitive) processes are distinct. This idea clearly separates implicit emotional memory processes from explicit cognitive processes. As discussed, models that rely on separating implicit and explicit processing in this way are problematic.

In response to the problems with these models, Seamon, Brody and Kauff (1983a) argue against an approach based on separate memory systems. Instead, they suggest that the findings of subliminal MEE research can be explained by existing theories of recognition memory. Seamon and colleagues conducted a number of experiments assessing whether affective judgements and recognition occur independently. The experiments involved manipulation of exposure duration, pattern and energy masking and verbal shadowing to determine if these manipulations change the way stimuli are encoded into memory. Only the variation of exposure duration leads to different effects for recognition accuracy and affective ratings. As with other observations of the subliminal MEE, Seamon, Brody and Kauff found that liking remained relatively consistent whilst recognition accuracy decreased as exposure duration decreased. Zajonc (1980) argued that the memory systems for affective and cognitive processes are independent, however, Seamon, et al. (1983a) have demonstrated that manipulation of the exposure conditions to cater to the encoding requirements of these supposedly divergent systems makes little difference to preferences for exposed stimuli.

As Seamon and colleagues (1983a) had all but eliminated dual systems of memory encoding as an explanation for the differences in affective and recognition ratings, a greater emphasis on the retrieval of the representation of the exposed stimulus from memory evolved in the mere exposure literature. Seamon, Brody and Kauff (1983b) suggest that there is a misattribution of the feeling of familiarity that comes to mind as liking. The resulting theory is that it is not familiarity through recognition that leads to increased preference, but rather familiarity with processing the stimulus, which is either inherently affectively positive, (Reber, Winkielman & Schwartz, 1998) or ultimately misattributed as liking (Lee, 2001). This enhanced processing of the stimulus is known as processing or perceptual fluency.

Processing fluency as an explanation of the mere exposure effect

A number of studies have since suggested that the MEE is the result of variations in processing fluency (Seamon et al. 1983a, 1983b, Winkielman, Schwarz, Fazendeiro & Reber, 2003). Moreland and Topolinski (2010) refer to this as the ‘second generation’ of research into the MEE. This approach has risen to prominence due to the ability of processing fluency to explain the familiarity and preference ratings in the absence of recognition in the subliminal MEE. As discussed, this has been a particularly difficult observation to explain. Seamon et al. (1983a; 1983b) and Mandler et al. (1987), suggest that when subjects are asked if they recognise a stimulus, a memory search ensues, whereas when asked if they prefer the stimulus a different memory retrieval process occurs based on familiarity, this is the two factor model of perceptual fluency (Bornstein & D'Agostino, 1994). Familiarity appears to be a faster and more effortless cognitive heuristic for judging prior exposure than a conscious memory search (Juola, Fischler, Wood & Atkinson, 1971), however, this sense of familiarity does not appear to be sufficient to support effective conscious recognition (Seamon et al., 1983a). In other words, recognition requires a level of accuracy not required by liking judgements, which allows the subtle effect of processing fluency to influence the latter but not the former. Seamon et al. (1983b) argue that the increased fluency of processing for familiarity and not for recognition can therefore explain the subliminal MEE. The processing fluency approach thus explains that the MEE comes about through familiarity that is due to enhanced ease in processing stimuli through repeated exposure (Johnson, Dark & Jacoby, 1985).

Using this model of the MEE as a framework, Seamon, Marsh and Brody (1984) examined an extended range of exposure durations of target stimuli and found that recognition is more likely as exposure duration increases whilst affective judgments were unaffected. Bonanno and Stillings (1986) also manipulated contextual features of target stimuli and found that preference and familiarity judgements remained impervious to unrelated changes in context. They argue that differences in memory retrieval and encoding conditions can be altered without a corresponding change in preference ratings. This indicates that when participants are asked if a stimulus is familiar to them, their judgement is made without reference to the context in which the stimulus was previously seen. This suggestion leads to the conclusion that another process is involved in influencing the familiarity judgement. If the familiarity is not related to memory of the stimulus then familiarity with processing the stimulus is hypothesised to be responsible for the subjective experience of familiarity, which in turn leads to a preference for the stimulus (Seamon, McKenna & Binder, 1998). Numerous studies have examined the relationship between processing fluency and preferences, with stimulus repetition being one of a number of other factors that lead to increased preferences. Changes that make the stimulus easier to process, such as greater prototypicality, enhanced figure-ground contrast and greater symmetry, have all been found to increase liking (Reber, Schwarz & Winkielman, 2004). Furthermore, these findings have been supported by computational modelling and neurological studies, giving this approach considerable explanatory power (Winkielman & Huber, 2009). Although it remains unclear how the resulting preference arises, the ability to account for the subliminal MEE without relying on models based on separate memory systems has led to processing fluency becoming the dominant model explaining the MEE.

In addressing the underlying mechanisms of this approach, Hansen and Wänke (2009) argue that a clear relationship exists between familiarity and preference, which is independent of recognition. This supports Bonnano and Stillings' (1986) finding that encoding context can influence recognition performance whilst making no difference to either preference or familiarity ratings. Although it can explain the absence of recognition in the subliminal MEE, within the perceptual fluency model the relationship between preference and familiarity remains largely unexplained, particularly when the effect is interpreted as being the result of hedonic marking. As opposed to the suggestion that fluent processing is misattributed as liking, the hedonic marking approach suggests that processing fluency itself is experienced as affectively positive (Winkielman et al., 2003). Research into hedonic marking has provided some of the most compelling evidence for the positive affect associated with fluency (see Winkielman & Huber, 2009). Thus, although it is possible to argue that familiarity, like preference, can result from misattribution of processing fluency (see Whittlesea, 1993), it poses a problem for the competing hedonic marking approach. Understanding how familiarity relates to processing fluency is therefore an essential consideration in the current research because the hedonic marking approach does not easily account for it.

Problems with the hedonic marking hypothesis suggest that the perceptual fluency model, although the favoured candidate for a convincing explanation of the MEE, remains incomplete. Butler and Berry (2001, 2004) are critical of the perceptual fluency model and suggest that the model needs modification in order to explain how the MEE differs from a typical repetition priming effect. Repetition priming occurs when previous exposure to a stimulus facilitates later retrieval of the representation (Tulving & Schacter, 1990). Although Butler and Berry do not suggest an alternate explanation for the MEE based on repetition priming, there is sufficient evidence to suggest that both phenomena are similarly based on facilitation in bringing a stimulus representation to mind when encountering it subsequent to previous exposure. Although the perceptual fluency theory is unable to completely explain the relationship between recognition, familiarity and preference in the MEE and is difficult to differentiate from repetition priming, it does appear that this approach provides the most reasonable explanation of the mechanisms underlying the effect (see also Butler & Berry, 2004; Fang et al., 2007; Whittlesea & Price, 2001; Willems, Dedonder & Van der Linden, 2010).

In order to address some of the criticisms of the theory, Whittlesea and Price (2001) propose a refinement of the perceptual fluency model of the MEE by suggesting that the formation of a preference without any associated recognition might actually be a consequence of using non-analytic processes to evaluate affective responses and analytic processes for recognition. In this respect, the global representation of the stimulus is enough to trigger a sense of familiarity and preference, but attempts to accurately identify the stimulus are hampered by an approach that relies on remembering distinct features of the stimulus. Whittlesea and Price's amendment is intended to counter the idea that the perceptual fluency approach is related to implicit/explicit memory, which they describe as obstructive to the understanding of how memory mechanisms are involved in the MEE, an argument that is consistent with those mentioned previously. This amendment to the perceptual fluency approach has been supported by results from a number of studies testing the affect disruption hypothesis (e.g., Willems & Van der Linden, 2006, 2009). Halberstadt and Hooten (2008), provide an example of affect disruption. They asked participants to think critically about the reasons why they liked or disliked a number of paintings and found that analytic thought disrupted the fluency-liking relationship leading to diminished preferences for exposed paintings compared to a control group who were not asked to give reasons. Moreover, Willems et al. (2010) directly compared processing strategy (analytic/non-analytic) with dual memory processing (explicit/implicit) to determine which causes an increase in liking with no associated increase in recognition. They found reliable evidence suggesting that processing strategy is the factor responsible for the development of preference in the absence of recognition. Generally, an accumulation of research supports Whittlesea and Price's notion that these conscious, analytic processes can attenuate what appear to be fluency-based preference responses.

Summary

What all the existing theories of the MEE have in common is that they do not seem to be able to completely explain all the observations associated with the phenomenon, particularly in terms of the exact nature of the relationship between familiarity, preference and recognition and precisely how memory influences affective and recognition responses. Klinger and Greenwald (1994) go as far as to say that "it is easier to obtain evidence of mere exposure than it is to account for it" (p. 69). To date very few experiments have tested any cognitive process other than memory within the mere exposure paradigm. Instead, research has focussed on the stimulus and presentation factors such as duration of exposure or type of stimulus (Yagi et al., 2009), or on further examination of what underlies perceptual fluency. When examining the history of studies into the MEE it seems that it has taken a substantial accumulation of data to move away from the idea that some conscious cognitive process does not mediate the effect, that it is indeed the result of being merely exposed. Although it is clear that preferences based on repeated exposure can be modulated by 'inferences', much work remains to be done before these processes are understood enough to produce a comprehensive explanation of the MEE. The next chapter will focus on some mediating factors that have not been extensively examined in the mere exposure paradigm and may help to fill some of the explanatory gaps that currently exist in theories of the processes underlying the MEE.

Chapter 2. Distractor devaluation - is mere exposure enough?

If cognitive processing attenuates preferences for an exposed stimulus, this has particular relevance within a marketing context given the competition for the attention of consumers (Ferraro, Chartrand & Fitzsimons, 2009). Should the MEE be found to be only effective when consumers pay attention to the stimulus, this could have broad ranging effects on the nature of advertising. Given that it is still unclear how the MEE works, it is plausible that established advertising strategies need a rethink. As it stands, traditional marketing wisdom states that any exposure is good exposure. However, if exposure to a product or brand name is incidental and occurs whilst the consumer is engaged in a cognitive task, the exposure might not lead to the desired preference for the product or brand name developing. Considering the worldwide investment in incidental advertising with the aim of increasing liking through exposure and the uncertainty surrounding the mechanisms responsible for the MEE, the relationship between cognitive processing and the formation of preferences needs to be examined further.

As discussed in the first chapter, the question of whether the MEE can be modified via cognitive processes other than memory has remained largely unexplored. Recently however this oversight has been addressed (see Craver-Lemley & Bornstein, 2006; Prescott, Kim & Kim, 2008; Yagi et al., 2009). For instance, Craver-Lemley and Bornstein presented an ambiguous duck/rabbit figure during the exposure phase of a typical mere exposure experiment and tested participants' preferences for disambiguated figures. Participants who were told that the ambiguous duck/rabbit figure was a duck preferred the disambiguated duck to the disambiguated rabbit, whereas participants who were told that the ambiguous duck/rabbit figure was a rabbit preferred the disambiguated rabbit to the disambiguated duck. This provides firm evidence that top-down, cognitive processes can alter the MEE, as preference ratings in this case were influenced by the cognitive interpretation of the image.

A number of cognitive processes remain unaccounted for in mere exposure research. Amongst these is attention. Researchers have come to focus on attention due to the close relationship attentional processes share with other cognitive functions such as memory (Jacoby, Kelly & Dywan, 1989; Pashler, 1998), consciousness (Chalmers, 1995; Pratto, 1994), and also with our perceptual systems (Broadbent, 1958). Unlike ‘slower’ cognitive processes such as conscious judgment and decision making, an investigation of attention also allows examination of the cognition/emotion interface at the most basic level (Niedenthal & Kitayama, 1994). Niedenthal and Kitayama argue that attention deserves to be central in any investigation of cognition and emotion because attention is often outside deliberate control and is a more instantaneous and automatic process, much like that described in Zajonc’s (1984) affective primacy hypothesis. Therefore, examining attentional influences on cognition and emotion could help in the development of a more complete understanding of the relationship between these processes and their influence on behaviour.

A number of recent studies have demonstrated that the exposure/liking relationship is modulated by selective attention. This line of investigation began with Raymond, Fenske and Tavassoli (2003), who manipulated participants’ attentional state in order to determine whether liking for a stimulus is altered if the stimulus is ignored. Raymond and colleagues asked participants to pay attention to or ignore intricate but meaningless visual patterns. These experiments involved initial exposure to a pair of abstract visual stimuli to the left and right of a fixation point. The task for participants was simply to find one type of stimulus (target) and ignore the other (distractor). A short time after each trial, participants were asked to rate a target, distractor or a novel shape in terms of whether they found it ‘cheery’ or ‘dreary’. Distractors were generally rated more negatively than targets or novel shapes, indicating that stimuli that were previously ignored became devalued. The phenomenon has become known as the distractor devaluation effect (DDE – Raymond et al., 2005). This finding that ignored or distracting stimuli tend to become disliked has been replicated a number of times (see Fenske & Raymond, 2006; Raymond, 2009 for reviews).

In order to explain how ignoring leads to devaluation, Fenske and Raymond (2006) argue that distractor devaluation works via an inhibitory mechanism. Kiss, Raymond, Westoby, Nobre and Eimer (2008) found physiological evidence for these inhibitory mechanisms using an electroencephalogram (EEG) to record activity during a task that required response inhibition. Furthermore, Fragopanagos et al. (2009) constructed a neural model to account for the process responsible for attentional inhibition resulting in devaluation of a distractor. This research strongly suggests that selective attention can mediate the exposure/affect relationship and this has implications for our understanding of how likes and dislikes are developed.

Interpreting the significance of the DDE is problematic given that it is the exact opposite of the MEE (Zajonc, 1968) in that exposure to a stimulus leads to it becoming disliked rather than liked. Explaining how this could be so, Fenske and Raymond (2006) point out that distractor devaluation observations parallel physiological studies suggesting that the selective attention systems of the brain tend to suppress distracting stimuli in order to facilitate processing of task significant information (Kastner & Ungerleider, 2000; Moran & Desimone, 1985). It appears that this attentional inhibition results in the distracting or ignored stimulus becoming preferentially devalued (Raymond, Fenske & Westoby, 2005). Processing of distracting information when engaged in a visual search task is also suppressed to allow attention to be focussed on targets (Neill, 1977).

Devaluation of an ignored stimulus whilst engaged in a selective attention task therefore poses an exception to the MEE, and suggests that mere exposure to a stimulus does not necessarily lead to preference.

Selective attention, exposure and preferences

Considering the MEE appears to be associated with the earliest stages of processing, it seems anomalous that attention has not been examined as a possible modulator of the MEE (see also Yagi et al. 2009). Although previous mere exposure research has examined aware/unaware differences, very little mere exposure research has controlled for selective attention directly. Not accounting for attention seems peculiar, as there are demonstrated links between conscious recognition, conscious familiarity and attention (Yonelinas, 2002). This oversight is also surprising considering that attentional processes and memory processes are so closely related (Broadbent, 1958; Jacoby, Woloshyn & Kelley, 2004), and that the most accepted theory of the MEE, the perceptual fluency model, involves memory processes (Bornstein & D'Agostino, 1994). Similarly, if the MEE is an example of repetition priming, as Butler and Berry (2004) contend, not accounting for attention is anomalous considering attentional processes can influence repetition priming (see Stone, Ladd & Gabrieli, 2000). What is evident from the work of Raymond and colleagues (Fenske & Raymond, 2006; Raymond, 2009) is that a stimulus may only come to be preferred when an individual pays attention to it or, at least, does not actively ignore it. As the influence of attention on the MEE has not been examined extensively, this suggests that attention might be the mediating factor that could explain the inconsistencies in mere exposure research.

Selective attention and mere exposure

At this point, it is prudent to review the research into attention to determine a possible way attention might influence the exposure/affect relationship. William James famously said that "everyone knows what attention is, (it is) the taking possession of the mind [and that] it implies withdrawal from some things in order to deal effectively with others" (James, 1890 pp. 403-404). Despite James' insight, over 100 years later, the mechanisms of attention are still not completely understood (Treisman, 2009). Nevertheless there appears to be three components of attention – selection, vigilance and control (Parasuraman, 1998). This taxonomy has evolved from an ongoing debate about whether attention involves early or late selection of objects, features or locations to attend to (Pashler, 1998). This debate has a long history, which dates back to the pivotal work carried out by Broadbent (1958). What has become evident is that attentional processing is driven predominantly by top-down cortical processes (Kastner & Underlinger, 2000; Tsotsos, 1990). This top-down processing comes at a cost, as capacity for processing information about stimuli appears to be limited (Duncan, 1980; Schneider & Shiffrin, 1977; Treisman, 1969; Tsotsos, 1990). Out of the array of sensory information humans are exposed to, selective attention is the term used to describe the process of choosing what is attended to and what the effects of this choice are (Johnston & Dark, 1986). In other words, we must selectively attend to certain incoming sensory information at the expense of other input (Driver, 2001).

What remains to be seen is how this selection process influences the development of preferences due to exposure. Many mechanisms influence this process of selection to either inhibit or enhance processing of certain stimuli (Kinchla, 1992). A closer examination of the mechanisms associated with selective attention in the visual domain reveals that two separate but allied processes are involved. One of these processes involves location of a stimulus in space while the second is concerned with identifying the object (Neisser, 1967). Theories attempting to explain these processes fall into three broad categories – object-based, discrimination-based and space-based theories (Duncan, 1984). Object based theories describe selective attention as a process where the features and spatial orientation of an object are processed pre-attentively before attention becomes fixed on the stimulus itself (Neisser, 1967). Of these object-based theories, one has been able to account for virtually all observations from neurological and experimental research into selective attention: the feature integration theory (Treisman, 2004).

Feature integration theory, first proposed by Treisman and Gelade in 1980, is the predominant cognitive explanation of visual selective attention with a wealth of supporting evidence (c.f. Styles, 1997; Treisman, 1993; Treisman, 2004; Treisman, Kahneman & Burkell, 1983). Treisman proposed that simple physical features are coded pre-attentively in parallel, however a serial process is required for effective coding of the relationships between features that allows for object identification. In visual search tasks, Treisman noted that the features of an object are conjoined only when the object falls within the narrow focus of directed visual attention. Simple features, in contrast, can be detected without this directed processing. Thus, only simple physical features such as colour can be processed outside of the ‘attentional spotlight’, whereas combinations of features cannot (Johnston & Dark, 1986). Feature integration theory provides the best framework for explaining selective attention because this model most adequately explains observations of visual search (Henderickx, Maetens & Soetens, 2010). In a direct comparison of selective attention models, Chan and Hayward (2009) attempted to separate processes thought to underlie competing guided search models from those of feature integration theory. By manipulating the parameters of a search task they found variations in performance that could not be explained without the parallel and serial processes of feature integration theory, reaffirming its position as the leading model of selective attention. Support for feature integration theory has also come from a number of neurological findings examining perceptual and cortical processes involved in selective attention (Kastner & Ungerleider, 2000; Treisman, 2004, 2009). In sum, feature integration theory provides the best speculative framework for the investigation of the influence of selective attention on the MEE.

Feature processing and the mere exposure effect

As a starting point for the current investigation of attentional influences on the MEE, the parallel processing of simple features as described in feature integration theory could lead to a sense of familiarity but would potentially be insufficient for reliable recognition of a stimulus. Janiszewski (1993) found increased familiarity ratings for features of exposed brand names and product packages in the absence of any recognition. This difference between levels of processing for familiarity and recognition might be what is underlying Zajonc's (1980) 'preferenda' and 'discriminanda'. Zajonc surmised that a combination of global stimulus features and internal states (preferenda) lead to a preference without recognition. Discriminanda on the other hand are the integrated relationships between stimulus features that allow accurate identification and recall of a stimulus. Preferenda, as understood through feature integration theory, could therefore be the result of familiarity with pre-attentive stimulus features. In this way, feature integration theory might explain how differences in the processing and encoding of stimulus features bring about changes in preference for a stimulus even in the absence of recognition.

Whittlesea and Price (2001) propose that inconsistencies in the recognition, familiarity and preference ratings for merely exposed stimuli result from analytic and synthetic processing differences in relation to stimulus features. In feature integration theory, synthetic processes are seen as stemming from pre-attentive parallel processes while attentive serial processing is akin to analytic processing. Thus, the formation of preferences and a sense of familiarity without recognition described in MEE research might be the result of parallel and serial processes of selective attention. That is, synthetic processing of stimulus features leads to familiarity and preference and occurs pre-attentively, whilst analytic processing of a stimulus sufficient for discrimination and recall requires serial, focussed attention.

Not only can feature integration theory explain unattended and ignored stimuli being processed implicitly in terms of discrete features, it might also explain the devaluing of unattended stimuli observed by Raymond and colleagues (Raymond, et al., 2003). In a series of experiments, Goolsby and colleagues (Goolsby et al., 2009) examined whether a distinctive stimulus (a face or a building) or a feature of the exposed distractors (colour) underlies the DDE. Participants consistently devalued stimuli based on the colour as the global feature and not on the distinctive aspects of the stimulus such as an individual face or building. Their results clearly indicate that a single feature of the distractors was leading to the devaluation. Feature integration theory is based around the premise that pre-attentive processing is feature based and this might be what is happening with the distracting stimuli. Distractor devaluation could be the result of pre-attentive (synthetic) processing of stimulus features generating a global representation of the distractor, which is used as a cue to guide attention away from stimuli that are to be ignored.

There is some evidence to suggest that in visual search tasks simple features are used when possible to guide attention away from distractors (Yang, Chen & Zelinsky, 2009). However, it might be the active suppression of distractors that leads to devaluation. DeSchepper and Treisman (1996) presented irrelevant novel shapes in a selective attention task and found that, although participants had no conscious recollection of the ignored shapes, there was a slight delay in responding to these shapes compared to control shapes in later trials. Negative priming and associated inhibition or suppression of irrelevant features could account for stimulus devaluing by participants engaged in selective attention tasks, typical of DDE studies (Griffiths & Mitchell, 2008). Feature integration theory thus provides a theoretical model for framing the investigation of the relevance of the distractor devaluation effect for theories of the mere exposure effect.

Physiological processes, selective attention and preferences

As well as being able to potentially explain observations from distractor devaluation research, feature integration theory has the added advantage of potentially shedding light on possible top-down influences on the MEE. Craver-Lemley and Bornstein's (2006) research with the ambiguous duck/rabbit figure strongly suggests that top-down processing can influence the MEE. There is growing evidence suggesting that top-down processes can influence selective attention (Rauss, Schwartz & Pourtois, 2010; Zanto, Rubens, Bollinger & Gazzaley, 2010). Moreover, Dijksterhuis and Aarts (2010) argue that most attentional processes are driven by higher cognitive intentions. Given the findings of Craver-Lemley and Bornstein, it is therefore possible that, similar to processes influencing selective attention, top-down influences could modulate the MEE.

Craver-Lemley and Bornstein's (2006) research aside, mere exposure studies have predominantly focused on bottom-up processes such as memory encoding, making the link to any top-down processing questionable. However, although top-down cortical processing may predominantly determine where attention is focussed, evidence suggests that attention can also be driven by an evaluative system (Vuilleumier & Brosch, 2009) and might go some way to explaining the DDE. This process is based on the emotional representation of stimuli in terms of motivational value. Attention is guided by an emotionally mediated evaluation concerning the importance of stimuli to current or future goals (Ortony, Clore & Collins, 1988). Within the DDE, this motivational value could be assigned to a target or distractor in a search task based on their relevance to completing the goal. Furthermore, Fenske and Eastwood (2003) found that faces expressing negative emotion influence performance on a selective attention task. This suggests that the modulation of affect also determines where attention is directed (see also Eastwood, Smilek & Merikle, 2001; Fox, Russo, Bowles & Dutton, 2001). It is thus apparent that motivational value and emotional relevance can influence where attention is focussed. Therefore, it is reasonable to hypothesise that, if a motivational value can influence attention through a reciprocal relationship between attention and emotion, it is possible that the same emotional representation influences later preference ratings.

Consequences of distractor devaluation for the mere exposure effect

Although it is unclear whether or not the motivational value of distractors is responsible for the DDE, observations of the effect lead to the possibility that selective attention could similarly influence the MEE. Yagi and colleagues (2009) examined the possible effect of selective attention on the MEE within a standard mere exposure experiment. Exposing participants to composites of a target and distractor polygon led participants to prefer targets to distractors, however, there was no direct evidence that distractors were devalued compared to novel shapes. Prescott, et al. (2008) also asked participants to attend to or ignore a stimulus, in this case odours, and found no evidence of a devaluation of the ignored stimuli despite finding an increase in liking when attention is specifically directed toward the target stimulus. These are just two examples of a number of studies using standard mere exposure methodology that did not find devaluation of ignored stimuli when participants were engaged in a selective attention task during the exposure phase (see also Hansen, & Wänke, 2009; Obermiller, 1985; Seamon et al., 1997).

At the same time, studies investigating the DDE using the methods most commonly employed in research into that effect do not find robust preferences developing for targets over novel shapes (Yagi et al., 2009). Studies exploring the DDE differ from mere exposure studies in a number of critical ways, the exposure and rating phases are often combined so that ratings occur immediately after each exposure and therefore the frequency and duration of exposure is often greater than in mere exposure studies when the exposure during the rating stages are taken into account. What this suggests is that studies examining the DDE are limited in terms of what they can contribute to the understanding of the MEE. This is because despite claims to the contrary (see Fenske, Raymond & Kunar, 2004; Tavassoli, 2008), a devaluation effect is yet to be reliably replicated under conditions analogous to those in mere exposure studies (see also Kihara, Yagi, Takeda & Kawahara, 2011). Notwithstanding this criticism, these studies led to the development of a model where the MEE and the DDE fit neatly within one all-encompassing theory explaining all possible affective outcomes of exposure (see Figure 1.).

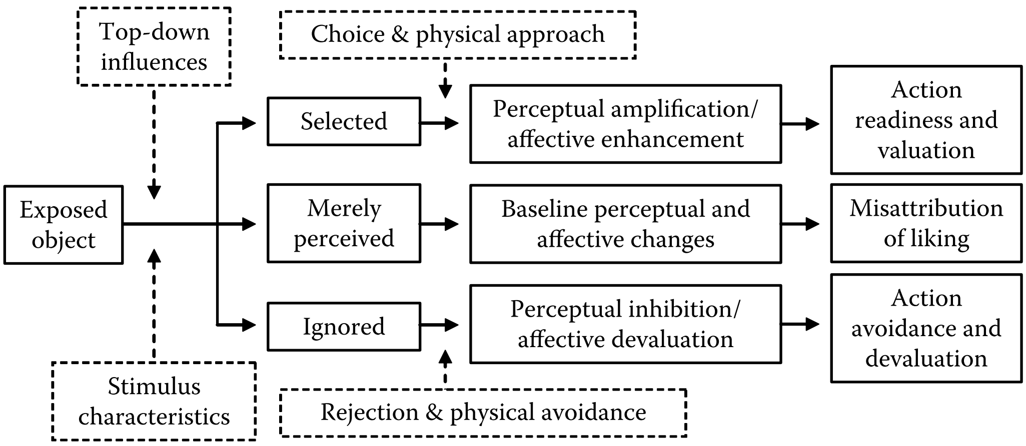


Figure 1. Tavassoli's (2008) model of exposure effects (reproduced with permission)

Approaching the effects of exposure on liking from a marketing perspective, Tavassoli (2008) argues that selecting, ignoring and merely perceiving represent three parallel streams of a single stimulus processing system. Ignoring is presumably related to avoidance, the stimulus is perceptually inhibited and this leads to distractor devaluation. Selecting a stimulus for attention then leads to approach motivation, perceptual amplification and liking, a finding supported by Prescott et al. (2008). Finally, Tavassoli argues that merely perceiving a stimulus leads to a misattribution of fluency as liking due to mere exposure and completes a single model of the hedonic consequences of selected and ignored stimuli. Despite Tavassoli providing some behavioural and physiological evidence to support this model, the contention that the processes underlying the MEE are comparable to those of the DDE has not been examined directly within the mere exposure paradigm. Without having collected evidence, Tavassoli's argument that the MEE and DDE can be explained within a single model of affective consequences of exposure therefore remains untested. What has been examined is the role of processing fluency in the DDE and the results of this research provide a suggestion of potential processing differences responsible for the effects in question.

Distractor devaluation and processing fluency

As the perceptual fluency model currently provides the most likely explanation for exposure effects based on mere exposure research, Fenske, Raymond and Kunar (2004) used a preview search task to examine whether processing fluency is involved in the DDE. The distractors were primed by a 1000 ms preview of the distractor before task completion to increase processing fluency of the distracting stimulus. This preview of the distractor did not inhibit the DDE, suggesting that the DDE is not linked to changes in perceptual fluency. Instead of suggesting that separate mechanisms could be responsible for these effects, Fenske and colleagues argued, "these results do not support perceptual fluency or conditioning explanations for pre-exposure effects on evaluative responses" (p. 1060). If perceptual fluency is not responsible for changes in liking due to exposure, this poses a challenge to fluency-based explanations of the MEE. Fenske and colleagues did not eliminate the possibility that their results reflect different underlying processes than those that lead to a MEE. Despite their argument that these results call into question any fluency-based explanation of exposure effects, it remains to be seen how these results contribute to a complete picture of the exposure/affect relationship, as the possibility of divergent processes has not been eliminated.

Considering the wealth of research supporting the positive hedonic effects of processing fluency (Alter & Oppenheimer, 2009; Reber, Schwarz & Winkielman, 2004; Winkielman, Schwarz, Fazendeiro & Reber, 2003), it is unclear whether processing fluency contributes to responses in distractor devaluation studies. Griffiths and Mitchell (2008) suggest that distractor devaluation could actually be the result of processing disfluency. In their experiment, Griffiths and Mitchell negatively primed exposed stimuli by presenting them as a distractor in a previous trial to reduce the ease of processing. Participants responded slower to stimuli that were previously ignored and these stimuli were also devalued compared to control stimuli. This suggests that perceptual fluency plays a role in distractor devaluation although the effects of disfluency on judgements are somewhat ambiguous due to it only being possible to infer fluency through its effect on reaction times (Oppenheimer, 2008).

Raymond and colleagues (Fenske & Raymond, 2006; Raymond, 2009) dismissed processing (dis)fluency as a valid explanation for distractor devaluation by demonstrating that conditions that should lead to an increase in processing fluency and therefore positive affect did not make any difference to the DDE. Furthermore, Tavassoli (2008) has proposed that the MEE and the DDE are due to the same underlying mechanisms and fit within one model of exposure effects (see Figure 1.). It is unclear whether they are components of a single process of perceiving and evaluating stimuli in the environment or whether they are the result of fundamentally different valuation mechanisms. Ultimately, the interaction between perceptual fluency and inhibitory processes in the DDE as outlined by Fenske, Raymond and Kunar (2004) is yet to be adequately explained.

There are a number of basic differences between mere exposure and distractor devaluation studies that make addressing these issues problematic. For example, distractor devaluation studies have used two-alternate forced-choice methodology or ratings of liking (‘cheeriness’ or ‘dreariness’) administered immediately after each exposure (eg. Raymond et al. 2003). On the other hand, mere exposure studies have used a range of rating scales, usually presented some time after the exposure phase (Bornstein & Craver-Lemley, 2004), in some cases weeks later (see Bornstein, 1989). The MEE appears to be more pronounced when stimuli are presented subliminally, whereas the consequences of subliminal stimuli on the DDE remain untested. The number of times a stimulus is exposed is an important consideration in mere exposure studies, while repeated exposure has received little attention in distractor devaluation studies. Prescott et al. (2008) suggested that these methodological differences might explain why mere exposure studies fail to find distractor devaluation and vice-versa. To determine if a single parsimonious model of the MEE and DDE is possible it is necessary to resolve these methodological differences.

Summary and aims of the current research

Although there is ample evidence for the effect of emotion on attention, the influence of attention on emotion has been largely overlooked despite the apparent connections between the neural structures involved (Bush, Luu & Posner, 2000). Considering the need for further investigation of this interaction, it is plausible that a currently unaccounted for mediating factor in the MEE is selective attention. Perhaps, as Raymond and colleagues (2003) suggest, if early stages of preference formation are based on reciprocal interactions between the cognitive and emotional functions of the brain, then the cognitive function central to ‘unconscious’ emotions is most likely pre-attentive processing of stimuli. Only a more systematic examination of this phenomenon can determine if attention is the factor responsible for some of the uncertainty surrounding the effect of exposure on liking. The current research aims to examine the role of selective attention in the DDE and MEE to determine if theories of selective attention can contribute to a greater understanding and explanation of the effect of exposure on the formation of preferences.

Chapter 3. Modulation of the mere exposure effect through selective attention

The review of research on the distractor devaluation effect (DDE) in the previous chapter identified a number of outstanding discrepancies to be explained before it is clear what this effect contributes to the understanding of the mere exposure effect (MEE). The aim of the following experiments was to bring research on these effects together to determine whether the single model proposed by Tavassoli (2008) can explain either of these effects or whether they are based on completely different underlying mechanisms. This research therefore set out to answer four main questions. Firstly, can the MEE be modulated by selective attention? Although there is some evidence that attention can modulate the MEE, this evidence is currently sparse and raises more questions than it answers in terms of a parsimonious explanation of the MEE. For example, can the perceptual fluency theory of the MEE account for attentional modulation?

Secondly, can subliminal distractors induce a DDE? This is an important question as the repeated presentation of subliminal distractors could induce pre-attentive inhibition and lead to devaluation of the distractors or they could become more fluently processed due to the exposure, as in the subliminal MEE. Considering the importance of explaining the subliminal MEE for any model of exposure effects, it is essential to understand reactions to repeatedly exposed subliminal distractors.

Thirdly, under what conditions does exposure in a selective attention task lead to liking or disliking? In order to answer this question, it will be necessary to attempt to elicit a DDE and a MEE under similar conditions. Kihara and colleagues (2011) found evidence of both effects operating concurrently in a study investigating the attentional blink. Producing both the distractor devaluation and mere exposure effects under similar conditions allows for manipulation of these conditions to determine the relationship between liking due to exposure and devaluation due to ignoring or, in other words, to find the boundary between liking and disliking for exposed stimuli.

Lastly, are these results consistent with observations from the original DDE experiments? As the approach taken in the current research is predominantly based on the methods used in mere exposure studies, it is essential to replicate the findings under conditions equivalent to those used in distractor devaluation studies. The decision to approach these experiments from a mere exposure paradigm was because it was the more established of the two phenomena and thus provided a more complete foundation from which to conduct the current investigations. As discussed, the methods used to elicit these two effects are different and because the mere exposure paradigm will serve as the starting point for these investigations, this final step is necessary to ensure that the conclusions reached through the current research are robust across the varied methods used to examine the two effects in question.

In the course of examining these main questions, other important factors are considered. These include those mentioned previously such as stimulus familiarity, feature processing, perceptual fluency and theories of selective attention. Each will be discussed in the context of the experiments presented here. The methods used throughout this research program reflect not only those used in studies concerning the MEE and the DDE, but also attempt to integrate these additional factors into experiments to determine the exact nature of the effect of selective attention on liking for exposed stimuli.

The first issue that needs to be addressed in order to ascertain whether the MEE and DDE are based on the same process is whether or not the MEE can be modulated by selective attention. Both Prescott et al., (2008) and Yagi et al. (2009) found evidence that attention can modulate the MEE, however, there was no evidence of a devaluation of distractors in either study. These results therefore do not help to determine whether the effects arise from the same or divergent mechanisms. In order to address this limitation, the first experiment in this research attempted to expand on the findings of Yagi et al. (2009) by examining the effect of selective attention on the MEE and then by examining how this modulating effect contributes to a parsimonious understanding of the mechanisms thought to underlie the MEE. To achieve this, the number of exposures, stimulus features and processing fluency were manipulated in these experiments. The number of exposures is clearly important as the size of the MEE is related to the number of exposures (Bornstein, 1989), whereas it is unclear how repeated exposure to distractors influences the DDE (see Veling et al., 2007). The overall aims of the first two experiments were therefore to examine the modulating effect of selective attention on likes and dislikes for repeatedly exposed random geometric shapes and provide a better understanding of the influence of stimulus exposure on liking.

As previously discussed, determining whether and how attention influences the MEE is important as the evidence for this modulating effect is currently sparse. Only the research conducted by Prescott et al. (2008) and Yagi et al. (2009) has examined the effect of selective attention on the MEE. The results from these two studies suggest that attention can influence exposure effects, however, the nature of this modulation and how it relates to the DDE remains uncertain. The first experiments in the present research were designed to address this uncertainty before moving on to further examine the relationship between the DDE and the MEE.

Experiment 1

Stimuli being presented inside and outside the ‘attentional spotlight’ are processed differently (Johnston & Dark, 1986) and this disparity creates a potential confounding factor in understanding the DDE. By presenting all stimuli central in the visual field, it is possible to eliminate the influence of spatial differences in processing and better determine if perceptual fluency and stimulus features are responsible for apparent processing differences in the DDE. The first experiment therefore follows the approach taken by Yagi et al. (2009). In the current experiment, a colour-naming task was used as a manipulation of selective attention rather than a search task (as in distractor devaluation studies), since it was expected that this would eliminate processing differences based on the location of the stimulus.

A sequence of shapes was displayed to participants in a relatively standard exposure phase similar to that used in numerous mere exposure studies. As in standard mere exposure studies, one of the shapes in both sequences was presented multiple times whereas other shapes were only presented once. This occurred in two sessions: one where participants were required to name the colour of the shape by speaking into a microphone and the other during a passive presentation session where they were simply required to watch comparable sequences. Information that is not task relevant taxes attentional resources (Styles, 1997), therefore the task creates a load on attentional resources and directs attention away from the shape itself. Importantly, a colour-naming task is not so difficult as to use up all attentional resources. Lavie and Tsal (1994) found that task difficulty influences whether attentional selection happens early or late. Irrelevant or distracting information is only processed when there are sufficient resources available, which only occurs when the task is low-load. It was hypothesised that participants would be more likely to recognise and prefer repeatedly exposed shapes displayed during a passive exposure phase than when engaged in the colour-naming task, as there is less competition for attentional resources and therefore it should be easier to process the stimuli. The intention of this experiment was not to create conditions whereby the stimulus is only processed pre-attentively but to simply demonstrate that engaging attention can modulate the MEE. Pre-attentive processing of distractors due to increased attentional load is addressed in subsequent experiments.

In order to determine whether feature processing is an important factor in the modulation of the MEE by selective attention, a global stimulus feature also required manipulation. The stimuli used in these experiments were random shapes taken from the Vanderplas and Garvin (1959) set. These shapes have been used in a number of mere exposure experiments (e.g. Bornstein, Leone & Galley, 1987; Mandler, Nakamura & Van Zandt, 1987; Yagi et al., 2009) and such polygons generally produce comparatively strong mere exposure effects (Bornstein, 1989). Variations in the number of points of the Vanderplas and Garvin shapes have been effectively used as a salient feature in a selective attention task (Zuber & Ekehammar, 1988). It was therefore deemed appropriate to use complexity or the number of points of the shapes as the manipulation of stimulus features in this experiment. As colour was the target feature, the number of points on the exposed shapes was manipulated in this study to determine whether the processing of irrelevant stimulus features modulates the MEE, as reported by Yagi and colleagues. Although complexity of a stimulus can influence liking judgements (see Berlyne, 1970; Tinio & Leder, 2009), the global, non-analytic processing underlying the MEE is not altered by variations in stimulus complexity (Bornstein, 1989; Willems & Van der Linden, 2009) and complexity was therefore deemed to be a viable stimulus feature to manipulate.

To assess the impact of feature processing, one condition in this study was exposure to shapes that all had the same number of points as the target shape (congruent condition) whereas the other condition included shapes with different numbers of points (incongruent condition). A number of mere exposure studies have found that liking increases for stimuli that are similar to the exposed stimulus (e.g. Gordon & Holyoak, 1983; Zajonc, Crandall, Kail & Swap, 1974; Zizak & Reber, 2004). Repeated exposure to stimuli with similar features should lead to increased processing fluency, which in turn should lead to greater familiarity and liking. Thus participants in the congruent condition were exposed to a consistent set of features and thus will be expected to prefer shapes that share that feature as well as find them more familiar.

To address processing fluency, subliminal shapes were included in the exposure phase as the positive effects of processing fluency are greatest when the subjective experience of fluency is surprising (Whittlesea & Williams, 1998). Whittlesea and Williams argue that the positive effects of fluent processing are based on a misattribution of the feeling of familiarity and that the effect is diminished when that familiarity can be readily attributed to the repeated presentation of a stimulus. Subliminal presentation ensures that the level of fluency experienced cannot be easily attributed to the number of exposures consciously experienced. The subliminally presented shapes had the same number of points as the target shape in the congruent condition and a different number of points in the incongruent condition.

The potential feature processing of the subliminal shapes is also an important consideration. To contrast familiarity with feature processing, one subliminal shape was exposed multiple times. If familiarity and preference choices are made on the basis of individual shapes then this suggests that the perceptual characteristics of specific stimuli are responsible for the subliminal MEE; whereas if familiarity and preference choices are feature-based then liking will generalise to similar shapes (i.e. with the same number of points).

If both feature-based perceptual fluency and selective attention operate simultaneously to influence preferences due to exposure then one would expect that more participants would prefer exposed shapes and shapes of similar complexity to the exposed shapes after the passive exposure to visual stimuli, as opposed to exposure during a task.

The same would also hold true for familiarity and recognisability. Similarly, the inclusion of congruent distractors was hypothesised to lead to more participants selecting exposed shapes as most familiar and preferable.

Methods

Participants

Participants in this study were 59 psychology students (47 female). They ranged in age from 18 to 55 years with a mean age of 23.5 years. Based on an a-priori power calculation assuming a medium effect size ($\omega = 0.3$; e.g. Bornstein & D'Agostino, 1992) with $\alpha = .05$ and power at $1 - \beta = .8$, a sample size of 88 was required. For practical reasons based on the size of the participant pool and number of participants who completed both sessions, the final number of participants completing the study was 59. Psychology students from James Cook University Cairns Campus were recruited via an advertisement placed on a notice board on campus. Approval to recruit these volunteers was sought from and granted by the James Cook University Ethics Committee. All participants were informed of their rights and obligations before beginning the experiment and gave informed consent to participate. Participants also received course credit in return for participating. The procedures surrounding participant recruitment and ethics approval were consistent in all subsequent experiments unless otherwise stated. Volunteers were screened for colour blindness and none were found to be colour-blind. All participants had normal or corrected to normal vision.

Materials

This experiment was conducted in specialised testing labs at James Cook University, Cairns Campus. Ambient light in the testing room was kept low and participants were seated so as to bring the distance between their eyes and the computer screen as close as possible to 50 cm.

The visual stimuli were presented using E-Prime version 1 (Psychology Software Tools Inc., 2008) on a Dell desktop computer running a 3.0 GHz CPU with a 53 cm CRT monitor running at 85Hz positioned at eye level. A set of standard headphones with an inbuilt microphone was attached to the computer to ostensibly record responses. Data analysis was conducted using Microsoft Excel, SPSS and Psy (Bird, Hadzi-Pavlovic & Isaac, 2000).

Stimuli

The stimuli used in this experiment were random geometric shapes of low association value drawn from those developed by Vanderplas and Garvin (1959). The exposed stimuli were 40 24-point shapes and 40 6-point shapes and a pool of novel shapes was drawn from the 12-point shapes in the same set. Examples of the geometric shapes used in all experiments are presented in Appendix 1. The presented shapes were counterbalanced across and between conditions. All shapes used in the experiment were converted to red, green, yellow and blue for the colour-naming task. The shapes were presented subtending a visual angle of approximately 6.5˚.

Each set of exposures consisted of 80 stimulus presentations, 40 subliminal and 40 supraliminal. The supraliminal shapes were presented for 1000 ms, while subliminal shapes were presented for 33 ms followed by a mask of a picture of coloured broken glass for 1000 ms. Piloting of subliminal stimuli confirmed that observers were unable to detect the presence of a stimulus. The repeatedly exposed shapes were presented 20 times, as was the repeated subliminally presented shape. Similarly there were 20 different shapes presented once (including incongruent complexity shapes for those conditions) and 20 different subliminal shapes (including incongruent complexity shapes for those conditions). The 20 repetitions are within the range of exposures expected to yield the greatest MEE (Bornstein, 1989). A portion of the exposure sequence is displayed in Figure 2. The subliminal and supraliminal shapes were presented alternatively and the repeated/single exposure shapes were presented randomly, the colour (red, yellow, green or blue) of all shapes was also randomly determined and counterbalanced.

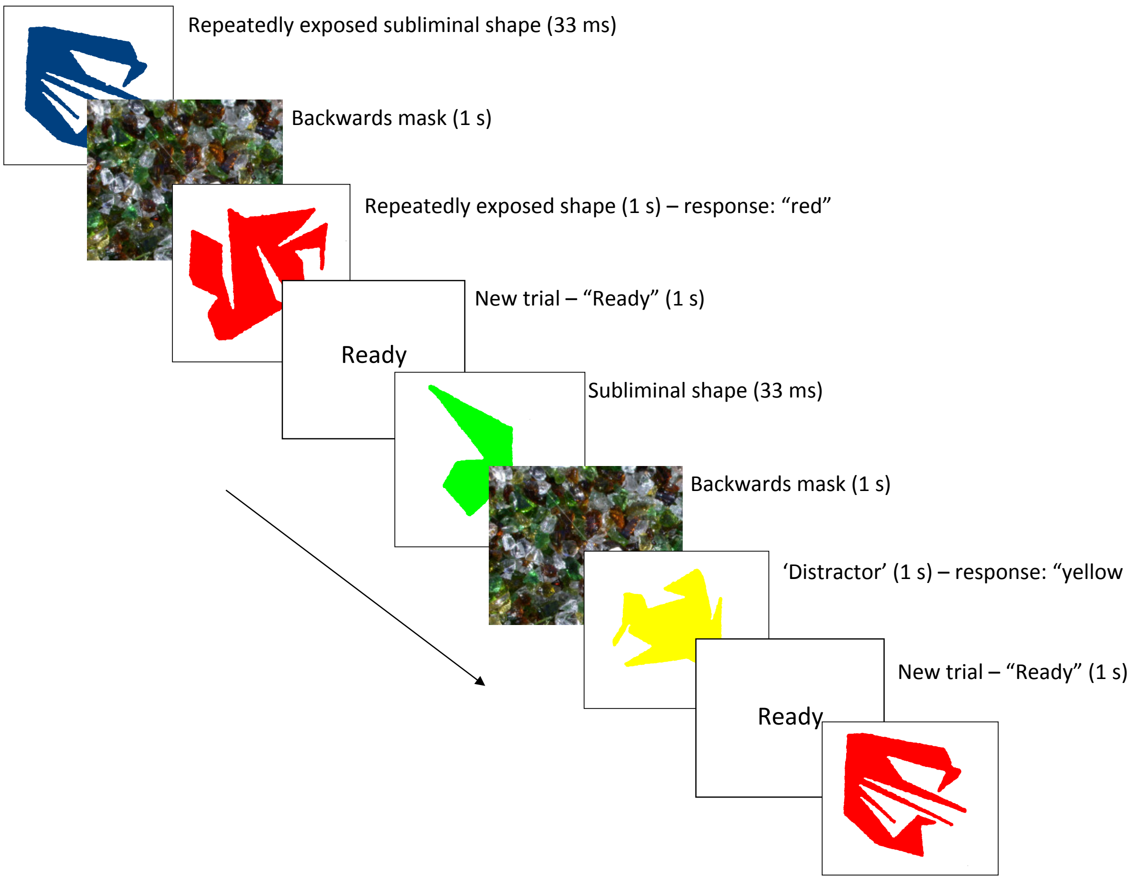


Figure 2. Portion of exposure sequence for experiment 1.

Procedure

Exposure phase

Participants were randomly assigned to one of four groups. The first two groups were congruent conditions and were either repeatedly exposed to one 24-point shape amongst 40 other 24-point shapes (20 supraliminal and 20 subliminal) or one repeated 6-point shape amongst 40 other 6-point shapes. The incongruent groups either had a repeatedly exposed 24-point shape presented amongst 40 6-point shapes or a repeatedly exposed 6-point shape presented amongst 40 24-point shapes. Thus there were eight exposure conditions. Each participant was exposed to two distinct sets of shapes, one in the active colour naming task and one in the the passive presentation. These tasks were held on separate days and the order was counterbalanced between participants. In the colour-naming task, a microphone was used to ostensibly record the participants stating the colour of the shapes. Participants were told that the speed and accuracy of their responses was being recorded, however this was not the case. The task was simply to ensure that they had to attend to a particular feature of the stimuli. Participants were, however, monitored to ensure that they were diligently completing the required task. The passive presentation simply involved the participants watching the monitor whilst they were presented with a different set of shapes.

Choice phase

At the completion of each exposure session, participants were asked to wait 10 minutes for the second phase of the experiment. They were not pre-warned that they would be asked to choose which of the stimuli they recognised, found familiar or preferred. Obviously, this unexpected test phase was only surprising in the first testing session, and thus the task and passive sessions were counterbalanced to partially control for this. The delay between exposure and the preference measures was to maximise the MEE (Bornstein, 1989).

A forced choice procedure was used to assess recognition, familiarity and preference. A single four-alternate forced choice (4AFC) procedure was used to ensure that neither a MEE nor a DDE were induced by the testing procedure through additional exposure to the stimuli. Forced choice measures have been commonly used in mere exposure studies (Bornstein, 1989). Dai, Brendl and Ariely (2010) also suggest that forced choice measures are more susceptible to preference decisions than rating scales because, although two stimuli may be judged equally on a rating scale, preferences are more apparent when participants are forced to choose between them. Considering there is a possibility of multiple processes impacting on preference judgements in these experiments, the more discerning measure was used in this experiment. Recognition, familiarity and preference were all measured using forced-choice items.

The participants were asked six questions, and responded by selecting one of four random geometric shapes presented in black. The first two questions assessed recognition. The first of these asked participants to indicate which shapes they saw during the experiments and the options included the repeatedly exposed shape, a shape exposed once, a similar but novel shape and an altogether novel shape with a different number of points (randomly selected from the pool of 12 point shapes). The second recognition question also asked participants to indicate which shape they saw in the experiment. This time the options included the repeatedly exposed subliminal shape, a subliminal shape exposed once, a similar novel shape and a completely novel shape. The third and fourth questions assessed familiarity. The third question asked participants to indicate which shape was most familiar and they were given the same options as for question 1 (i.e. the options were the repeatedly exposed shape, a different shape exposed once, a similar shape and a completely novel shape). The fourth question also assessed familiarity and included the same options as question 2. The fifth and sixth questions similarly asked participants to select the shape they preferred from the same list of options from questions 1 and 2 respectively. An example of the question sheet is included in Appendix 2.

Results

As the results yielded by this experiment were nominal in nature, responses were combined to give total numbers of participants who chose responses for each of the four choices for all questions. Data were then analysed using chi-squared, output tables are included in Appendix 3a. Chi-squared tests for independence were conducted across all questions to determine if responses differed significantly between the first and second sessions. There were no significant differences between responses in the first and second experimental sessions thus they were combined for the purpose of analysis.

Recognition

Most participants (80%) were able to accurately identify the repeatedly exposed shape after the passive presentation session but had more difficulty after the task condition, where 63% of participants accurately identified the repeated shape. This difference however was not statistically significant, χ^2 (1, n= 59) = 1.190, p = .275. In the colour-naming task, 25% of participants correctly selected the subliminal shape as the one they were presented, 27% did so after the passive presentation session. Recognition of the repeatedly exposed subliminal stimulus across the two conditions therefore did not significantly differ from chance levels, χ^2 (1, n= 59) = 0.102, p = .750.

Familiarity

Shapes with the same number of points as the repeatedly exposed shape were chosen as most familiar significantly more often than novel shapes, χ^2 (1, n= 59) = 60.215, p < .001. The repeatedly exposed shape complexity was chosen by 56% of participants as being most familiar over the other three shapes. The repeatedly exposed subliminal shape, however, was not chosen as familiar more often than a shape with the same number of points χ^2 (1, n= 59) = 0.282, p = .595, with 28% of participants choosing this shape as the one they found most familiar. There was no difference in familiarity responses between the task and passive presentation sessions, the proportion of participants selecting the complexity of the repeatedly exposed shape as most familiar was identical at 56%. There was a difference between the congruent and incongruent conditions; 67% and 47% respectively in each condition selected the repeatedly exposed shape complexity as most familiar, however, the difference was not significant χ^2 (1, *n*= 59) = 3.379, *p* = .066. This indicates that the number of points was used as the basis of familiarity ratings regardless of condition with a tendency for participants to find the repeatedly exposed complexity more familiar in the congruent condition.

Preference

Preference responses overall indicated that targets were more often preferred than shapes with the same number of points and novel shapes, χ^2 (3, *n*= 59) = 32.915, $p < .001$. Preference for repeatedly exposed subliminal shapes when compared to shapes with the same number of sides as the target and novel shapes did not differ significantly, χ^2 (3, *n*= 59) = 1.390, *p* = .708.

More participants preferred the target stimulus when exposed during the passive presentation condition than when engaged in the colour-naming task, χ^2 (1, *n*= 59) = 3.882, *p* = .049. Novel shapes with the same number of sides were also preferred over completely novel shapes, however, as multiple tests have been conducted on this data, this finding could be no more than a type 1 error and therefore should be treated with caution. These results can be seen in Table 1 and indicate the effect of engaging in a task on the MEE.

Table 1.
Proportion of preference choices in the colour-naming task versus passive sessions

	Repeated shape	Shape exposed once	Same no. points	Novel shape
Colour naming task	37.3%	25.4%	25.4%	11.9%
Passive	55.9%	13.6%	20.3%	10.2%

There was no difference between the proportion of participants choosing the repeatedly exposed shape as the preferred shape between the congruent and incongruent conditions χ^2 (1, *n*= 59) = 1.172, *p* = .279. There was however a significant difference in the proportion of responses to the most preferred complexity with more participants in the congruent condition selecting a shape with the same number of points as the repeatedly exposed shape over novel shapes, χ^2 (1, *n*= 59) = 4.522, *p* = .033. This indicates that a greater number of exposures to shapes of that complexity led to an increase in preference.

Table 2.
Proportion of preference ratings in congruent versus incongruent conditions

	Repeated shape	Shape exposed once	Same no. points	Novel shape
Congruent	32.0%	17.0%	35.0%	16.0%
Incongruent	39.7%	27.9%	16.9%	15.5%

Discussion

The results of this experiment demonstrate that participants are more likely to recognise and prefer shapes displayed in a passive exposure session rather than during a task and are more likely to find a shape familiar and preferable when exposed to shapes with similar features. There was no evidence in any of the conditions that exposed shapes were devalued compared to novel shapes, in all cases exposure led to increased familiarity and preference. Collectively, this experiment provided evidence of a MEE for repeatedly exposed shapes based on familiarity with the features of the repeatedly exposed shape. This MEE was evident irrespective of the other factors involved.

The results of this experiment suggest that selective attention and perceptual fluency can work independently to influence the development of preferences through exposure to a stimulus. Engaging in the colour-naming task led to a lower proportion of participants selecting the repeatedly exposed shape as the shape they most prefer than when the shapes were presented and required no response. Engaging in the selective attention task in this case seems to have reduced the strength of the MEE. This result supports the findings of Prescott et al. (2008) and Yagi et al. (2009) and again demonstrates that selective attention can modulate the MEE.

There was little support for a subliminal MEE for specific shapes. As preferences for subliminal stimuli were no different than for shapes with the same number of points and these similar shapes were consistently preferred over novel shapes, it suggests a generalisation of liking based on features. This finding is important as subliminal exposure often leads to a more pronounced MEE (Bornstein, 1989) however, subliminal effects have been known to generalise to similar stimuli (Bornstein, Leone & Galley, 1987) and this generalisation suggests feature processing is involved. In a similar vein, participants in this experiment consistently chose shapes with the same number of points as the repeatedly exposed shape as both more familiar and preferred over other shapes, particularly in the congruent condition. Moreover, the finding that the familiarity choices of the most exposed subliminal shapes were no higher than for other shapes with the same level of complexity would suggest that familiarity judgements were not being made on the basis of unique characteristics of the shapes themselves. This lends support to the notion that greater ease in processing shapes with the same number of points could be contributing to the observed MEE.

The first experiment indicates that both feature-based perceptual fluency and selective attention influence the MEE. There was however, no indication that shapes exposed during the colour-naming task were devalued compared to novel shapes. In every condition, novel shapes were least often chosen as familiar and least often preferred, this is particularly evident when considering that the other options in each question represent shapes with similar features (refer to Table 2.). There is a possibility that devaluation depends on the type of task. The majority of the research to date on the DDE has used visual search tasks, which requires the participant to search through the visual field in order to locate a stimulus in 2-dimensional space (see Raymond, 2009 for review). In order to find the target, distractors must be actively discounted, as opposed to the current experiment, where distractors were not actively discounted. Experiment 1, as with both Prescott et al. (2008) and Yagi et al. (2009), did not use a visual search task, distractors were not discounted, and all three studies failed to find evidence of devaluation of non-target stimuli. The logical course of action was to therefore take the findings of this previous research and examine the effects of combining increased levels of perceptual fluency on a standard visual search task to determine if increasing the exposure to distractors with different features to the targets in any way changes the expected devaluation of the distractors.

It is difficult to separate processing differences from spatial processing biases using a search task, because the inhibitory process thought to underlie the DDE could be due to differences in attentional processing or biases in processing based on spatial location (Yagi et al., 2009). Despite this, and in many cases because of it, search tasks are commonly used in research on visual attention (Pashler, 1998). In keeping with this approach, distractor devaluation studies also use visual search tasks (Raymond, 2009). Experiment 1 established that processing differences are involved in the attentional modulation of the MEE free from any bias associated with spatial location. With that established, it is then important to replicate the findings of experiment 1 within a search task.

Experiment 2

Experiment 2 aimed to determine whether the DDE depends on subjects being engaged in a conventional visual search task. As mentioned previously, studies conducted on the DDE to date have used a form of visual search task as the manipulation of selective attention and reliably produced a devaluation of distractors (see Raymond, 2009 for review). Tipper (1992) suggests that stimuli presented outside the ‘attentional spotlight’ can be subject to inhibitory processes. Posner and Cohen (1984) also found that participants take longer to respond to a target when it is presented in a spatial position previously ignored than elsewhere in a visual array. This process, called inhibition of return, is thought to drive attention to novel locations to facilitate search processes and can lead to features of objects presented at ignored locations also being inhibited (Klein, 2000). Lleras, Levinthal and Kawahara (2009) suggest it is possible that distractor devaluation is a by-product of inhibition of return. Thus it is feasible that the failure to find distractor devaluation in experiment 1 is because the effect depends on inhibition of return, which in turn depends on the spatial coding of the location of the ignored distractors. In experiment 1, all the stimuli were presented in the same spatial location and thus, any effect of inhibition of return would have been negated. Experiment 2 attempted to address whether the failure to find a DDE in experiment 1 was due to all stimuli being presented in the same location.

Consistent with the multiple presentations of ignored stimuli in experiment 1, the second experiment also included multiple stimuli. Also consistent with the procedure used in experiment 1, both supraliminal and subliminal distractors were included. The results of experiment 1 suggest that additional exposures to shapes with similar features lead to an increased likelihood that participants found a repeatedly exposed stimulus both more familiar and preferable over a novel stimulus. This supports the findings of research into the structural MEE (see Manza & Bonstein, 1995) and Nordhielm's (2002, 2003) argument that repeated exposure to stimulus features increases processing fluency and therefore liking. In this way, the second experiment compares the effect of processing fluency on one hand with inhibitory spatial processing bias on the other.

If, as Raymond and colleagues (Raymond et al., 2003; Fenske et al., 2004) have argued, the DDE is simply the by-product of an inhibitory process, the inclusion of two distractors in this experiment will make little difference to the DDE, the distractors will be inhibited in order to successfully complete the task and as a consequence devalued. As the two distractors share similar features and the effect is supposedly based on feature processing (Goolsby et al., 2009) an increased inhibition and therefore devaluation should be observed under these circumstances.

Alternatively, if perceptual fluency contributes to exposed stimuli being preferred, regardless of whether they are being exposed during a selective attention task, the inclusion of two distractors will increase fluency and therefore liking for the distractors. In this case, the predicted devaluation of the distractors will not be evident and there will be an increase in liking for the distractors relative to novel shapes. In other words, if increases in liking due to exposure occur regardless of the stimuli being presented as distractors, a MEE will be observed for both targets and distractors.

Methods

Participants

Fifty psychology students (36 females) naïve to the aims of the experiment were recruited and offered course credit for participation in a similar manner to experiment 1. Age of the participants ranged from 17 to 55 years with a mean age of 25.6 years. Participants all had normal or corrected to normal vision.

Materials

Materials in this experiment were similar to those used in experiment 1. Straight-edged shapes with low association value from the Vanderplas and Garvin (1959) set were again used in this experiment and the computer equipment and software were also the same. A 4x4 grid subtending a visual angle of 22.1˚ was used for the search task (See Figure 3). The Vanderplas and Gavin (1959) shapes used in this experiment were all presented in black and were reduced in size to a visual angle of 4.5˚ to fit within each square in the grid.

For the exposure phase two sets of search grids were constructed. One set included 24-point shapes as targets and shapes with 6 points as distractors, while for the other set, 6-point shapes were targets and 24-point shapes were distractors. Target and distractor sets were created using a single combination of shapes. These sets were then used to create 20 individual search grids corresponding to the 20 trials for each participant. This process was repeated five times for each condition resulting in ten variations of the task, five for each condition. A black and white picture of broken glass was used to mask the subliminal shapes.

Raymond, Fenske and Westoby (2005) suggest that the inhibitory processes appear to be more pronounced when distractors are spatially close to the target stimulus. Thus on each trial either the subliminal or supraliminal distractor was always located one grid reference (vertically, horizontally or diagonally) from the target. The distractor not located near the target was randomly displayed at another location in the grid away from the target. An example of a trial sequence is illustrated in figure 3.

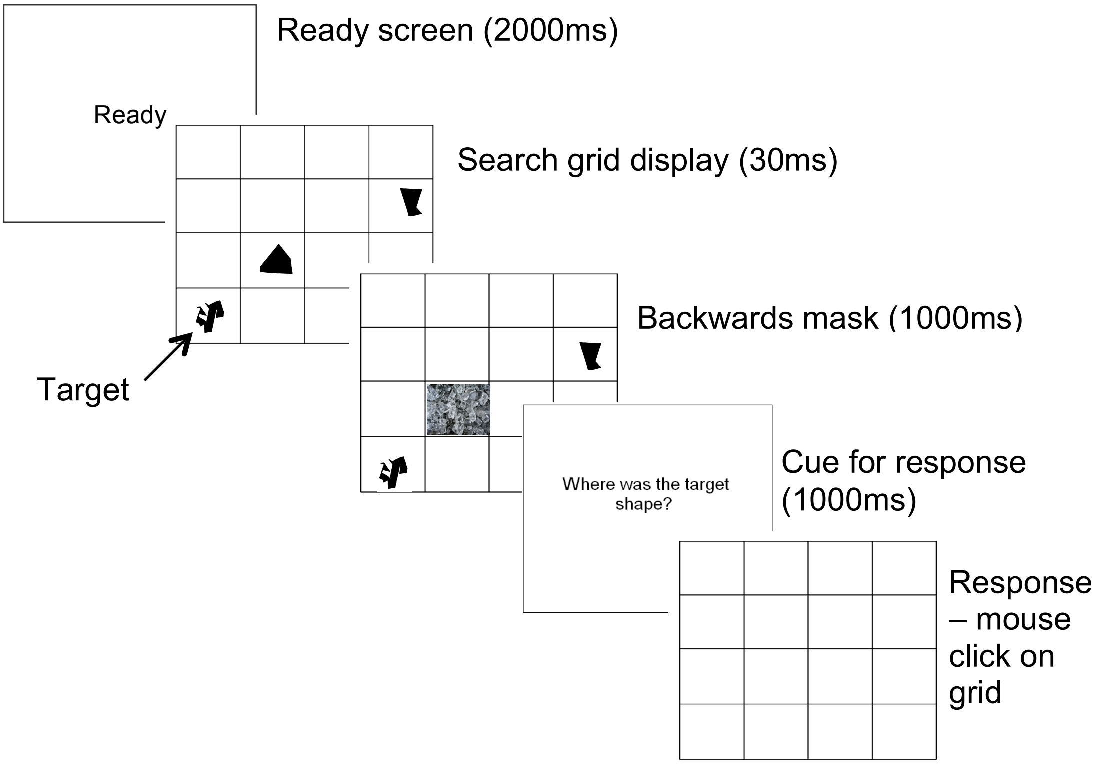


Figure 3. Trial sequence for visual search task

At the beginning of each testing session the participant was shown the target shape for 5000 ms before the exposure phase began. Each trial began with the word ‘ready’ on the screen for 2000 ms in 18 pt black font on a white background. The search grid with the subliminal distractor was presented for 30 ms followed by an identical search grid with the mask in place of the subliminal distractor for 1000 ms. A message reading, ‘Where was the target shape’ immediately followed the search grid for 1000 ms to cue the response. Participants were then shown a blank grid and required to use the mouse to click in the grid corresponding to where the target shape appeared. As in experiment 1, response correctness and reaction time were not recorded. Participants were instructed to find the target shape in the search grid and click in the grid reference where the target appeared.

Ten minutes after the completion of the exposure phase participants completed a series of forced choice measures similar to those in experiment 1 with the following modifications. Since there were no shapes in this experiment exposed only once as there were in the previous experiment, each 4AFC question for familiarity ratings included a shape with the same number of sides as the target and distractor and two novel shapes. Preference choices included the target, the visible distractor and two novel shapes.

There is a possibility, although unlikely, that the failure to find a DDE in experiment 1 is due to there being no explicit measure of devaluation, as in a negative attitude towards a distractor. Asking for both positive and negative responses is common in distractor devaluation studies. Diener and Emmons (1985) also suggest that positive and negative affect are independent, an argument supported by Larsen and Fredrickson (1999) in their review of issues in measurement in emotion studies and by evidence suggesting that distinct systems exist in the brain for the processing of positive and negative emotion (Caccioppo, Gardner & Bernston, 1999; Lewis, Critchley, Rotshtein & Dolan, 2007). In this experiment, participants were therefore asked to rate the most and least familiar and the most and least preferred rather than just most preferred and most familiar.

Results

When asked to identify which shapes they saw in the experiment, 92% of participants accurately identified the target and supraliminal distractor. Only four participants correctly indicated they had been presented the included subliminal shape.

Familiarity and preference choices were again analysed using chi-squared, output tables have been included in Appendix 3b. As comparisons have been conducted in terms of targets, distractors and novel shapes (of which there were two), expected frequencies for the chi-squared analysis were adjusted accordingly. Participants consistently chose target-like (52%) and distractor-like (42%) shapes (based on the number of points) as most familiar over novel shapes (2%), χ^2 (2, n= 50) = 22.36, p < .001. There were no differences in responses to which type of shapes participants found to be least familiar, χ^2 (2, *n*= 50) = 3.640, *p* = .162. These results are presented in Table 3.

Table 3.

Proportion of familiarity ratings based on similarity (number of points)

	Target like	Distractor like	Novel
Most familiar	52%	46%	2%
Least familiar	34%	44%	22%

Preferences for targets and distractors themselves followed a slightly different pattern, as can be seen in table 4. The majority of participants (62%) indicated a preference for the target with the remainder more likely to prefer the distractor shape (26%) over a novel shape (12%), χ^2 (2, *n*= 50) = 19.960, $p < .001$. When asked which shape they least prefer, the majority of participants stated that they least preferred the novel shape (64%) with a tendency of the remainder to indicate that they least prefer the target (26%) over the distractor (10%), χ^2 (2, *n*= 50) = 23.080, $p < .001$. Both measures suggest an increase in liking for target and distractor shapes compared to novel shapes.

Table 4.

Proportion of preference ratings for target and distractor shapes

	Target shape	Distractor shape	Novel shape
Most prefer	62%	26%	12%
Least prefer	26%	10%	64%

Discussion

The results of the second experiment indicate that both targets and distractors were preferred more often than novel shapes. This is an indication that, in both cases, targets and distractors, a MEE was observed. The second experiment again failed to produce a DDE, despite independently assessing positive and negative attitudes towards distractors and despite using a search task. These findings suggest that increased perceptual fluency associated with the presentation of multiple distractors leads to an increase in liking notwithstanding the possibility that in some cases, they may not have been processed as distractors in a way that is analogous with previous distractor devaluation studies. This is in contrast to numerous observations of a DDE when participants are exposed to only one distractor and one target (see Raymond, 2009). The engagement in the search task in this case did not devalue the distractor stimulus but rather it appears that the distractors became preferred relative to the novel shapes.

These results can be explained by an increase in processing fluency created by the inclusion of two similar, repeatedly exposed distractors compared to a single distractor or a number of different distractors commonly used in experiments of this type. The greater proportion of participants choosing the distractor shape or shapes similar to the distractor as both more familiar and preferred in this experiment, compared to that in experiment 1 and in other DDE experiments, could be the result of a misattribution of the familiarity generated by the exposure to these distractor shapes as liking. This explanation is consistent with the account of Bornstein and D'Agostino (1994), who argued that the increased ability to bring the stimulus to mind is misattributed as liking. If this is the case, distractors in this experiment may or may not have been inhibited but processing fluency may well have been increased and resulted in more participants preferring these shapes. This proposition is consistent with the argument made by Kihara and colleagues (2011) who found evidence to suggest that the inhibitory processes linked to the DDE and those underlying the MEE work independently and appear to have contradictory impacts on evaluative responses. Moreover, Whittlesea and Williams' (2001a, 2001b) discrepancy-attribution hypothesis also supports this possibility. The idea behind this hypothesis is that processing fluency has its greatest impact on familiarity and preference when the feeling of familiarity is unexpected. Accordingly the inclusion of a second distractor in the search grids in this experiment was subliminal, making any subjective experience of familiarity due to perceptual fluency surprising, as participants were unaware of being exposed to the second distractor. This second distractor appears to have increased processing fluency beyond what was expected and countered the devaluation of the distractors leading to the formation of a preference for both the exposed targets and distractors over novel shapes.

The results of this experiment therefore raise a number of questions. Firstly, it is evident that the inclusion of multiple distractors in this case has eliminated devaluation of the distractors. In this experiment, the methodology was equivalent to that used in multiple DDE experiments with care taken to present distractors close to the target to induce maximum possible inhibition of distractor shapes and features thereof. Despite this, there was still no evidence of a DDE. Fenske and colleagues (Fenske et al., 2004) made the suggestion that processing fluency does not play a role in the DDE but this experiment suggests that processing fluency could possibly influence responses in selective attention tasks by inducing a MEE via misattribution when the familiarity elicited by the more fluent processing is surprising.

General Discussion – Experiment 1 and 2

Overall, participants in these experiments preferred shapes with the same number of points as the shapes they were exposed to most in each exposure phase. This was most obvious in conditions where all shapes in this phase had the same number of points, as in experiment 1. This feature also appears to influence preference ratings overall, as shapes with a different number of points to what they were exposed to were consistently rated as preferred by fewer participants. This was particularly so in groups where incongruent distractors were included, as in the first experiment.

Since neither a clear liking or disliking for individual subliminal stimuli were observed in these experiments, this would suggest that further research is needed to determine exactly how the subliminal distractors and features thereof influence responses in the choice phase. The results of this experiment are clearly inconsistent with what would be expected when the observations of recent research into the DDE are replicated within an experimental paradigm more in the vein of previous mere exposure research. These experiments instead lead to the suggestion that both perceptual fluency and feature processing are involved in the evaluation of a repeatedly exposed stimulus whilst engaged in a task. The results of experiment 1 in particular suggest that feature processing appears to be involved in the development of preferences. There was evidence that the processing of a simple feature (i.e. the number of points on the exposed shapes) was enough to influence the affective rating of the shapes. What remains to be seen is how this processing is involved in attentional selection. In experiment 2 there was both a supraliminal and a subliminal distractor and it is therefore not possible to examine the effect of pre-attentive processing of stimulus features alone. This issue is examined in experiment 3.

The broader issue of modulation of the MEE by selective attention and the nature of the relationship between the MEE and the DDE remains uncertain. Although these experiments add to what is known through the studies conducted by Yagi et al. (2009) and Prescott et al. (2008), the nature of the modulation of the MEE by selective attention needs further examination before there can be a clear understanding of how pre-attentive processes and attentional selection can alter the MEE. Following on from the observations that the effect can be modulated, the next step is to examine the nature of this relationship in terms of the established theories and observations of selective attention. Considering that the number of points on the shapes appears to have been used by the participants as a cue to trigger feelings of familiarity and preference and that features have previously been found to be partly responsible for the DDE (see Goolsby et al., 2009; Zhou, Wan & Fu, 2007), the influence of feature processing, pre-attentive or otherwise, in the MEE needs further clarification. Explanations of the MEE to date have not extensively examined the influence of feature processing on the effect. Whilst some evidence has led to the suggestion that feature processing can play a role in mere exposure effects and can generalise to similar stimuli (Bornstein et al., 1987), other researchers have been less supportive of this view. There has been disagreement as to whether features are processed sufficiently to allow for processing fluency effects to occur. Winkielman and colleagues (Winkielman et al., 2003) have argued that feature processing is insufficient to elicit perceptual fluency but have also stated (Reber, Schwarz & Winkielman, 2004) that fluency effects can transfer from exposed stimuli to stimuli that share ‘properties’ with the fluently processed stimulus. Nordhielm (2003), on the other hand, found robust evidence that certain features of a visual stimulus can trigger liking by being repeatedly presented and suggested that feature processing, pre-attentive or otherwise, could be the key to understanding how the MEE works. Clearly there is some disagreement as to whether feature processing and perceptual fluency are in any way related. If there is any equating the observations of the feature-based DDE with perceptual fluency-based explanations of the MEE, feature processing needs to be examined in the context of exposure effects.

Whether or not the inhibitory processes outlined in theories of the DDE are working in tandem or in opposition to the processing facilitation supposedly induced by repeated exposure remains to be seen. The experiments presented thus far provide a starting point for the examination of these processes to better understand the preferential fate of exposed stimuli due to the engagement of selective attention. A number of questions have been raised by these two experiments. The following two studies aim to determine if subliminal distractors can induce a DDE and, if so, what is responsible for this effect. As discussed, the predominant theories of selective attention are built on the premise that some stimuli are attended to which leads to awareness, whereas others are only processed pre-attentively and are not only ignored but are not able to be recalled. The experiments thus far suggest that this filtering process can have opposing effects on preferences due to exposure. The next series of experiments therefore examine what happens when the distracting stimulus is filtered out pre-attentively and is therefore ignored before being sufficiently processed to allow for awareness of the exposure.

The subliminal mere exposure effect is one example of the effect of stimulus processing before any conscious processing takes place and is therefore, like other subliminal effects, seen as a form of pre-attentive processing (Mandler, 2002). Mere exposure effects are generally stronger when the stimulus is exposed subliminally (Bornstein, 1989), however, to date there is no evidence of a subliminal DDE. The results of experiment 2 suggest that multiple processes are working in opposition, therefore the next series of experiments set out to determine which of these processes is the result of pre-attentive processing of the stimulus. In other words, the aim was to establish what happens when participants are repeatedly exposed to a distracting stimulus subliminally and pre-attentively.

Chapter 4. The subliminal distractor devaluation effect

The overall aim of the next series of experiments was to address a discrepancy between studies on the MEE and the DDE by examining whether it is possible to generate a subliminal DDE. In order to achieve this, participants were repeatedly exposed to a subliminally presented distractor whilst engaged in a difficult visual search task. These experiments were designed to optimise conditions likely to elicit a MEE, such as there being a relatively small number of exposures and a wait period between the exposure and rating phases (Bornstein, 1989). The question these experiments attempt to answer is if subliminal stimuli can produce a stronger MEE, will subliminally exposed ignored stimuli lead to a MEE (that is, an implicit form of distractor devaluation)? Establishing whether it is possible for devaluation to develop for subliminal stimuli exposed during a task is essential to understanding whether the MEE and the DDE are based on the same underlying processes.

Subliminal stimuli were used because they limit conscious processing of the distractors. This is important because, subliminal stimuli have been found to be particularly effective at inducing a MEE (Bornstein, 1989). The affective consequences of subliminal presentation of stimuli are pivotal to the processing fluency hypothesis (see Bornstein & D'Agostino, 1992; Kruglanski & Stroebe, 2005). If Fenske et al. (2004) are correct in their assertion that the results of distractor devaluation studies do not support fluency as an explanation of exposure effects when stimuli are distractors, there will be little evidence of a subliminal MEE in this experiment as this effect appears to be based on processing fluency. There should be evidence of a DDE because the shapes are still being ignored in the task and, if feature processing occurs pre-attentively (c.f. Treisman &

Gelade, 1980), and the DDE is based on feature processing, stimuli will be devalued despite being subliminal. Alternatively, if divergent mechanisms are in fact responsible for the mere exposure and distractor devaluation effects as suggested by experiments 1 and 2, there is a possibility that the two processes will operate independently as they may have done in the research conducted by Kihara and colleagues (2011). What is unclear is whether the distractor under these circumstances is filtered out pre-attentively resulting in less opportunity for inhibitory mechanisms to impact on the subsequent processing of the stimulus. If so, participants would therefore be more likely to rely on their subjective fluency to make preference judgements than to devalue the distractor.

Furthermore, the results of experiments 1 and 2 suggest that selective attention can modulate the MEE but questions remain about the extent of this modulation and whether or not feature processing and perceptual fluency are related in these effects. As previously discussed, there is mixed evidence concerning this relationship. However, there is some agreement within marketing theories that fluent processing of stimulus features leads to an increase in liking (see Fang et al., 2007; Nordhielm, 2002; Omanson, Cline & Nordhielm, 2005). An examination of the selective attention literature shows the importance of low-level feature processing (see Treisman, 2009; Wolfe, 2007). Considering the wealth of evidence suggesting that pre-attentive processing of stimulus features reliably occurs in visual search tasks, it is a logical next step to determine whether subliminal exposure to a distracting stimulus leads to liking through an increase in perceptual fluency or a dislike through attentional inhibition. Both effects appear to be related to low-level processing of stimulus features (for DDE see Goolsby et al., 2009; for MEE see Nordhielm, 2003). The next two experiments are therefore designed to also examine the effect of pre-attentive exposure to distractor features.

Determining whether or not processing fluency is a factor in these studies is made difficult due to there being no way of separating any underlying positive or negative valence form subjective reporting of attitudes. A common solution for examining implicit affect is to equate these processes with reaction time (Oppenheimer, 2008). Affective priming has become a popular technique for assessing unconscious attitudes (De Houwer, Teige-Mocigemba, Spruyt & Moors, 2009; Fazio, Sanbonmatsu, Powell & Kardes, 1986). but has not been employed as a measure of attitudes towards an exposed stimulus in distractor devaluation research.

Generally an affective priming procedure involves priming a word with either positive or negative valence with the stimulus in question. The task for the participant is to react as quickly as possible to the target word by indicating whether the target word is in fact positive or negative in valence. Priming with a liked or positive stimulus can potentially interfere with responses to negative words in comparison to being primed with a novel or neutral stimulus. This is thought to be the result of a form of affective dissonance between the positive valence for the stimulus and the negative valence of the target word (De Houwer et al., 2009). Differences in the pattern of responses between positive and negative words discount the effect of simple negative priming. This is because negative priming caused by pre-exposure to stimuli would interfere equally with responses to both negative and positive words primed with these stimuli, compared to the responses to words primed with novel stimuli (see Frings & Wentura, 2008 for a discussion of differences between these effects). This technique is useful for separating conscious judgements of liking from unconscious hedonic processes (Wittenbrink, 2007).

There is some evidence that mere exposure effects can be detected using affective priming (Lodge & de Zilva, 2011; Ying & Renlai, 2008) and this has implications for the idea that a misinterpretation of fluency is responsible for the effect. If there is an increase or decrease in liking in the absence of any associated change in implicit valence, it is support for the idea that changes in liking are due to a misattribution of fluency or disfluency and not an underlying hedonic state that should be detected by the affective priming. In other words, if the effect of fluency is tied to underlying affect and not a cognitively mediated misattribution, there should be evidence of this in the affective priming responses. Therefore, in order to measure the unconscious effects of the subliminal distractors and shed light generally on the role of unconscious processes in both effects, affective priming is used as a measure of unconscious valence in these experiments.

Experiment 3

The aim of the third experiment is to test the effect of presenting subliminal distractors whilst participants were engaged in a selective attention task. To our knowledge, this was the first attempt to induce a subliminal DDE, although the procedure has been used in studies examining the MEE. In these experiments, participants are exposed to ‘web advertisements’ while their attention is engaged in a comprehension task involving a simulation of the Internet. The exposure reliably leads to positive attitudes towards the brand in the advertisements despite the fact that they are presented whilst the participants are engaged in a task and oblivious to being presented the information (Yoo, 2008). Although Yoo discusses the explicit and implicit processing differences supposedly observed in this research, the experiments were framed in terms of applied marketing and the author does not comment on the mechanisms that could lead to these observations beyond attributing the results to the subliminal MEE.

It appears that both the DDE and the MEE depend on feature processing to some degree (Goolsby et al., 2009; Zhou, et al., 2007; Gordon & Holyoak, 1983; Manza & Bornstein, 1995). Feature processing appears to be an integral part of the exposure/affect relationship and thus stimulus features were also manipulated in this experiment. If feature processing is involved in both the mere exposure and distractor devaluation effects, the effects should generalise to simular stimuli. This experiment was aimed at inducing a subliminal DDE as the next step in exploring whether the two effects indeed share feature processing and processing fluency as common mechanisms.

Methods

Participants

Sixty- eight (47 female) psychology students naïve to the aims of the study were recruited and received course credit for their participation as per the previous experiments. The age of the participants ranged from 17 to 48 years with a mean age of 24.9 years. Participants all had normal or corrected to normal vision.

Apparatus

The experiment was conducted on a Dell desktop computer running a 3.0 GHz Intel Core 2 duo CPU with a 53 cm CRT monitor running at 85 Hz. Both the search task exposure phase and affective priming measure were run using E-Prime version 2.0. All word and shape stimuli were presented in black on a white background.

Exposure phase

During the exposure phase, participants were presented with 20 trials. They were asked to search for the letter ‘Z’ amongst a large search field of approximately 680 letters (N, M, W, X, K, A and Y). All letters were presented in black 18 point font on a white background. This search array was based on the difficult version of a letter search task developed by Neisser (1964). The search arrays were always 17 lines vertically with an average of 40 letters in each horizontal line. Participants were informed that they would only be given 8 seconds to find the Z in the array. Search arrays were presented in a different random order for each participant. At the end of each trial, participants were asked to press the letter N on a standard keyboard if they did not find the Z and the letter Y if they did locate the Z. The task sequence is illustrated in Figure 4.

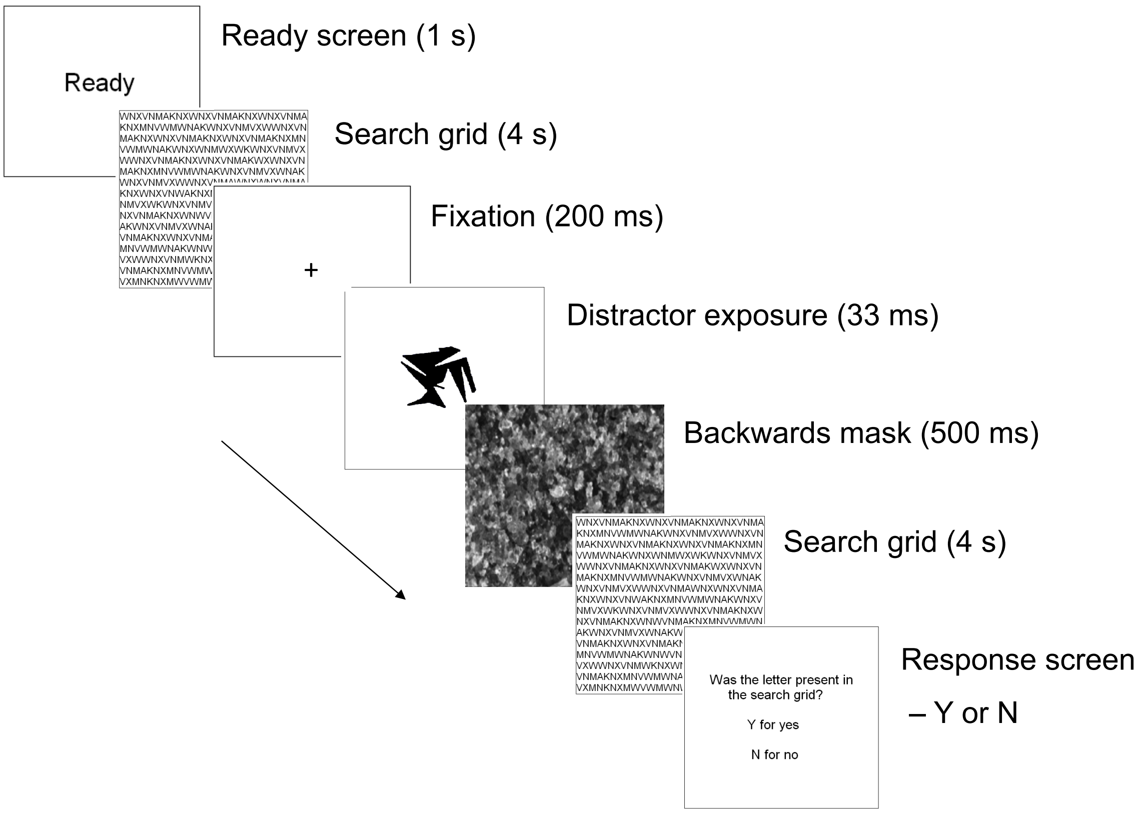


Figure 4. Example trial sequence for experiment 3.

In the middle of each trial, a task-irrelevant distractor shape was exposed for 33 ms followed by a 500 ms mask and then the search array returned for the remainder of the trial. Participants were not informed of this, they were simply told to ignore anything else on the screen. The distractor stimuli were either 24-point random geometric shapes from Vanderplas and Garvin (1959) or rounded shapes created to resemble as closely as possible items from the straight-edged Vanderplas and Garvin set. These shapes were thus similar to the 24-point shapes in complexity and examples are presented in Appendix 1. The rounded and straight edge shapes were counterbalanced so that shapes that were distractors for some participants were presented as novel shapes in the choice phase for others. The exposure of each of the distractor shapes was preceded by a fixation cross (+)

also in 18-point font for 200 ms to direct attention to the centre of the display. This cross appeared exactly 4000 ms into the search task in each trial. The distractor was drawn from a pool of 5 different straight-edged and 5 different rounded shapes. Each distractor was displayed subtending an angle of approximately 6.5˚.

Affective priming phase

Three minutes after the exposure phase, subjects completed the affective priming task. Each trial began with the word 'ready' appearing on the screen for 1000 ms followed a fixation cross for 200 ms. A shape was then presented as an affective prime for 30 ms followed by the mask for 500 ms and then the target word. Subjects were only required to respond to the target word: 'A' for words with positive meaning or 'L' for words with negative meaning. This sequence is illustrated in Figure 5.

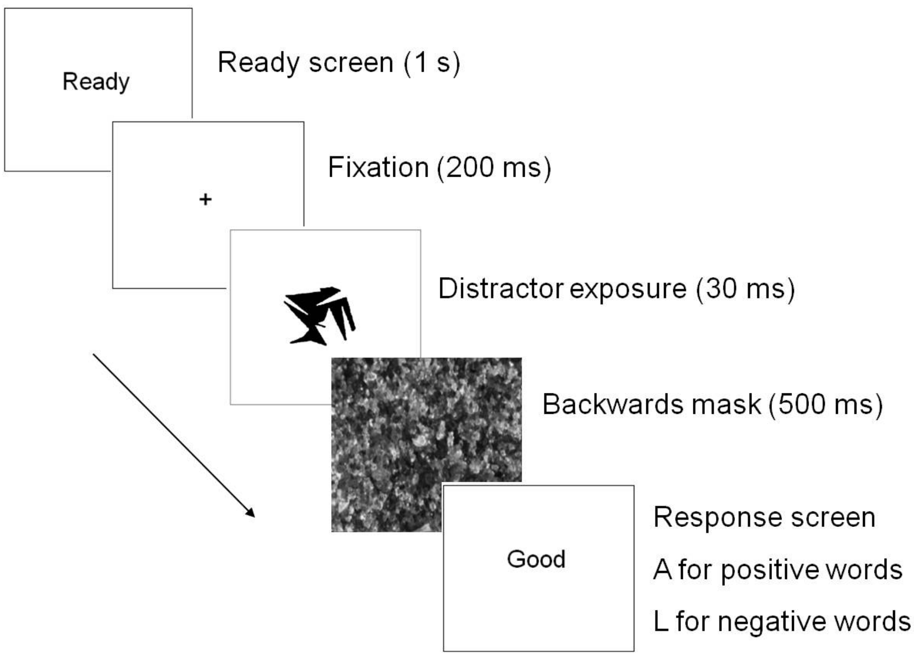


Figure 5. Trial sequence for affective priming task

The shapes were either the masked distractor (from the exposure phase), a shape with similar features (different shape in each trial) or a completely novel shape (also different in each trial). Target words were all simple, commonly used words with positive and negative valence such as ‘good’, ‘bad’, ‘pretty’, ‘ugly’ etc. Each trial was completed when participants made a response; either positive or negative. Primes and words were presented in a random order until each (distractor, similar shapes and novel shapes) had primed negative and positive words seven times each. As the affective priming involves exposure of the targets it could be acting as an additional unattended exposure phase. To minimise this possibility the number of priming trials was kept to a minimum. Piloting led to the adoption of seven trials because this is as many as can be accommodated without potentially influencing response patterns through further presentation of the stimulus. The combination of words used to make up each positive and negative set were matched between the three shape types and between participants; all three shape types had the same number of pairings with each of the positive and negative words used. The target words were presented in 18-point font.

Bornstein’s (1989) meta-analysis of mere exposure studies indicated that excessive of exposures (10-20 is ideal) can lead to boredom with a stimulus and hence the effect dissipates, therefore, seven trials for each was determined to be sufficient to get reliable response times without exposing participants excessively to the stimuli and hence attenuating any exposure effect. Participants completed 10 practice trials including fixation crosses, pattern masks and target words before being exposed to the subliminal primes. Piloting of the affective priming procedure was conducted and indicated that it does not have any immediate or persistent effect on preference responses.

Choice phase

Following the affective priming phase, subjects were asked to wait a further five minutes before completing recognition, familiarity and preference measures. These measures were generally like those used in experiments 1 and 2. Recognition, familiarity and preference were assessed with a series of four alternate forced choice (4AFC) tests for recognition, most and least familiar and most and least liked. The four alternatives included the subliminal distractor, a shape with similar features (straight or rounded edges) and two novel shapes. In the familiarity questions, shapes with different features to the distractor (straight or round edges) and completely novel shapes differing in complexity and overall shape were used to elucidate the level of feature processing involved in familiarity judgements.

In questions about preference, distractors, shapes with similar features and shapes with different features were used. Subjects were asked to identify the distractor shape and to indicate which of the four options was both most and least familiar and most and least liked. Alternate options with similar features or different features were randomly assigned to each of the five straight-edged and five rounded distractors used in the exposure phase creating 10 variations of the forced choice task presented to participants on an A4 sheet with instructions to circle the appropriate choices similar to the example included in Appendix 2.

Results

Overall, participants performed very poorly on the search task. Very few of the participants located more than one or two Zs out of the 20 search trials, confirming that the task was difficult enough to keep them engaged for the duration of each trial. Participants were also no better than chance at recognising the subliminal distractor shapes, χ^2 (1, N = 68) = 1.255, p = .263, indicating that any processing of the distractor was not conscious. Participants generally reported seeing the screen flickering and the mask but could not report what else they had seen. Participants were also asked verbally if they could guess the hypothesis, none did and therefore no data were eliminated on this basis.

For the affective priming data, one-way repeated measures ANOVAs were conducted on reaction times to positive and negative words separately as the target words were not matched for word frequency and thus could not be directly compared. This also circumvents the problem of comparing positive and negative attitudes, which the results of experiment 2 and those of Diener & Emmons (1995) and Diener (2009) suggest do not necessarily mirror each other. All responses greater than 2.5 *SD* from the mean reaction time for each condition were trimmed to eliminate outliers (as recommended by Ratcliff, 1993) and incorrect responses were not included in the analysis. Errors made up 3.3% of responses in the task overall, however there were no significant differences in the error rate between any of the conditions. The output tables are available in Appendix 3c.

Reaction times to both positive and negative words were analysed separately via a one –way ANOVA. Responses to positive words did not significantly differ between the three shape types, $F_{(2,66)} = 0.569$, $MSE = 3967.01$, $p = .567$, $\eta^2 = .008$. Reaction times to negative words primed with each of the three shape types did significantly differ $F_{(2,66)} = 5.651$, $MSE = 5157.31$, $p = .004$, $\eta^2 = .078$. As a follow up, responses to the distractor and shapes similar to the distractor were also analysed by comparing each of these items to the novel (baseline) shapes. Reaction times for responses to negative words primed with the distractor were slower than for novel shapes (baseline) $F_{(1,67)} = 4.519$, $MSE = 6322.9$, $p = .037$, $\eta^2 = .063$ indicating a positive emotional response to the subliminal distractor. All other contrasts revealed non-significant differences between reaction latencies for positive or negative words primed with different shape types. This pattern of results is presented in Figure 6.

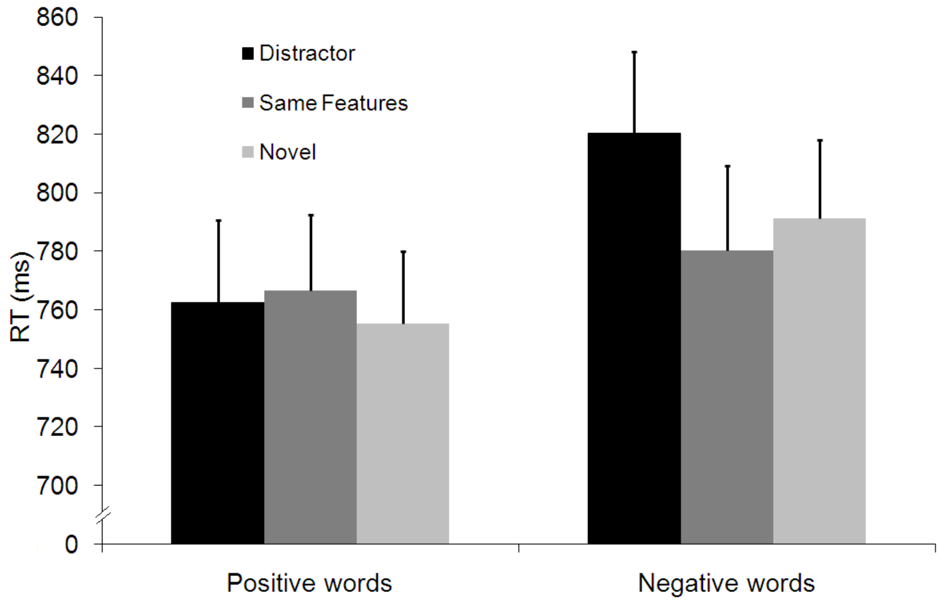


Figure 6. Mean reaction times (SEM) for responses to positive and negative words primed with distractors, similar shapes and novel shapes.

Responses to the 4AFC items for familiarity and preference were collapsed into three options for analysis. For familiarity choices, comparisons were conducted between shapes with the same features as the distractor, shapes with different features but with same complexity of which there were two and completely novel shapes. For preference choices, the two novel options were also amalgamated to provide comparisons between the distractor, shapes with similar features to the distractor and completely novel shapes. Thus the chance level of performance for shapes with different features for the familiarity choices is 50% and 50% for novel shapes in the preference choices. Expected frequencies for the chi-squared analysis were adjusted accordingly and the output tables are available in Appendix 3c.

The proportion of participants responding to the various options for familiarity is reported in Table 5. There are no differences between familiarity ratings for shapes: participants were equally split between same, different and novel when reporting most familiar χ^2 (2, N= 68)= 1.059, p = .589 and least familiar χ^2 (2, N= 68)= 0.206, p = .902.

Table 5.
Proportion of participants responding to each shape type in familiarity choices

	Same features	Different features	Novel
Most familiar*	29.4%	44.1%	26.5%
Least familiar*	30.9%	35.3%	33.8%

*Familiarity ratings assessed in terms of features – ‘different features’ are similar in complexity but novel, novel shapes share no common features with distractors.

If the subliminal DDE exists, participants should have selected distractors and shapes with the same features as distractors as least preferred relative to novel shapes. Although there was a tendency for participants to select the distractor as most liked (33.8%) more than the expected 25%, the differences across the row were not significantly different from expected values, χ^2 (2, N= 68)= 5.158, p = .076. There was, however, a strong tendency to dislike shapes similar to the distractor (54%) above and beyond what was expected, χ^2 (2, N= 68)= 46.660, p < .001, consistent with a feature-based subliminal distractor devaluation effect.

Table 6.
Proportion of participants responding to each shape type in preference choices

	Distractor	Same features	Novel
Most prefer	33.8%	17.7%	48.5%
Least prefer	19.1%	54.4%	26.5%

Discussion

The forced choice data from this experiment indicate that participants developed a dislike for the global features of the distractors presented whilst engaged in a task. This devaluing of the distractor features in this case also appears to be limited to stimulus features because the distractor shape itself was not chosen as the least preferred and there was a tendency towards participants choosing it as most preferred more often than expected. This is all despite the features not being related to any subjective experience of familiarity. Overall, this suggests that a DDE can occur with stimuli presented subliminally and it is feature-based while exposure to a distinctive stimulus leads to that stimulus alone becoming preferred.

Interference occurred in the affective priming task when participants were exposed to a distractor stimulus and asked to respond to a negative word. This is consistent with an implicit positive attitude towards the distractor. That is, the distractor acts as a positive emotional prime, which inhibits a response to a word with a negative emotional quality (Fazio, et al., 1986). There was, however, no facilitation of response times to positive words primed with the distractor compared to novel shapes. This might simply be due to a floor effect common in affective priming studies (see Hermens, De Houwer & Eelen, 2001) when response times are relatively rapid and thus it becomes impossible to speed responses further. As processing fluency is most commonly thought to be the mechanism behind liking in mere exposure studies (Greenwald & Banaji, 1995), it is possible that the unconscious positive attitude towards the distractor in this case is due to increased ease of processing through repeated exposure. This also supports the findings of Ying and Renlai (2008), who found similar results using an affective priming procedure. There is some evidence to suggest that repeated exposure increases processing fluency and that, rather than relying on misattribution, this fluency leads to positive affect (Winkielman & Huber, 2009). It is this induced positive affect that could be causing the interference with responses to negative words reported here.

An alternate explanation for these results could be that the interference with responses to words primed with the distractor is the result of negative priming (Tipper, 1985). Typically, negative priming occurs when the prime is a previously ignored distractor, which interferes with responses to the target (for review see Fox, 1995). However, if this were merely a case of negative priming, there would be a similar pattern of responses to both positive words and negative words as the distractor would cause similar interference regardless of word valence. This was not the case in this experiment as interference was only found for the negative words, which rules out the possibility that negative priming was responsible for these results.

Interestingly, shapes with similar features did not produce similar interference in reaction times to negative words despite the negative responses in the forced choice measure generalising to similar stimuli. A number of factors could contribute to this result. Features (in this case, rounded or straight edges) may not be the only information being processed pre-attentively. There is a possibility that some other perceptual characteristic of the distractor is influencing responses or that the distractor serves as some sort of prototype for similar shapes. In this vein, Gordon and Hollyoak (1983) observed a systematic generalisation of increased liking for distorted versions of exposed stimuli over novel stimuli that decreased as the level of distortion increased. The combined perceptual characteristics of the stimulus may therefore cause the greatest interference with negative responses. In contrast, shapes with similar features are not being generalised but rather discriminated pre-attentively as sufficiently different to the distractor to cause interference in the priming task.

Winkielman, Halberstadt, Fazendeiro and Catty (2006) found a similar increase in preferences for prototypical dot patterns and geometric shapes compared to similar, distorted patterns and shapes and found a greater preference for the prototypes apparently based on increased perceptual fluency. This is supported by the results of a study by Labroo, Dhar and Schwarz (2008), who examined priming and perceptual fluency for brands including distinct perceptual features. They concluded that the type of perceptual fluency that leads to the MEE only results in more positive attitudes towards the exact stimulus. The failure to find the same results with stimuli similar to the distractors also has parallels in a number of mere exposure studies. For instance, Newell and Bright (2003) failed to induce a mere exposure effect in stimuli that were structurally similar to a subliminally exposed stimulus. In sum, this research suggests that there is something specific about the distractor that leads to it being processed in a different way to stimuli that share the global features of the distractor, which requires further explanation.

The other possibility is that these data could reflect an attenuation of the positive effects of processing fluency via the inhibitory processes Raymond and colleagues (Raymond et al., 2003; Raymond, 2009) argue are responsible for the DDE working in parallel. The failure to find a similar interference with responses to negative words in the affective priming task could be due to the influence of attentional inhibition based on features of the distractor. Thus the distractor itself is not being processed like a typical supraliminal distractor but becomes more fluent to process, which generates a positive reaction to the stimulus and it interferes with responses to negative words. The stimulus features are filtered out pre-attentively and trigger inhibition, which counteracts any positive affect induced by the fluent processing of the stimuli or the features thereof and leads to a dislike for stimuli that share common features. Why distractors themselves should become implicitly positive whilst shapes with similar features do not could be a combination of inhibitory and fluency processes and requires further investigation.

The results from the affective priming task suggest that the exposed stimulus only is fluently processed whereas devaluations of similar stimuli are more likely the result of inhibition associated with stimulus features. These results imply that the combination of perceptual characteristics is integrated when the stimulus is processed more fluently, but features alone are the basis for subjective judgements. This is reflected in the conscious measures of attitudes towards the distractors. Distractor shapes and other shapes with the same features were most often rated as least preferred and this is evidence for a feature-based subliminal DDE. A number of studies suggest that the MEE may rely on an implicit familiarity that can occur at the very earliest stages of perceptual processing (e.g. Hansen & Wänke, 2009). These studies may provide an explanation for the current results. The distractor was chosen nearly twice as often as similar shapes when participants were asked which shape they most preferred. This result supports the argument made by Winkielman et al. (2006) that the distractor itself is processed more fluently than similar shapes and becomes preferred. In a similar vein, repetition priming studies have found that target identification is facilitated whilst distractor identification is inhibited. This appears to occur through automatic feature processing based on repeated presentation of stimuli with similar features (Maljkovic & Nakayama, 1994), confirming the possibility of parallel inhibitory and facilitatory pre-attentive processing of stimulus features. In the present experiment, the distractor devaluation presumably caused by the inhibitory processing of the distractor generalised to similar shapes whilst the supposed fluency-based increase in underlying positive affect associated with the distractor did not.

It would be premature to conclude on this basis that parallel independent mechanisms are at work in these two effects as far as pre-attentive processing of a stimulus goes. The mismatch between the apparent positive implicit influence of the distracting exposure to the stimulus in this experiment and the self-reported responses in the 4AFC measure do however require further investigation as they suggest that perceptual fluency and feature-based inhibitory processes are both at work in the exposure/affect relationship when selective attention is involved. The preferences indicated in the forced-choice responses show a devaluation of distractor stimuli and any other stimulus sharing the same features when participants were asked which they liked least. This is at odds with the implicit processing evident in the results of the affective priming task.

The mismatched results in this experiment can be explained through parallel processes of processing fluency and attentional inhibition. One way to test whether it is the individual stimulus and not features of the stimulus contributing to the affective priming results in experiment 3 is to alter the way the stimulus is presented in the affective priming task without altering the stimulus features. Fahle and Morgan (1996) argue that low-level perceptual learning is very specific to the stimulus and that the process can be interfered with through simple manipulation of the stimulus such as altering its orientation. This provides an avenue for manipulating the stimulus to separate processes related to the specific distractor from those related to the global features of the distractor. In order to further examine exactly what is processed pre-attentively in this scenario, experiment 4 examined the role of features in an attempt to verify if the feature-based inhibitory mechanisms thought to underlie the DDE are influencing unconscious processing as measured by the affective priming task or whether the results of the affective priming in experiment 3 are specific to the distractor only.

Experiment 4

It is important to examine whether or not feature-based inhibition is a distinct process contributing to distractor devaluation within the broader context of the effects of selective attention. One of the dominant theories of the mechanisms underlying visual selective attention, the feature integration theory (Treisman & Gelade, 1980), suggests that features are processed pre-attentively, especially when the stimulus is presented for periods too brief to allow recognition. This might provide a clue as to the distinction between the processes underlying the MEE and the DDE. Yagi et al. (2009) suggest that the positive affect observed in mere exposure studies is not based on any pre-attentive processing of a stimulus despite extensive replication of the subliminal MEE. This, in addition to the perceptual fluency based prototype preference account suggested by Winkielman et al. (2006), implies that distractor devaluation could be a pre-attentive feature-based process whereas the MEE occurs after attentional selection, is highly specific and is based on fluent processing of the stimulus itself. This suggestion differs from the argument made by a number of researchers (e.g. Hupbach, Melzer, & Hardt, 2006; Nordhielm, 2002, 2003; Vanhuele, 1994), who claim that feature-based processing is an important part of the MEE. An examination of how feature processing and perceptual fluency contribute to these effects and how this is related to the processes of selective attention will add support to the possibility that different processes are responsible for the different effects.

As a first step in examining if features of a distractor influence the subliminal DDE observed in experiment 3, a distractor was again presented as it was in the previous experiment. To determine if features are the factor contributing to the effect observed in experiment 3, orientation of the distractor was varied in the affective priming task. Thus, the rotated stimulus had exactly the same global features (i.e. colour, size, spatial frequency, complexity and sharp or round edges) but falls on the retina in a different way. The aim of this test is to determine if there is any validity to the idea that the exact stimulus as it is presented is responsible for differences in the affective priming task. If the response latency for words primed with the distractor differs from those of the distractor rotated to various degrees, it is an indication that the distractor itself as it falls on the retina is becoming more fluent to process and not features thereof. This would corroborate the findings of experiment 3 and support the suggestion made by Winkielman et al. (2006) that fluency is based on the specific perceptual image and not on stimulus features. As the DDE appears to be based on stimulus features, it should not be influenced by distractor orientation, as both complexity and shape type (rounded or straight-edged) remain constant. Alternatively, if the interference with negative responses found in the affective priming phase of experiment 3 is maintained, there will be no observable differences in response latency in the affective priming task, however subjective response biases should remain intact.

In terms of measuring response biases, forced-choice measures provide a good approximation of decision making processes, but are not as susceptible to the small variations in preferences induced by exposure as are rating scales (Bornstein & Craver-Lemley, 2004). Furthermore, Krosnick, Judd and Wittenbrink (2005) argue that a construct has greater validity when assessed using multiple measures. As the exposure phase was identical to that in experiment 3, a rating scale was introduced in this experiment to provide robust support for the distractor devaluation found in experiment 3. If pre-attentive inhibition of stimulus features is responsible for the DDE but plays no role in preferences based on perceptual fluency, there will be no difference in response latencies in the affective priming task but conscious preferences will be the same as those in experiment 3 and confirmed using the rating scale measure.

Methods

Participants

The sample for this experiment consisted of 33 students (25 female) from The University of Queensland who were offered 10 dollars each for participating. Recruitment was via an online electronic research participation tool secured and managed by the School of Psychology at The University of Queensland. Participants were briefed on the research and gave informed consent to participate as per the previous experiments. The sample ranged in age from 18 to 36 years, with a mean age of 22.8 years. Participants all had normal or corrected to normal vision.

Apparatus

Materials used in this experiment were the same as those used in experiment 3 with the exception that the paper-based 4AFC task was replaced with a computerised rating scale assessing attitudes towards the three shape types: the distractor, a randomly selected shape with the same features as the distractor (from a pool of 10) and a randomly selected novel shape (from a pool of 10). The shapes used in these ratings were displayed in the same dimensions as per experiment 3 for the both the exposure and affective priming phases.

Affective priming task

Participants undertook the affective priming task three minutes after the exposure phase. The affective priming task was the same as that in experiment 3 with the following modification: positive and negative words were subliminally primed with the distractor shape rotated 0, 45, 90 and 180 degrees clockwise. As with experiment 3, each of the four orientations was presented prior to both negative and positive words seven times in a random order. In order to attempt to increase the sensitivity of the affective priming, participants were also given 60 practice trials in this experiment. De Houwer and Eelen (1998) suggest that this additional familiarisation with the task is beneficial within this paradigm.

Preference ratings

Participants were asked to rate the pleasantness and unpleasantness of a distractor shape, a shape with the same features as the distractor and a novel shape. The ratings were recorded via computer three minutes after completing the affective priming task. Participants rated each shape (distractor, same features, novel) for both pleasantness and unpleasantness making up six rating trials in total, one for each rating type, presented in a random order. Each shape to be rated was displayed for 1000 ms followed by a screen with the words 'Rate now' and a 0-9 scale with anchor points: 0 (neutral), 5 (moderately pleasant or moderately unpleasant) and 9 (very pleasant or very unpleasant). Each rating trial was completed when the participant entered a number 0-9.

Results

Again, participants were asked if they could guess what the hypothesis of the experiment was. One participant correctly guessed the hypothesis and their data were eliminated on the grounds that it may have biased their responses. The data from two participants were removed due to software malfunctions.

One-way repeated measures ANOVAs were again conducted on reaction times to positive and negative words separately. Output tables are included in Appendix 3d. Responses greater than 2.5*SD* faster or slower than the mean reaction time for each condition were trimmed to that level and incorrect responses were again not included in the analysis. Overall 1.6% of responses were errors. The mean reaction times for responses to positive and negative words are displayed in figure 7.

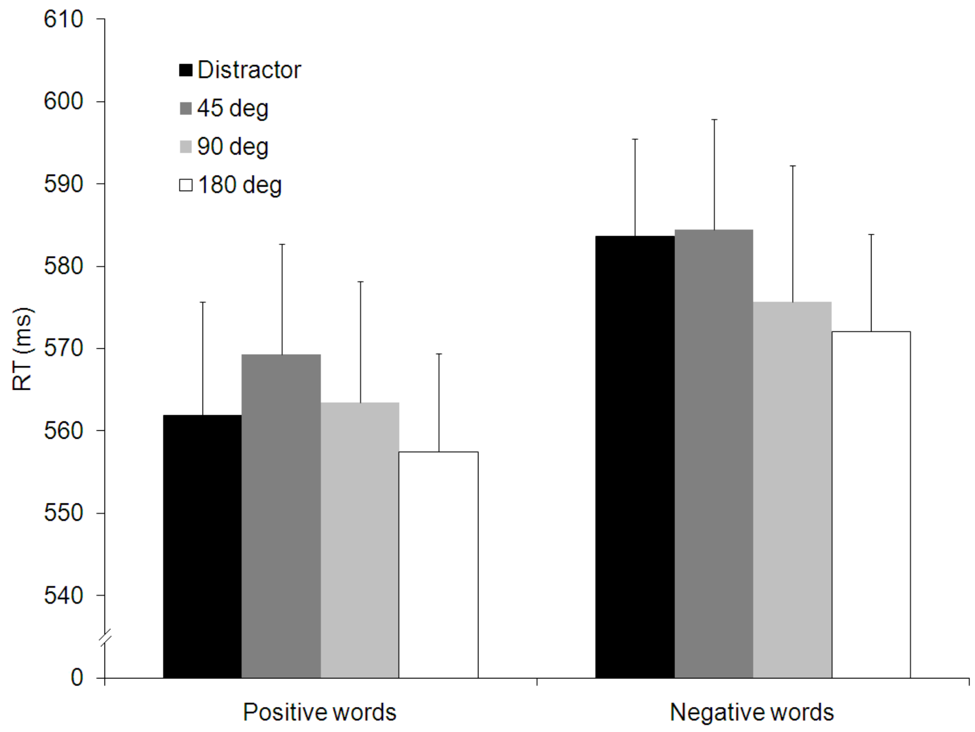
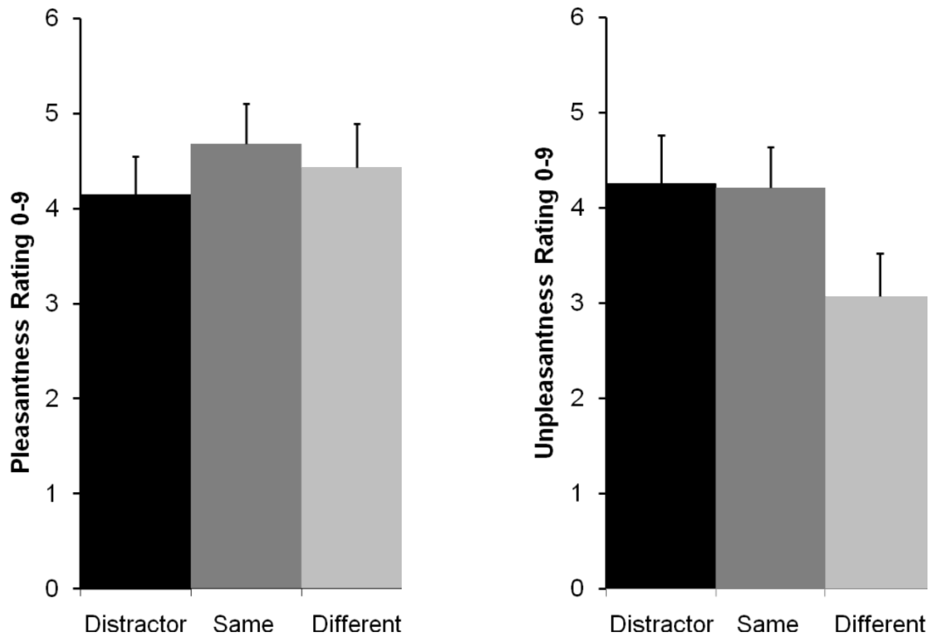


Figure 7. Mean (SEM) response time to positive and negative words primed with the distractor and the distractor rotated to 45, 90 and 180 degrees

There were again no significant differences in the error rate between conditions. One-way ANOVAs suggest that there was no overall difference between reaction times to shape types for either positive, $F_{(3,27)} = 0.496$, $MSE = 1790.89$, $p = .69$, $\eta^2 = .05$, or negative words, $F_{(3,27)} = 1.49$, $MSE = 1610.26$, $p = .24$, $\eta^2 = .14$. Contrasting response times to positive words primed with distractors rotated to 0, 45, 90 and 180 degrees revealed no significant difference $F_{(1,29)} = 0.021$, $MSE = 1658.4$, $p = .86$, $\eta^2 = .9$. Similarly, contrasting response latencies to negative words primed with the distractor with those primed with the rotated distractor also revealed no significant difference, $F_{(1, 29)} = 0.848$, $MSE = 1267.60$, $p = .365$, $\eta^2 = .9$. Thus, there was no evidence that the distractor stimulus as it was perceived had any distinct effect on priming from the rotated stimulus.

Ratings of pleasantness and unpleasantness were also analysed using separate one-way ANOVAs. Responses to the novel shape were contrasted with responses to distractors and distractor-like shapes based on the pattern of responses to these shapes in experiment

3. The distractor (*M* = 4.3) and the shape with the same features as the distractor (*M* = 4.2) were rated as significantly more unpleasant than the baseline novel shapes (*M* = 3.1), $F_{(1,29)} = 5.709$, $MSE = 6.867$, $p = .024$, $\eta^2 = .164$. There was no such difference in ratings of pleasantness for distractors and similar shapes compared to baseline novel shapes, $F_{(1,29)} = 0.303$, $MSE = 4.124$, $p = .587$, $\eta^2 = .01$. These results are presented in figure 8.



(a) (b)

Figure 8. Mean (+SEM) pleasantness (a) and unpleasantness (b) ratings of distractors versus shapes with the same features and shapes with different features (novel shapes)

Discussion

The results of experiment 4 suggest that the individual stimulus as it is presented and as it falls on the retina when subliminally exposed during a selective attention task influences affective priming in a way that is no different to when the stimulus is presented in a different orientation. The aim of this experiment was to determine whether or not it is the unique perceptual characteristics of the stimulus that lead to later fluent processing. The features of the shapes presented in the affective priming phase were identical to the distractor in complexity and shape type (rounded or straight-edged), only orientation differed. This variation did not influence performance on the affective priming task, however, it should be noted that, similar to experiment 3, it is possible that the failure to find an effect in reaction times could be nothing more than a floor effect. When considered with the results of experiment 3, it suggests that either the results of experiment 3 are simply not replicable using a rating scale or that something other than the processing of the specific stimulus contributed to the fluent processing that lead to interference with responses to negative words in experiment 3. It is also difficult to determine whether the results of this experiment replicate those of experiment 3 due to the the non-rotated stimulus being the comparison condition rather than a completely novel stimulus. This leaves open the possibility that global stimulus features can influence both fluency-based liking responses and attention inhibition-based devaluation of exposed stimuli.

The significant difference between unpleasantness responses to the distractor and shapes similar to the distractor and novel shapes supports the results of the forced-choice responses in experiment 3. The negative responses to the distractor and the distractor-like shape in this experiment were more consistent than those in experiment 3. Overall there was a devaluation of the distractor, and shapes similar to the distractor, compared to the baseline of the novel shape using forced-choice and rating scales. The results obtained using these measures, however, are not supported by the affective priming results of experiment 3. Given that a devaluation of shapes that resemble the distractor was evident in this experiment using a rating scale just as they were in experiment 3 using a forced-choice measure, the results of this experiment partially support a subliminal DDE that is based on pre-attentive feature processing.

General Discussion – Experiments 3 and 4

Overall, the results of experiments 3 and 4 support a feature-based subliminal DDE or, at least suggest that distracting stimulus features are devalued. This is the first evidence in the current series of experiments of a DDE. One must be cautious in interpreting the absence of a DEE in these studies as the presentation of the distractors in these experiments differs markedly from the way in which they are typically presented in in DDE. The results do however, indicate that the mere exposure and distractor devaluation effects could be based on different underlying mechanisms that work in tandem to influence whether exposure to a stimulus under attentional load leads to liking or disliking. Experiment 3 demonstrates a subliminal DDE as measured by conscious selection of the least liked stimuli, however, this devaluation of distractors was not reflected in the implicit measure, which seems to indicate a positive implicit attitude towards the stimulus and suggests the influence of multiple systems. The affective priming results in these experiments are inconclusive but provide some support for research by Ying and Renlai (2008) who found evidence of a MEE using affective priming.

At the same time that positive affect appears to become attached unconsciously to the stimulus, participants are subjectively reporting a greater dislike for the stimulus and others similar to it. This is evident in responses to the least liked shape in experiment 3 and the ratings of unpleasantness in experiment 4. This devaluation is not reflected in the ratings of the most liked shape. This might represent negative affect induced by inhibitory processes, as suggested by Raymond and colleagues (Raymond et al., 2003). Alternatively, it could be explained by Mandler's (1982, 1984) argument that disliking judgements are not simple opposites of liking judgements but are more complex and therefore do not exist on a one-dimensional continuum, with liking at one end and disliking at the other. This view is also consistent with Diener's (Diener & Emmons, 1995; Diener, 2009) argument that the positive and negative affective systems are independent. Whether or not the DDE and the MEE are based on different mechanisms, the results of experiments 3 and 4 support the argument for independence of processes and reinforce the importance of examining each separately. Participants did not generally like distractors any more or less than novel shapes but they did dislike them more than novel shapes, a trend evident in both experiments using multiple measures.

Despite it being apparent that the distracting stimulus was devalued in both experiments, fluency may still result from exposure, as apparent from the results of the affective priming task. This fluency appears not to have been sufficient to prevent devaluation of the distracting stimulus features. The results of experiment 3 were generally supported by the results of experiment 4 in this respect. This then leads to the possibility that processing fluency, by whatever mechanism, is leading to positive affective responses and, independently, an inhibitory process is giving rise to negative attitudes towards distractors. It is possible that both the positive affect associated with increased processing fluency and the negative affect induced by distraction-related inhibition could work in parallel, a possibility also raised by Kihara et al. (2011). Further research is needed to confirm if this is the case. Future studies would benefit from using conditions known to modify processing fluency and feature-based inhibitory mechanisms in selective attention tasks, to differentiate these processes and determine the independent effect of each on liking.

It remains to be seen how these results and interpretations contribute to a complete picture of the exposure/affect relationship and what it means for the explanations of the MEE. The findings of Fenske et al. (2004) are inconsistent with the perceptual fluency approaches to the MEE, however, there is a wealth of research supporting the positive hedonic effects of processing fluency (Alter & Oppenheimer, 2009; Reber, Schwarz & Winkielman, 2004; Winkielman et al., 2003). It is therefore difficult to see how increased fluency is not somehow influencing responses in distractor devaluation studies. It appears as though, under some circumstances, they might cancel each other out by both influencing attitudes towards the exposed stimulus simultaneously. Moreover, Griffiths and Mitchell (2008) suggest that distractor devaluation is due to a type of processing dis-fluency. In their experiment, Griffiths and Mitchell presented stimuli within a negative priming paradigm to reduce the ease of processing. In order to achieve this, a stimulus, which was ignored in one trial, had to be attended to in the next. Consistent with distractor devaluation studies, the ignored stimuli were rated as less pleasant than novel stimuli. Based on their results, Griffith and Mitchell proposed that a decrease in perceptual fluency linked to negative priming led to a dislike developing for the exposed stimulus. This leads to the implication that perceptual fluency does play a role in distractor devaluation although the interaction between perceptual fluency and the inhibitory processes outlined by Fenske and Raymond (2006) is yet to be explained. The results presented here suggest that both processes are contributing to exposure-induced preferences although there are several potential problems with the experimental design including the inability to be certain that participants were actively engaged in the task. There are a number of inconsistent findings in the current experiments. However regardless of potential limitations and use of different measures across the two experiments, the ambiguous results of experiments 3 and 4 suggest that multiple forces operate in the exposure/affect relationship. These forces also appear to exert their influence over preferences at the earliest stages of stimulus processing. What remains to be determined is how much each contributes to preference in various situations where selective attention is involved.

The results from experiments 3 and 4 also indicate that features are being used to make judgements in distractor devaluation, although the affective priming results in these two experiments provide inconclusive evidence for pre-attentive processing of features. Despite this, experiment 4 does provide some evidence that features, as opposed to other perceptual characteristics, are contributing to the DDE, even when filtered out pre-attentively. Features such as colour have been previously found to contribute to the DDE (Goolsby et al., 2009), however, evidence that features are involved in the MEE is not as universal. A number of studies (e.g. Monahan, Murphy & Zajonc, 2000) have found evidence that structure or other features, such as elements of Chinese ideographs versus polygons, contribute to the MEE, possibly through enhanced processing fluency based on features. At the same time, others have found no support for the idea that the MEE is related to features of the exposed stimulus (e.g. Newell & Bright, 2003).

While the role of features in the MEE is unclear, there is some evidence of the modulating effect of selective attention on the MEE (see also Prescott et al, 2008; Yagi et al. 2009). Feature integration theory (Treisman & Gelade, 1980) is a widely accepted theory of the mechanisms underlying selective attention (Müller & Krummenacher, 2006; Quinlan, 2003). Feature integration theory also accounts for pre-attentive feature (and to some extent orientation) processing of visual stimuli and is consistent with feature-based theories of the DDE, particularly as parallels have been found between feature processing and negative priming (DeSchepper & Treisman, 1996) and between negative priming and distractor devaluation (Griffiths & Mitchell, 2008). Considering these parallels and given that the results of the current experiments thus far suggest that feature processing appears to have a different influence on the MEE than it does on the DDE, this conceptual frame of selective attention provides avenues for continued investigation.

A direct test of the involvement of selective attention, as described by feature integration theory, would be to exchange the typical exposure phase of a mere exposure study for a feature-based selective attention task that varies selective attention load. Taken together, the results of the four experiments presented thus far suggest that variations in attentional load and stage in processing lead to different preference outcomes. Although Yagi et al. (2009) and Prescott et al. (2008) have manipulated attention within a mere exposure paradigm, these studies did not manipulate attentional load in a manner analogous with research on selective attention and feature integration and this provides a possible way forward for further examining the underlying mechanisms of the two effects in question. This is particularly so if increased perceptual fluency via repetition is also controlled within this context.

The next series of experiments examine the interplay between perceptual fluency and feature-based inhibition to determine under what circumstances liking or disliking for exposed stimuli develops in selective attention tasks. Multiple processes appear to be at work. It is therefore essential to examine the two effects within a paradigm that allows observation of both, but also allows for manipulation of the engagement of attention whilst catering for variations in attentional load based on feature processing. One such option is to use a similar approach to that taken by Kihara and colleagues (2011) and present the stimuli in rapid serial visual presentation streams. The following experiments used this approach to further examine the mechanisms responsible for the distractor devaluation and mere exposure effects.

Chapter 5. The role of parallel processes in mere exposure and distractor devaluation

Based on the findings of the previous four experiments, the aim of the next series of experiments is to continue the examination of the role of perceptual fluency and feature processing in the mere exposure and distractor devaluation effects in association with other factors. The affective consequences of repeated exposure to distractors remain uncertain. In previous studies, Veling and colleagues (2007) found devaluation of repeatedly exposed distractors, whilst Yagi and colleagues (2009) did not. As opposed to these studies, the experiments presented here aimed to assess perceptual fluency and feature-based inhibition in a task where other factors such as attentional load can be manipulated. The experiments presented so far suggest that separate mechanisms underlie the DDE and the MEE and that feature processing and perceptual fluency could be involved. However, without observing both effects under similar conditions and manipulating those conditions to determine where the boundary is between these processes, this possibility remains untested. The next series of experiments therefore intends to shed light on how these processes contribute to liking for repeatedly exposed distractor stimuli by attempting to separate the parallel processes that appear to have led to the results of the experiments presented thus far.

In order to delve into these processing differences, it was necessary to use a task that could potentially elicit a DDE and a MEE under the same conditions, then alter these conditions to determine which impacts on each effect. A central consideration was that attentional load could be manipulated whilst also ensuring that stimuli were presented centrally to make certain that variations in processing due to presenting the stimuli in different locations was controlled for. It was therefore decided that rather than simply using a left and right of fixation point search task, common in distractor devaluation studies (see Raymond, 2009), rapid serial visual presentation (RSVP) streams would be used to present the stimuli and manipulate attentional load. RSVP streams involve presentation of a number of stimuli in a rapid sequence. Participants are tasked with determining how many times a target appears in the streams. Targets can be defined as a specific object or by a feature or combination of features (for a review see Shapiro, 2001).

RSVP-based tasks were deemed a good alternative in this research for several reasons. Firstly, RSVP tasks have a long history of use in research into selective attention (see Dux & Marois, 2009; Potter & Levy, 1969; Shapiro, 2001). At the same time, distractors presented in RSVP streams are also inhibited and this appears to be related to distractor features (Dux, Coltheart & Harris, 2006). This inhibition leads to what has become known as an attentional blink (Raymond, Shapiro & Arnell, 1992). The attentional blink occurs in RSVP sequences when two targets are separated by less than 500 ms. Participants are generally unaware of being exposed to the second target under these circumstances and this suggests that the demands of processing the first target inhibit the processing of a similar stimulus for a short period of time (Dux & Marois, 2009). Mantonakis, Whittlesea and Yoon (2008) suggest that RSVP streams are a reliable way to increase processing fluency without increasing awareness of the exposure. Furthermore, Raymond (2001) found evidence that the nature of the RSVP task can alter the attentional blink based on differences in object and feature processing. Thus, the attentional blink is in practice a subliminal presentation of a stimulus that seems to be related to inhibition of the stimulus but can simultaneously increase processing fluency.

In addition to the benefits provided by the attentional blink, by presenting stimuli serially in RSVP streams rather than in a search grid, the inhibition found in spatial search tasks is eliminated. A temporal task, like an RSVP task, allows for a better understanding of the perceptual processing of stimuli free from any modulation by variations in spatial location (Ariga & Yokosawa, 2008) since all the stimuli are presented in the same location. Subsequently, according to the attentional inhibition hypothesis (Fenske & Raymond, 2006), these distractors should undergo inhibition due to attentional processing rather than being influenced by spatial processes such as inhibition of return.

In addition to separately catering for object or feature processing free from spatial bias, attentional load can also be manipulated in RSVP tasks via the use of various target and distractor manipulations. For instance, it is possible to alter the task requirements to make it a ‘pop-out’ task where participants search for shapes with a single unique feature in the stream. Participants can be asked to search for a combination of features (as in a conjunction search) or they can be asked to search for a specific stimulus. RSVP streams also have the added advantage of allowing control of the exact duration of each stimulus or each type of stimulus. This is important to determine exactly which process in a selective attention task leads to liking and which leads to devaluation because variations in exposure duration can alter perceptual fluency (Winkielman & Huber, 2009). Being able to control the length of exposure eliminates the possibility of a stimulus or a group of stimuli being exposed for longer or shorter periods of time as in a spatial search task that ends when a stimulus is located. Given that other aspects of the task or the RSVP sequence can be manipulated, this consistency in exposure duration ensures that any increase in processing fluency can be made consistent between conditions that are manipulated in any of these other ways.

In addition to being able to look at processing differences based on features and attentional load, the presentation of all stimuli for a set period in the centre of the visual field, is what is required to determine how each of these factors might contribute to the

MEE and the DDE. This is particularly so considering that Kihara and colleagues (2011) found evidence to suggest that the mechanisms that lead to both effects can be triggered using an RSVP task and that the task given to participants can be altered in a number of ways. Manipulating the requirements of RSVP tasks is therefore a suitable option for continuing the examination of the potentially divergent processes underlying the MEE and the DDE.

Experiment 5

The aim of this experiment was to gain further insight into the ways in which target and distractor stimuli are processed in an attentional task and to what effect the similarities between these stimuli affect responses to them. The main manipulation in this experiment was to alter the nature of the distractors in an RSVP task to determine if any similarity between distractors and targets leads to greater or less liking for the stimulus after repeated exposure to targets and distractors over a number of trials. The inclusion of similar or different distractors should influence the development of preferences for exposed stimuli in one of two ways. If processing fluency is contributing to exposure effects in this case, the inclusion of distractors that share similar features with the target shape should lead to a greater MEE evidenced by participants selecting targets as most familiar and preferred. On the other hand, if inhibitory processes thought to underlie the DDE are at work, there should be a less pronounced MEE when distractors are similar to the target, due to inhibitory mechanisms leading to a devaluation of the target based on similarity to distractors.

This experiment therefore included two conditions: in one condition, participants searched for a specific target shape amongst a stream of shapes that share the same features (straight or rounded edges, consistent with previous experiments) while in the other condition, the target differed from the distractors in this feature. Since it appears that the DDE is feature based (Goolsby et al., 2009), a finding supported by the experiments presented thus far, there should be devaluation of distractors particularly in the condition where targets and distractors do not share common features. There is less evidence to suggest that processing fluency is based on features, however, as mentioned, repetition of stimulus features has been found to reliably lead to a feature-based preference (Nordhielm, 2002, 2003). There is also evidence that mere exposure effects generalise to similar, novel stimuli based on perceptual features of the exposed stimulus (Monahan, Murphy & Zajonc, 2000). This is supported by the results from experiments 1 and 2.

In the event that the processing of shapes with similar features does contribute to the MEE, processing fluency should be greatest when targets and distractors in the RSVP stream share common features – the congruent condition. As per experiment 1, the inclusion of stimuli that are not consciously recalled, in this case due to an attentional blink, will lead to the fluency being greater than expected, hence fulfilling Whittlsea and Williams' (1998) requirements that the fluency is unexpected and therefore misattributed as liking. By maximising the effect of perceptual fluency through presenting multiple distractors in the RSVP stream, including stimuli that are effectively exposed subliminally, there should be an increased MEE when targets and distractors share common features. In this circumstance, there should also be reduced distractor devaluation due to targets and distractors sharing common features and the results will therefore reflect those of Kihara et al. (2011).

In terms of the overall research program presented here, this experiment was an attempt to build on the findings of experiment 1 and establish that the processes responsible for the observations in experiments thus far can be demonstrated in an RSVP task. The methods used in experiment 5 are similar to those in experiment 1. An important variation in this experiment is that the defining features of targets and distractors in this case are being assessed directly, unlike experiment 1 where the assessed features were not task-relevant. Similarly, this experiment is not an attempt to replicate the findings of Kihara and colleagues (2011), as their aim was not to elucidate the mechanisms of the DDE and the MEE, but to use distractor devaluation to help explain the attentional blink. This experiment aims to consolidate and build on previous research by attempting to explain the processes that lead to each effect under these circumstances.

Like experiments 3 and 4, an affective priming task was used as an implicit measure of liking. It is expected that a MEE will be induced through repeated exposure to a target stimulus during the RSVP task and thus interference with responses to negative words in an affective priming task. Target stimuli in RSVP tasks have reliably induced a MEE in numerous experiments (e.g. Newell & Shanks, 2007; Whittlesea & Price, 2001) and in experiment 1 using a similar procedure. It was expected that the presentation of targets in this case would lead to the same outcome. What is of particular interest in this experiment is whether exposure to targets and distractors sharing common features, will lead to a relative difference in RTs for the previously exposed shapes compared to novel shapes given the additional exposure to shapes with the same features.

Methods

Participants

Sixty psychology students (47 females) naïve to the aims and hypotheses of the experiments volunteered to take part in this study and were granted course credit for participating. The sample ranged in age from 17 to 48 years old with a mean age of 24.6 years. All participants had normal or corrected to normal vision.

Materials

This experiment was conducted using the same equipment as previous experiments. Both the RSVP exposure phase and the affective priming measure were run using E-Prime version 2.0. Shapes from Vanderplas and Garvin (1959) were used as stimuli (24-point) as were rounded shapes created to resemble the Vanderplas and Gavin 24-point shapes to ensure all shapes had low association value. Examples of these shapes are presented in Appendix 1. As in previous experiments, novel shapes were created using a different sub-set of Vanderplas and Garvin shapes as a foundation. These three shape types formed the set of exposed stimuli used in this experiment and were counterbalanced between conditions such that shapes used as distractors in one condition were targets in the other. This counterbalancing procedure was used to eliminate any possible bias for or against any of the individual shapes. All word and shape stimuli were presented in black on a white background. Random geometric shapes were all presented subtending a visual angle of approximately 6.5˚.

Exposure phase

Participants in this experiment were asked to identify a specific shape in a rapid stream of similar shapes and report the number of times the target shape appeared. Participants were randomly assigned to one of two groups. One group searched for shapes with matching distractors (e.g. straight-edged targets amongst straight-edged distractors – congruent condition) and the other searched for shapes with different distractors (e.g. round targets amongst straight-edged distractors – incongruent condition). The condition in which all stimuli shared common features is hereby referred to as the congruent condition, the other condition is the incongruent. An illustration of the sequence of a typical trial is included in Figure 9.

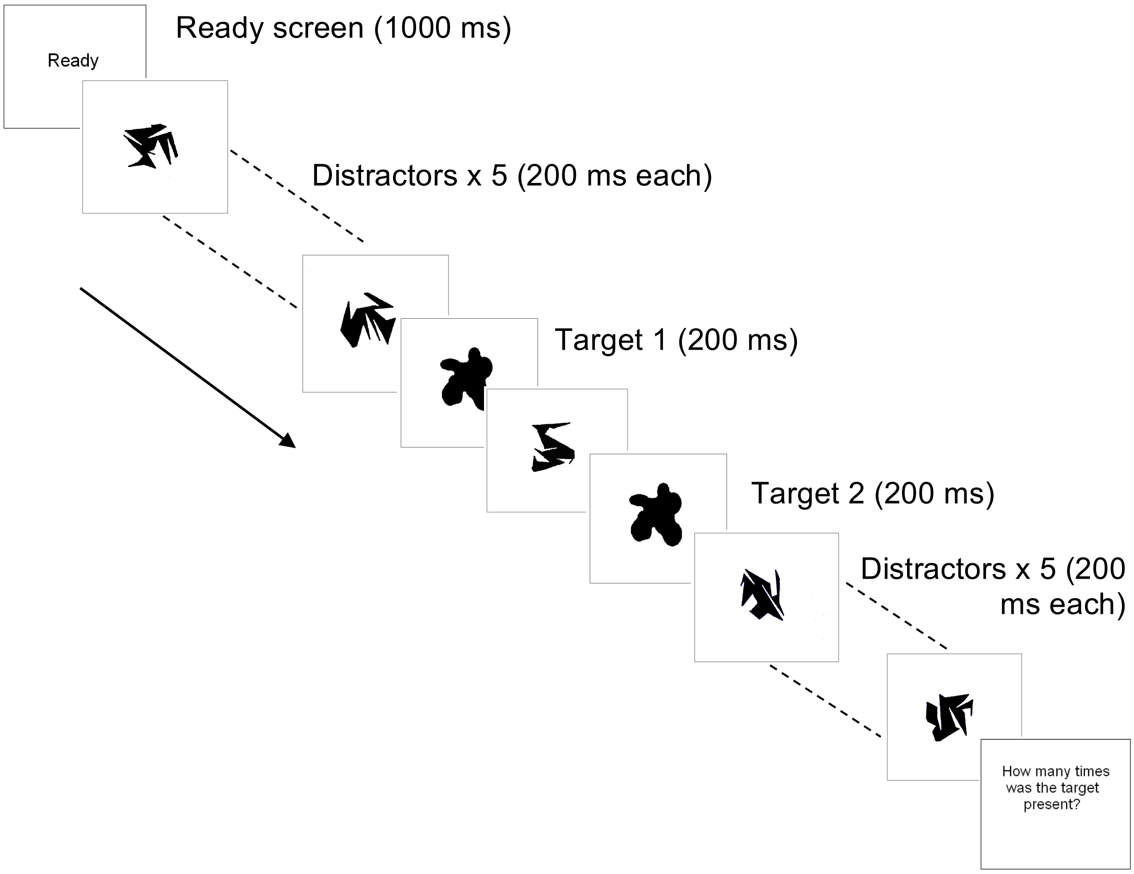


Figure 9. Trial procedure for a trial containing two targets, incongruent condition.

Participants were tested individually and were given 5000 ms to study the target stimulus displayed on the computer monitor before the RSVP trials began. The RSVP streams in this experiment included between 10 and 12 different distractors and between one and three identical targets. Five different rounded and straight-edged targets were used throughout the experiment and these were randomly assigned to individual participants. Each of the 20 RSVP streams, constituting 20 trials, began with a ‘Ready’ screen for 1000 ms followed by five different randomly chosen distractors with either the same or different features as the target depending on the condition. Each of the distractors was displayed for 200 ms. After five distractors were displayed one, two or three targets were presented for 200 ms each separated by a distractor for 200 ms. After this, five more distractors were displayed before participants were asked to indicate how many times the target was presented. Participants indicated the number of times they saw the target by pressing the corresponding number on the keyboard.

Affective priming task

Three minutes after the completion of the RSVP trials, participants were again asked to complete an affective priming task. This task required participants to respond as quickly as possible to simple positively and negatively valenced words. They were asked to press the ‘A’ key on the keyboard for positive words such as ‘good’ or ‘pretty’ and the ‘L’ key for negative words such as ‘bad’ or ‘nasty’. Following ten practice trials, each word was preceded by the word ‘ready’ for 1000 ms, then a fixation cross for 500 ms. Reaction times to positive and negative words were assessed when they were primed with the target shape, a distractor shape, with target-like shapes (i.e. shapes with the same global features as the target but not previously presented to participants) and with novel shapes, all masked to make them subliminal. Seven trials for each condition were again used to lessen any effect of the affective priming phase serving as an additional exposure phase. This process was the same as that used in experiments 3 and 4.

Forced choice measures

To ensure comparability with the earlier experiments, attitudes towards targets and distractors were also assessed with the same four-alternate forced choice measures (4AFC). As discussed previously, forced-choice measures give a more realistic and robust estimate of attitudes (for discussion of these measures in exposure studies see Bornstein & Craver-Lemley, 2004). Participants were asked to choose the most and least familiar and the most and least preferred shapes. The options for each question included a target, a distractor and two novel shapes. Participants were asked to complete this task on paper with the questions followed by the four alternatives and instructions to circle the shape corresponding to their choice.

Results

Although several participants were able to guess that the nature of this study was related to the development of preference, none were able to identify the actual hypothesis. Therefore, no data were eliminated on this basis.

Performance in the RSVP task was generally very poor. Participants in all conditions reliably exhibited an attentional blink. As discussed, in RSVP streams including more than one target, participants consistently miss targets presented within 500 ms of the first presentation of a target. No participants in any trial in any condition reported seeing more than one target despite two thirds of all trials including two or three targets. Participants in the congruent condition had difficulty in finding the target shape at all, with the target being missed on 49% of trials. In the incongruent condition, participants failed to report the target on only 5.8% of trials. Picking the targets from the distractors was clearly more difficult in the congruent condition.

Affective Priming

In the affective priming task, approximately 2.3% of responses were errors and these responses were eliminated from the reaction time analysis. All responses greater than or less than 2.5 *SD* above or below the mean were trimmed from each condition (as recommended by Ratcliff, 1993). There were also no significant differences in error rates between conditions ($p > .05$). The output tables for this experiment are available in Appendix 3e. The mean reaction times for each of the conditions are presented in figure 10.

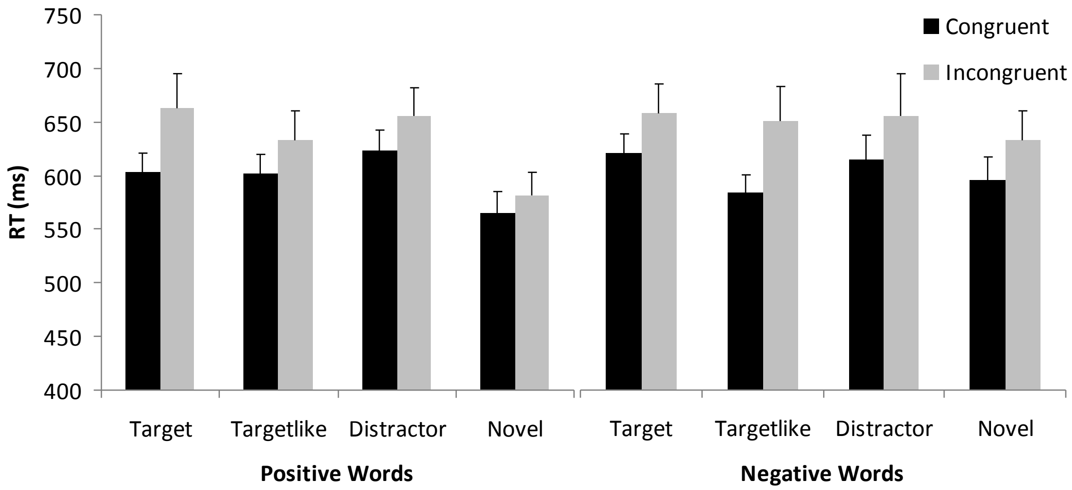


Figure 10. *Mean (SEM) response latencies to positive and negative words in affective priming task*

To determine if there were any differences in processing between the congruent and incongruent conditions, between shape types and any possible interactions between these variables, a 2 x 4 ANOVA was conducted on the response latencies for the positive and negative words. Again, as the results of previous experiments have suggested that positive and negative responses are not mirror images of each other, they have been analysed separately here.

There was a significant overall difference in response latencies to positive words across the three shape types, $F_{(3,174)} = 5.606$, $MSE = 7235.858$, $p = .002$, $\eta_p^2 = .231$. Reaction times to positive words were faster when primed with novel shapes ($M = 573.3$ ms) than for distractors ($M = 639.4$ ms), target-like shapes ($M = 617.2$ ms) or targets ($M = 632.8$ ms). There was, however, no difference in response latencies between the congruent and incongruent conditions for positive words primed with the various shapes, $F_{(1, 58)} = 1.611$, $MSE = 44683.19$, $p = .209$, $\eta_p^2 = .027$, indicating that exposure to the shapes did not result in an implicit positive attitude evident in facilitating, or negative attitude interfering with responses to the exposed shapes compared to novel shapes. The interaction of shape type and congruency was not significant for positive words either,

$F_{(3,56)}$ = 0.789, *MSE* = 7235.858, *p* = .505, η_p^2 = .231. Similarly, there was no significant difference in response latencies to negative words between the congruent and incongruent conditions, $F_{(1, 58)}$ = 2.001, *MSE* = 71815.14, *p* = .163, η_p^2 = .033, meaning no evidence for underlying positive affect interfering with, or negative attitude inhibiting responses.

There was no significant main effect for reaction times to negative words primed with the different shape types, $F_{(3,174)}$ = 0.934, *MSE* = 9930.458, *p* = .421, η_p^2 = .049 and no evidence of an interaction between shape type and condition for negative words, $F_{(3,56)}$ = 0.785, *MSE* = 9930.458, *p* = .507, η_p^2 = .04. A follow-up post-hoc analysis was conducted to determine which of the comparisons between shapes were responsible for the difference between response latencies between the shapes for positive words. The analysis revealed that this result was due to a significant difference between response latencies for targets (*M* = 632.8ms), target like shapes (*M* = 617.2ms) and distractors (*M* = 639.4ms) compared to novel shapes (*M* = 573.3ms), $F_{(1,57)}$ = 11.831, *MSE* = 12597.901, *p* = .001, η_p^2 = .786. As this difference is between exposed shapes and non-exposed shapes and was consistent regardless of condition, it is indicative of a standard priming effect and suggests that there were no meaningful differences in response latencies between conditions or shape types to positive or negative words.

Forced Choice task.

Responses to the four alternates for most and least familiar and most and least preferred are displayed in table 7.

Table 7.

Familiarity and preference choices - % of participants choosing each shape type in congruent and incongruent conditions

	Congruent			Incongruent		
	Target	Distractor	Novel	Target	Distractor	Novel
Most familiar	85.0	11.7	3.3	65.0	33.3	1.7
Least familiar	6.7	38.3	55.0	23.3	20.0	56.7
Most preferred	81.7	11.7	6.6	53.3	40.0	6.7
Least preferred	26.7	28.3	45.0	35.0	25.0	40.0

The target was more often than chance selected as familiar, χ^2 (2, N= 60) = 174.45, p < .001, and preferred, χ^2 (2, N= 60) = 131.8, p < .001 across both congruent and incongruent conditions. The novel shapes were generally rated as least familiar, χ^2 (2, N= 60) = 6.45, p = .04, and least preferred compared to other shapes across conditions, although the least preferred response pattern did not significantly differ from chance, χ^2 (2, N= 60) = 3.117, p = .21. Expected frequencies were again adjusted to account for collapsing the two novel options in the 4AFC.

To determine if there were any differences in response tendencies between the congruent and incongruent conditions, chi squared analysis was also conducted. In this experiment, a contingency table analysis method was used and Cramer's V statistic is therefore also reported (see Field, 2009). In comparing the congruent and incongruent conditions, it is evident that targets were more likely to be rated as most familiar in the congruent condition, χ^2 (2, N= 60) = 8.193, p = .017, ϕ = .261 and less likely to be rated as least familiar, χ^2 (2, N= 60) = 9.028, p = .011, ϕ = .274. The target was more often rated as preferred in the congruent condition than in the incongruent condition, χ^2 (2, N= 60) = 12.89, p = .002, ϕ = .328. There was, however, no evidence of devaluation of distractors based on the likeness of the distractors to the target. Ratings of the least preferred shape did not significantly differ between conditions, χ^2 (2, N= 60) = .977, p = .614, ϕ = .09. Participants were therefore more likely to find familiar and prefer shapes if the distractors shared stimulus features with the target shape despite the task being more difficult in this condition.

Discussion

The results of this experiment generally substantiate those of experiment 1. In this experiment, as opposed to experiment 1, the features separating the shapes in the choice phase were specifically task-relevant. Despite this modification and the different task in the presentation phase, the results generally reflect those of experiment 1. Participants chose targets over distractors, as most familiar and most preferred particularly in the congruent group where targets and distractors shared similar features. Generally, exposure to the targets and distractors led to an increase in liking that was not reflected in the affective priming measure.

In discussing the results of this experiment, the evidence for attentional blink will be addressed first. The attentional blink that was expected to occur in the RSVP task occurred, as participants were generally unaware of multiple presentations of the target. Essentially, these stimuli are supposedly inhibited (see also Olivers & Watson, 2006) and were thus presented to participants outside their awareness. Subliminal stimuli have been shown to elicit both mere exposure and distractor devaluation effects (as demonstrated in experiments 3 and 4 and by Kihara et al., 2011). In order to separate the effects of the underlying mechanisms of perceptual fluency and inhibition, the fact that some targets were not consciously perceived makes little difference in this respect as repeated targets were subliminal in both conditions. Furthermore, this is likely to have made any subjective experience related to fluent processing of these shapes surprising and reinforces the involvement of processing fluency in the MEE observed in this experiment. This supports the conclusion reached by Kihara et al., who also found evidence of an attentional blink and a fluency-based MEE using RSVP streams. What is clear from these results is that, whether the targets and distractors share common features or not, feature processing differences do not appear to differentiate the processes underpinning the DDE and the MEE.

In terms of the affective priming results, the only significant result was an increase in response latencies to positive words primed with exposed shapes and similar shapes compared to the responses to words primed with novel shapes. Pre-exposure to stimuli often causes negative interference with response latencies in this type of priming task (Mayr & Buchner, 2007). However, these effects are usually associated with distractor stimuli and not with targets (see Fox, 1995). There were no meaningful differences between distractor and target stimuli in this study and therefore the results are of limited use in developing an understanding of the conditions which lead to liking or disliking. As there was no difference in terms of response latencies between target and distractor shapes, between congruent and incongruent conditions or any interactions between these variables, the affective priming results do not contribute anything to our understanding of the divergent processes involved in the MEE and the DDE. Although Topolinski and Strack (2009b) argue that they found consistent evidence of processing fluency using affective priming, the relative contributions of facilitatory and inhibitory processes in affective priming have been the source of some debate (Hermans, De Houwer, & Eelen, 1994). Considering there are potentially both inhibitory and facilitatory processes impacting on the participants' responses in this experiment due to distractor inhibition and processing fluency, it is difficult to separate these processes without further examination of affective priming itself.

The subjective reports, however, do again support the involvement of feature processing and perceptual fluency in the MEE, even in a difficult selective attention task. In this case, participants in the congruent condition more often preferred the target stimulus than those participants in the incongruent condition. This suggests that feature processing is contributing to perceptual fluency and that experiencing additional presentations of shapes with the same features leads participants to become more likely to prefer the target shape. This is further supported by the observation that, even though participants had more difficulty finding targets in the congruent condition, they were still more likely to prefer them to other shapes than participants in the incongruent condition. Alternatively, participants in the incongruent condition, where distractors were clearly different from targets, were more likely to choose a distractor as the most preferred stimulus than participants in the congruent condition. In this case, rather than exposure to a distracting stimulus leading to devaluation, the distractors were more likely to be chosen as the shape the participants most preferred than in the congruent condition where the distractors had similar features to the target. This implies that exposure to shapes with these features led to them being liked possibly due to increased processing fluency. They certainly did not become disliked which would have been expected if distractors were being inhibited.

In general, both targets and distractors became preferred over novel shapes in this experiment and there was no evidence of a DDE. There was a tendency for participants to choose the novel shape as the one they least preferred, though this difference was not statistically significant. This suggests that the inhibitory mechanisms thought to underlie the DDE were not evident in this temporal task or that they were being counteracted by fluency based preferences (see also Kihara et al., 2011). If there were evidence of a feature-based DDE, participants in the incongruent condition would have selected distractor shapes as least preferred over target or novel shapes. Participants in this condition should have experienced inhibition and hence devalued the distractors based on their features due to these shapes not sharing common features with the target. An explanation for the results for the shape rated as most liked is that the increase in perceptual fluency, due to exposure to shapes with other features, has led to those shapes becoming more likely to be chosen as the preferred shape than in the congruent condition.

The results of this study also do not fit neatly with observations of the DDE. There are several possible reasons that a DDE was not induced in this task. It may be the case that the DDE is not based on the same mechanisms as similar phenomena such as negative priming but may be an inhibitory process that is based on spatial inhibition of distractors. If this is so, then it supports the idea that distractor devaluation is related to inhibition of return (see Lleras et al., 2009). The evidence gleaned from experiment 2 suggests that the situation is more complex than this. There was no evidence of distractor devaluation in experiment 2 despite the fact that the task was spatial in nature. It could also mean that the DDE is not cumulative like the MEE seems to be (see Zajonc, 1968). That is, increasing the number of exposures leads to an increase in liking in the latter but not devaluation in the former.

The evidence for cumulative devaluation of distractors is not as abundant as is support for cumulative mere exposure effects (see Veling et al., 2007). Distractor devaluation studies generally involve ratings of stimuli on a trial-by-trial basis, including the only example of research where both a MEE and a DDE were observed simultaneously (i.e. Kihara et al., 2011). This suggests that the inhibition associated with the negative responses in distractor devaluation is only short term, a possibility that will be addressed in a later experiment. Whatever the case, the failure to elicit distractor devaluation in either the congruent and incongruent conditions in this experiment suggests that factors other than feature-based inhibitory processes could lead to devaluation of distractors when distractors are repeatedly exposed.

Given that changes in feature processing do not appear to lead to divergent outcomes in terms of preference, other attentional factors known to modulate behavioural outcomes need to be assessed. Typical studies in selective attention vary perceptual load to determine whether task difficulty influences what is processed, attended to and recalled (see Lavie, 1995). Varying perceptual load can shed light on differences in attentional processing, particularly in terms of feature processing and distractor inhibition (Lavie, Hirst, de Fockert & Viding, 2004) and in terms of whether the effects are based on a global impression of the stimulus or on a more fine-grained, analytic representation. The distinction in processing strategies has also been found to be important in the development of mere exposure effects (see Whittlesea & Price, 2001; Willems et al., 2010), although it would appear in the current experiment that more frequently exposing distractors did not result in greater processing fluency. Attentional load influences the ability to process distractors, evidenced by reduced recognition rates, as well as the elimination of repetition priming effects (Lavie, Lin, Zokaei, & Thoma, 2009). Recognition and repetition priming are also important in theories underlying the MEE (see Butler & Berry, 2004). As there appears to be a relationship between several factors associated with the MEE and processing variations based on the manipulation of attentional load that may or may not lead to an increase in processing fluency, these factors therefore warrant investigation.

The discussion of the parallels between theories attempting to explain selective attention and those attempting to explain perceptual fluency and the MEE in the opening two chapters of this thesis highlights the importance of integrating theories and methods of selective attention into this research. Now that evidence for parallel processes in the DDE and MEE effects has been found and a foundation for examining this relationship using RSVP streams has been established, the next experiment sought to examine whether the manipulation of attentional load is also a factor in the divergent outcomes found in DDE and MEE experiments, particularly in relation to the differences associated with global and analytical processing of stimuli in a manner analogous to the model of mere exposure effects forwarded by Whittlesea and Price (2001). Considering that processing fluency and feature-based processing differences do not appear to adequately separate the processes supposedly responsible for these effects, examining other attentional factors is the most logical way to progress considering their importance in understanding selective attention.

Experiment 6

The separation of synthetic and analytic processing has also been found to alter liking responses in mere exposure studies (Whittlesea & Price, 2001). In this vein, Willems et al. (2010) found that analytic processing of a stimulus is accompanied by more extensive scanning of a stimulus, leading to a diminishing of the MEE for exposed stimuli. Nonanalytic, or a more global processing of the stimulus, therefore appears more likely to lead to increases in liking. Given that more extensive scanning of a stimulus implies more attention is being paid to it (see Harris & Jenkin, 2001), the difference between global and analytical processing of exposed stimuli could provide a reasonable explanation for the results of the experiments presented so far.

The aim of experiment 6 is to determine if the observations of experiments 1 and 5 can be explained through differences in global or feature-based attending by manipulating attentional load. This manipulation is necessary to be certain that the effects of selective attention on the exposure/affect relationship that cause the DDE are not simply a case of spatially-based inhibition of distractors. In this vein, Yagi et al. (2009) presented targets and distractors in the same spatial location. Both in Yagi and colleagues' research, and in experiments 1 and 5 of the current research, where targets and distractors were presented in the same location, there was no evidence of distractor devaluation. Although there was also no evidence of a DDE in experiment 2 of the current research, most distractor devaluation studies involve a spatial search task (see Fenske & Raymond, 2006 for review). Variations in processing strategy provide an alternate explanation and have been seen to influence the MEE (Willems et al., 2010). Kihara and colleagues (2011) and experiments 3 and 4 of this study have demonstrated reliable evidence of distractor devaluation using a non-spatial task, which implies that the inhibitory processes involved in the DDE are not simply related to inhibition of return as was suggested by Lleras et al. (2009). This means that other factors involved with attending or ignoring a stimulus must have produced the DDE reported in these experiments. A variation in task requirements can cater to these different strategies and provides a way forward for this investigation.

In order to examine different processing strategies as a possible factor in distractor devaluation, the RSVP task used in experiment 5 was altered so that attentional load could be manipulated by varying levels of perceptual processing. Pop-out and conjunction searches are commonly used in selective attention research to separate the processing of pre-attentive and attended stimuli and stimulus features (Wolfe, 1998) and are frequently used as a manipulation of perceptual load with RSVP streams (Martens & Wyble, 2010). Pop-out search is based on a pre-attentive processing of an overall global impression of the stimulus that does not require further analytical processing. A feature such as colour, that is very easy to identify in a visual display, defines the target. Conjunction searches are more difficult as participants are required to search for a combination of features, which must be brought together to identify the targets (for review see Wolfe, 2007). Treisman

(1982) argues that pop-out search tasks are based on a pre-attentive, global or synthetic impression of the stimulus whereas conjunction tasks require a more fine-grained analytic approach to locating targets, which causes greater load on the attentional system and is therefore less efficient (see also Lavie, 2005).

In this experiment, participants were exposed to a number of RSVP streams, again in two separate conditions. The first of these conditions included a simple pop-out search where the goal was to identify shapes in the stream that were red as opposed to black. In the other condition, participants were asked to engage in a more difficult conjunction search where they needed to find shapes that were both red and either straight-edged or round-edged. The streams in both conditions included the same number of straight-edged and round-edged shapes. The only difference between the two conditions is that the conjunction search was more difficult and made the feature of interest (straight or round edges) task relevant. This creates circumstances where participants need to closely attend to the stimulus features and, therefore use a more analytic processing strategy than when completing the pop-out task (as per Lavie, 2005). This experiment was aimed at determining if the analytic processing strategy elicited by making the target feature relevant to the task would devalue targets and shapes with similar features compared to the simpler pop-out search where a global, synthetic strategy is sufficient to locate targets because the colour of the shape pops out. The goal was to compare the preferences for targets and distractors between the two conditions.

The analytic strategy required by the conjunction search was expected to lead to greater distractor devaluation and/or a reduced MEE, similar to that reported by Willems et al. (2010). Making the additional feature task relevant would determine if the corresponding increase in attentional load and need for top-down analytical processing rather than just spatial inhibition can cause the DDE. If selective attention is operating independent of processing fluency in terms of the influence it has over the DDE and the MEE, attentional load is more likely to influence subjective ratings than response latencies in an affective priming task. Incompatible results from the two measures in this experiment would provide evidence that analytic and synthetic processing strategies operate independent of fluency and suggest that the processing strategy could lead to the divergent effect of the MEE and the DDE.

In order to lower extraneous variance that may have come from using a between subjects design in the previous experiment, this experiment instead employed a within subjects design. Participants in this experiment completed both conditions on separate days. Pilot testing of the within subjects design found no pre-test differences in preferences between the first and second sessions. This check was carried out to be certain that there were no residual preferences carried over from the first session. The affective consequences of conceptual priming, as opposed to perceptual priming dissipate quickly (Roediger & McDermott, 1993). It was therefore deemed that the assignment of the conceptual status of ‘target’ or ‘distractor’ was unlikely to influence responses to a separate exposure session on a separate day (this issue will be discussed further).

Methods

Participants

Thirty-one psychology students (22 female) naïve to the aims and hypotheses of the experiments were recruited and received course credit in exchange for participation. Participants ranged in age from 18 to 46 with a mean age of 23.8 years. Participants had normal or corrected to normal vision and none reported being colour-blind.

Materials

The materials in this experiment were the same as those used in experiment 5. The RSVP streams from the incongruent condition in experiment 5 were altered to include coloured targets for the pop-out condition and coloured targets and distractors for the conjunction condition. This was done by changing a number of targets and distractors in the RSVP streams used in experiment 5 to red for the purpose of providing a pop-out feature for the tasks. The RSVP streams therefore included target shapes that were red and were of a different type than the distractor shapes. For example, in the pop-out condition, in a stream of rounded shapes, targets were straight-edged shapes and were all red. In the equivalent conjunction condition, targets were also straight-edged shapes and were red, distractors were all rounded shapes but some of these were also red to make the task more difficult (i.e. participants needed to use both colour and shape information to identify targets). In this way, the shapes that were deemed to be targets in both conditions were either consistently rounded or straight-edged and distractors were always the other shape type.

Exposure phase

Participants were exposed to targets and distractors in RSVP streams in two separate sessions on different days. Participants were also exposed to the same target – distractor combination in each session (i.e. if they had rounded targets in the pop-out session, they were also exposed to rounded targets in the conjunction search). The sessions were counterbalanced between participants. Half of the participants were exposed to rounded targets amongst straight-edged distractors, with the other half looking for straight-edged targets amongst rounded distractors. The target and distractor shapes were again counterbalanced between conditions.

The pop-out search task required participants to simply count the number of red shapes in the RSVP streams. Targets (red shapes) were always sharp or round and distractors in the same stream were always the other type. Previous research on visual search has found that pop-out searches of this nature require little engagement of selective attention (see Theeuwes, Reimann & Mortimer, 2006). Participants can rely on the single feature of colour as a cue to locate targets in the stream and do not need to process stimuli any further.

The alternate session involved a more difficult conjunction search task where participants were asked to identify the number of shapes that have straight (or round) edges and are red (some distractors were red in this condition). This meant that, in this condition, the feature that differentiates distractors from targets is task relevant and requires processing of both colour and whether the shape was round or straight-edged, hence making the task more difficult (see also Lavie, 2005).

Affective Priming

Affective masked priming was again used in this experiment. As per experiments 3, 4 and 5, subjects responded to positive and negative words after brief, backwards masked exposures to targets, distractors and novel shapes, seven trials of each. Due to there being no evidence of any differences in responses between targets and target-like shapes in experiments 4 or 5, target-like shapes were not included in the affective priming phase of this experiment. Reaction times and error rates were again recorded.

Preference measures

Ratings for pleasantness and unpleasantness on a 10-point scale were used in this experiment. As mentioned previously, rating scales offer a more robust measure of differences between conditions (see Bornstein & Craver-Lemley, 2004). As per experiment 4, rating scales were deemed to be more appropriate in this experiment given that the differences between conditions are likely to be more subtle with both sessions involving a selective attention task which increases processing fluency for targets and distractors as per experiment 5. Five minutes following the RSVP (exposure) task, participants were asked to rate the pleasantness and unpleasantness of a target, a distractor shape and a novel shape on a scale of 0-9. A score of 0 was anchored as being neutral with a score of 9 representing either very pleasant or very unpleasant. Each shape was presented on the screen for 1000 ms above the scale with numbers 0-9 and the anchor points described above. Immediately after the presentation of the shape to be rated and the scale, a screen with the words ‘Rate now’ appeared until participants made their selection by pressing the key corresponding to the score they wished to give on the keyboard. There were six ratings to be made in total – a target, distractor and novel shape were rated for both pleasantness and unpleasantness. Ratings were presented in a random order until all six had been completed, a single rating for each shape type, positive and negative. This procedure is similar to that used in experiment 4.

Results

There were again no participants able to correctly guess the hypothesis of this experiment and no data were removed on this basis. One participant’s mobile phone rang whilst they were participating and this participant’s data was removed from the final analysis leaving 30 participants (21 female) who completed both conditions.

There was less evidence of an attentional blink in this experiment. The number of participants failing to see the second and third targets in this experiment was far less than in the previous experiment. Overall, 7.9% of responses to RSVP streams with two or three targets were incorrect in the conjunction condition and 5.9% of responses in the pop-out condition were incorrect. There was less evidence of an attentional blink occurring in the current experiment due to targets being defined by features rather than targets being specific objects (see also Raymond, 2003).

Errors in the affective priming task were low at around 0.7% of responses. These responses were removed from the data, as were responses that were outside 2.5 *SD* above or below the mean reaction time for each condition. The output tables for this experiment are included in Appendix 3f. The mean reaction time for each condition in the affective priming task is displayed in figure 11.

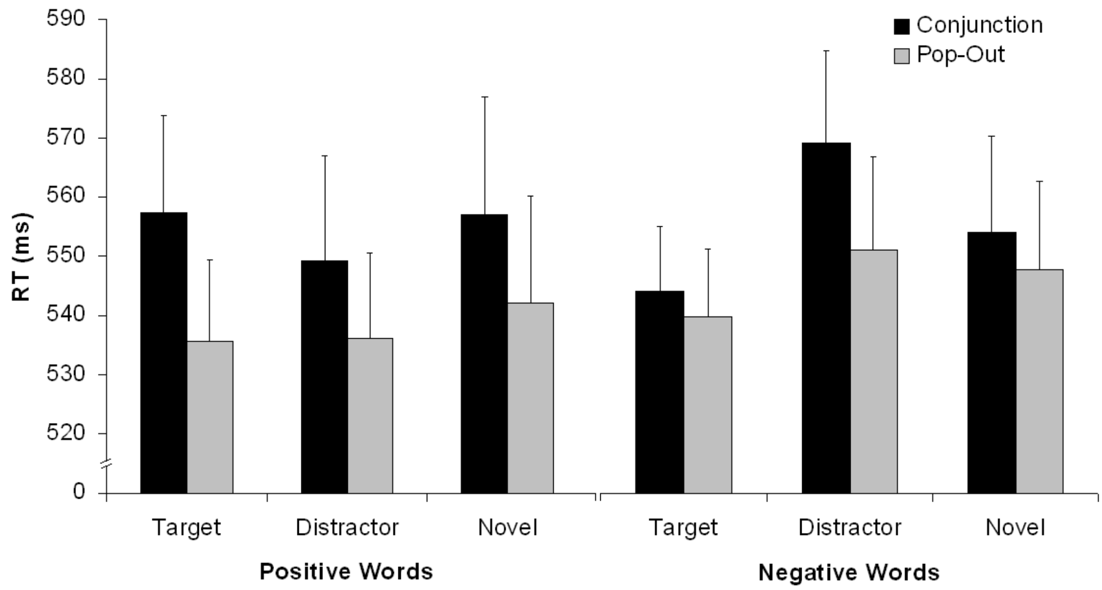
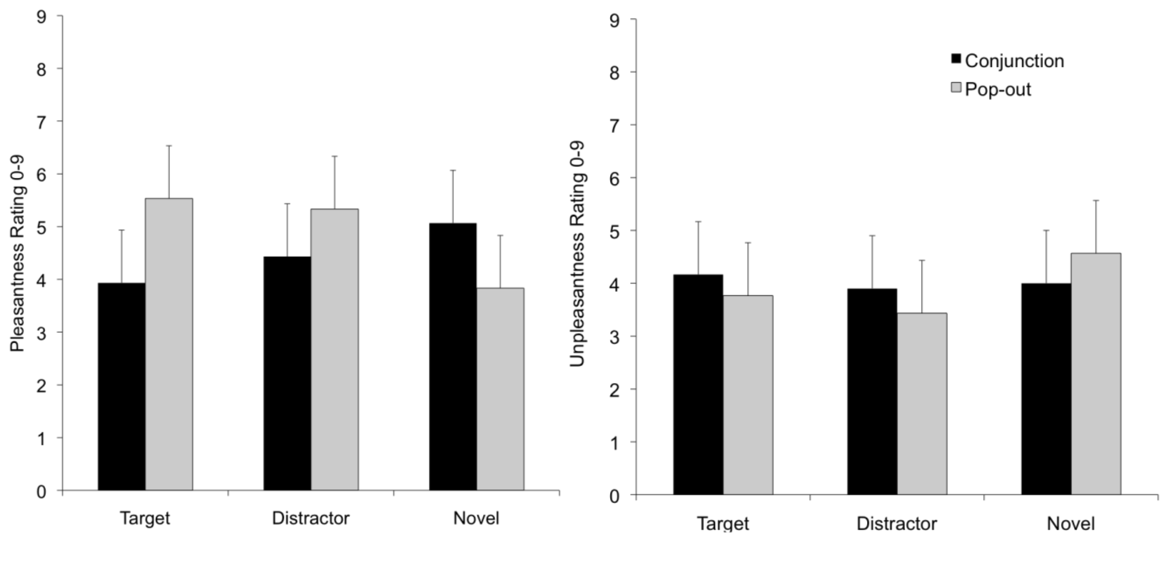


Figure 11. *Mean (SEM) reaction times for positive and negative words in affective priming task*

No significant differences were found between conditions in terms of reaction times or error rates in the affective priming task. The differences between response latencies for the different shape types were not significant for positive words, $F_{(2,58)}$ = 0.026, *MSE* = 2033.56, *p* = .975, η_p^2 = .001, or for negative words, $F_{(2,58)}$ = 2.596, *MSE* = 3966.720, *p* = .08, η_p^2 = .08. Neither were there any significant differences between the pop-out or conjunction conditions in terms of response latencies for positive, $F_{(1,29)}$ = 0.787, *MSE* = 26343.34, *p* = .382, η_p^2 = .026, or negative words, $F_{(1,29)}$ = 0.871, *MSE* = 25601, *p* = .358, η_p^2 = .028. Moreover, there were also no significant interactions between shape type and attention task (pop-out or conjunction) for either positive, $F_{(2,58)}$ = 0.774, *MSE* = 2881.16, *p* = .774, η_p^2 = .025, or negative words, $F_{(2,58)}$ = 0.749, *MSE* =

2679.90, $p = .477$, $\eta_p^2 = .024$. Overall, there were no meaningful differences between any of the conditions in the affective priming task.

There was also no evidence of any differences in preferences for types of shape with ratings of pleasantness, $F_{(2,58)} = 1.052$, $MSE = 2.762$, $p = .356$, $\eta_p^2 = .035$, and ratings of unpleasantness, $F_{(2,58)} = 1.263$, $MSE = 4.516$, $p = .290$, $\eta_p^2 = .042$. There were also no significant differences between the pop-out and conjunction conditions in the main effect for pleasantness, $F_{(1,29)} = 0.902$, $MSE = 9.28$, $p = .350$, $\eta_p^2 = .030$, or unpleasantness, $F_{(1,29)} = 0.085$, $MSE = 5.314$, $p = .773$, $\eta_p^2 = .003$ ratings. Finally, there were no significant interactions between the shapes and attentional tasks, for either pleasantness, $F_{(2,58)} = 2.967$, $MSE = 11.011$, $p = .059$, $\eta_p^2 = .093$, or unpleasantness ratings, $F_{(2,58)} = 0.656$, $MSE = 11.793$, $p = .656$, $\eta_p^2 = .014$. The mean rating scores for each condition are displayed in figure 12.



(a) (b)

Figure 12. *Mean (SEM) rating of pleasantness (a) and unpleasantness (b) for exposed shapes and compared to novel shapes*

Discussion

Overall, there was no evidence that the tasks in this experiment had any effects on positive or negative attitudes as gauged by either the affective priming or subjective rating measures. Participants in this experiment did not have as much difficulty with the RSVP task in either the pop-out or conjunction conditions as participants in the previous experiment did when searching for a specific stimulus. While it suggests that the experimental manipulation in this experiment had little effect, this is perhaps not surprising as participants were asked to search for basic stimulus features in this experiment and not a unique shape, hence enabling participants to pick out targets based on processing of stimulus features. This has also been observed numerous times in other studies using RSVP streams (e.g. Raymond, 2003; Ward, Duncan & Shapiro, 1997). It also goes some way to explaining why there was no evidence of a MEE in this experiment. Any experience of fluency is easily attributable to the exposures during the RSVP streams, very few of which were presented outside awareness in this case. According to Whittlesea and Williams (1998), the feeling of fluency needs to be surprising to be misattributed as liking. As participants were able to accurately assess the number of times the target was presented, they were obviously aware of the repeatedly exposed targets. Thus this might have resulted in participants attributing any feeling of fluent processing to repetition, which in this case attenuated the MEE.

The lack of any significant differences in the affective priming task replicates the results of experiment 5. This suggests that the observations in experiment 3 were the result of the stimulus exposure being subliminal and hence the stimulus was processed unconsciously. This implies that implicit measures of attitude towards stimuli in these studies are useful in detecting unconscious changes in affective value for subliminally exposed stimuli but are insensitive to changes in implicit attitudes towards supraliminally exposed stimuli. Apart from experiment 3 of the current research and that of Ying and Renlai (2008), there is very little evidence of mere exposure being sufficient to influence outcomes in affective priming measures. Furthermore, the variability in the results could suggest that processing fluency and attentional inhibition are both influencing response latency. There is also debate about the influence of selecting or ignoring a stimulus on the automatic evaluation underlying affective priming (Buttaccio & Hahn, 2010). Ultimately, although the contribution of processing fluency and attentional inhibition on affective priming is an avenue for future exploration, it is unlikely to contribute to the current research questions without further examination in its own right.

In terms of subjective responses in this experiment, there was an overall tendency for participants engaged in pop-out tasks to find targets more pleasant than when engaged in the more difficult conjunction task (see figure 8) and this was expected. Unexpectedly, there was a tendency for participants to find distractors more unpleasant following pop-out search exposure. One possibility for this is that participants could be less likely to develop a dislike in the conjunction condition than the pop-out due to the task taxing working memory resources. Goolsby, Shapiro and Raymond (2009) found that there must be sufficient working memory available for distractor devaluation, as increasing the load on working memory decreased disliking of distractors. It is plausible that the feature binding required in conjunction tasks does rely on working memory (Allen, Baddeley & Hitch 2006) and this may be limiting distractor devaluation in these conditions. Although neither of these tendencies was statistically significant, it leaves unanswered the question of whether or not making the defining feature of the distractor task-relevant increases the supposed inhibitory mechanisms responsible for distractor devaluation, or whether this is just a result of the requirement to engage working memory.

The lack of any significant differences in preferences for targets and distractors in experiment 6 is surprising given that this is what is clearly predicted based on previous studies on the DDE (see Fragopanagos et al., 2008). It is also surprising considering the evidence suggesting that differences between analytic and synthetic processing alter preferences in mere exposure studies (Whittlesea & Price, 2001; Willems et al., 2010). Although it is possible that the failure to find any differences between conditions could be due to a lack of power given that fewer participants were involved in this experiment, using a within-subjects design should have been sufficient to reduce variability sufficiently to detect an effect. The most obvious reason for this failure to induce a DDE might be the delay in obtaining preference ratings due to the way the preferences have been measured here as opposed to how they are measured in distractor devaluation studies. There is also the distinct possibility that the affective priming task is influencing responses in the later measures, a limitation of experiments 3 to 6, even though piloting of this procedure indicates it does not influence persistent preferences.

In a typical mere exposure experiment, preferences are measured after a wait period, however in distractor devaluation studies, preferences are assessed during the exposure phase (with the exception of Veling et al., 2007). This suggests that the inhibitory effects on distractors are transitory and do not persist beyond when the inhibition is required to complete the search task. Given that the experiments presented thus far have examined perceptual fluency, feature processing, familiarity, analytic and synthetic processing of stimuli and attentional load and have been unable to separate the mechanisms responsible for the DDE from those of the MEE, it is worth examining these methodological differences with a larger sample than that in experiment 6.

Based on the discussion of methods in the introduction, the aforementioned parallels between a number of observations in studies on both the DDE (see Griffiths & Mitchell, 2008) and the MEE (see Butler & Berry, 2004), studies concerning repetition and negative priming might provide some explanation. As mentioned, conceptual priming of a stimulus has short-term consequences on affective responses (Roediger & McDermott, 1993) and it is the duration of these effects which suggests that this is fundamentally different from mere exposure effects that can last for weeks or longer (see Bornstein, 1989). Conceptual priming is the process whereby a concept such as a category is primed (Shanks, 1997). For example, when given examples of specific animals (e.g. dog, cat, horse), it is more likely that these examples will be recalled when asked to give examples from a category, in this case, animals. Perceptual priming on the other hand is an enhanced ability to identify an object based on prior experience with it. For example, people are generally more accurate and faster at identifying and labelling objects they have been repeatedly presented based on the perceptual features of the stimulus (Wiggs & Martin, 1998).

Perceptual priming can be modulated by top-down selective attention (Stephens, Wig & Schacter, 2008) and this may provide an indication as to why the MEE can be modulated in similar ways. Priming of perceptual features of a stimulus can lead to a feeling of familiarity in the absence of recognition and this appears to be based on perceptual fluency. Willems and Van der Linden (2009) suggest that a common mechanism based on fluency can explain perceptual priming and the MEE and that the disparity in performance on recall and preference measures that are problematic for models of the MEE are due to the nature of the measurement task. Either way, there is evidence suggesting that there is a relationship between the MEE and perceptual priming based on fluency. Similarly, the DDE could be related to the conceptual priming of 'target' and 'distractor' because these categories are explained to participants in order for them to complete the required task in a distractor devaluation study. In this vein, it follows that perhaps conceptually driven top-down influences are responsible for the DDE but perceptually driven top-down processes drive the modulation of the MEE.

Observations of the DDE and the MEE could give the impression that similar mechanisms are at work because both result in a change in liking due to the engagement of selective attention but are, in fact, related to separate processes associated with the aim of the task. The implication of this is that the conceptual notion of a target or a distractor is attached to a hedonic evaluation, which assists in enhancing visual search and is responsible for short-term changes in the DDE but has less effect on persistent preferences. This is similar to the time course of conceptual priming effects (Roediger & McDermott, 1993). Alternatively, perceptual priming based on fluency is more persistent (see Tulving, Hayman & Macdonald, 1991). If the DDE is similar to conceptual priming in that it is transient and related to the requirements of the task, the effect is likely to be short-lived. Therefore, if the DDE parallels a conceptual priming mechanism, a measure aimed at detecting persistent effects like those of perceptual priming and mere exposure, is not going to find evidence of a DDE.

Conceptual and perceptual properties of the stimulus could explain why making the features task relevant and increasing attentional load by asking participants to complete a conjunction task in experiment 6 did not appear to make a significant difference in terms of preference formation. Previous experiments reliably found that engaging attention can modulate the MEE (see experiments 1 and 2; Yagi et al., 2009). The results from experiment 6 suggest that the nature of the task is less relevant to the development of liking or disliking for targets and distractors than is the fact that participants are engaged in a task where the concept of target and distractor take precedence because they are related to successful task completion. The results of experiment 1 indicated that engaging in a colour-naming task reliably led to participants being less likely to prefer an exposed stimulus over a novel stimulus than when they viewed similar stimuli passively. When considering the observation that a difference in preference for exposed stimuli has been found when attention is engaged compared to when it is not, the results of experiment 6 suggest that it is not the variation in attentional load that is important, but the fact that attention needs to be engaged at all.

Supporting this suggestion, Raymond and O'Brien (2009) found that recognition for motivationally important stimuli is greater than for equally exposed stimuli in an RSVP task and that these effects are impervious to variations in attentional load. This leads to the hypothesis that devaluation of a distractor may be due to its short-term goal relevance and once its conceptual status as a distractor is no longer relevant, the devaluation diminishes (see also Prescott et al., 2008) rather than persisting as it does in perceptual priming and mere exposure effects. The failure to find a DDE in either experiment 5 or 6 therefore suggests that methodological differences could underlie the varying results in each effect. This could be because the methods used in typical mere exposure studies and employed here are not capturing attitudes towards stimuli in a timeframe in which the conceptual category of target or distractor are relevant to the stimulus. Experiment 7 examines these methodological differences and potential influence of goal relevance more closely.

Experiment 7

Given the failure to find any difference between affective priming and rating responses in experiment 6, experiment 7 aimed to examine whether or not the DDE is in fact a transitory phenomenon that occurs primarily during a task/exposure phase and is weakened afterwards as in conceptual priming. Distractor devaluation studies primarily involve measuring preferences throughout the 'exposure phase' whereas mere exposure studies have most commonly included assessment of preferences some time after the exposure phase. If distractor devaluation is related to motivational factors linked to task completion, it is less likely that the effect will be observed after a delay. The only report of a DDE found when affective ratings were taken after the exposure phase was Veling and colleague's (2007) experiment and the ratings in that study were conducted immediately after the exposure phase, not after a wait period as is most common and effective in the mere exposure paradigm (Bornstein, 1989).

The design of this experiment was essentially the same as experiment 6. The difference with this experiment was that measures of preference were taken before and during the exposure phase between the presentations of each RSVP stream. This was done in order to determine if the devaluation of distractors is a phenomenon that is attached to the task and does not carry over until later, as a MEE does. If the DDE is a transitory effect linked to the goal relevance of the distractor, there should be an immediate dislike develop for the distractor that remains stable throughout the exposure phase to enhance efficiency for completing the task but that diminishes shortly after the trials are completed. Further to this, there should be a dislike evident in the conjunction condition before the first trial but not in the pop-out condition. This is simply because participants in the pop-out condition did not know that either straight or round edges defined shapes as either targets or distractors until after the trials began – the shape of the stimulus was irrelevant to the task. In other words, the task for participants in the conjunction condition involves assigning the conceptual category of target or distractor to stimuli in order to complete the task whereas, in the pop-out condition, participants can rely on the pop-out feature to complete the task. Bottom up processing of the stimulus is sufficient to complete the task because the red shapes pop out of the stream distinctly from the other shapes. This situation should lead to devaluation of the distractor during the task (as per Goolsby et al., 2009), but not after it. Additionally, based on the results of experiment 6, these conditions should not lead to an increase in liking after a delay period due to the easy attribution of any fluent processing of stimuli. This is most likely because attribution of the subjective experience of fluency has been shown to attenuate the MEE (Willems & Van der Linden, 2006). As discussed, the MEE is more likely to occur when the fluency is surprising (Whittlesea & Williams, 1998).

Affective priming as a measure of preference was abandoned in this experiment due to there being no evidence of any differences between conditions in either experiment 5 or 6 and because it could be interfering with the preference measures. Although there was some evidence of this measure detecting differences in underlying preference in experiment 3, there has been no such evidence of these differences in later experiments. As discussed, the use of affective priming as a measure of preference in exposure studies as a way of understanding the underlying processes appears to be limited. In addition, the risk of this phase of the experiment contaminating the responses to the other measures was deemed to be greater than the potential usefulness of the data it produced. Thus, it was decided not to include affective priming in this experiment.

Methods

Participants

Forty psychology students (31 females) naïve to the aims and hypotheses of the experiment completed two sessions as per experiment 6. The sample ranged in age from 18 to 51 years with a mean age of 24.7 years. Participants all had normal or corrected to normal vision, one participant was excluded due to being colour-blind, all other participants reported normal colour vision.

Materials

Materials were identical to those used in experiment 6.

Procedure

Participants were again randomly assigned to two groups. One group was exposed to straight-edged shapes as targets with rounded shapes as distractors and vice versa for the other group. The order of the pop-out or conjunction condition was counterbalanced between participants with sessions being completed on a separate days. Pre-test measures of preference for the two sessions were again compared with no evidence of residual affect attached to any stimuli from the first exposure to the second.

The only difference in this experiment as opposed to experiment 6 was that participants completed additional trials – 60 RSVP tasks as opposed to the 20 completed in the previous experiment. This was done to accommodate 10 each of pleasantness and unpleasantness ratings for targets, distractors and novel shapes, one after each RSVP stream. The ratings were done in an identical manner to those in experiment 6 with the stimulus to be rated on either pleasantness or unpleasantness ratings determined randomly by the E-Prime script until all 60 ratings were completed. As per experiment 6, a further set of pleasantness and unpleasantness ratings for the three types of shapes constituting six ratings in total were conducted five minutes following the last RSVP trial, just as they were in experiment 6.

Results

Performance on the RSVP task in experiment 7 was similar to that in experiment 6. Participants made an error on 8.6% of trials in the conjunction condition and on 7.5% of trials in the pop-out condition when more than one target was present. These low error rates suggest that attentional blink or repetition masking were not as prevalent in this experiment as they were in experiment 5.

A 3 x 2 x 3 (time x task x shape type) ANOVA was conducted on ratings of both pleasantness and unpleasantness. The output tables for this experiment are presented in Appendix 3g. For pleasantness ratings, there were no main effects for testing time, $F_{(2,78)}$ = 1.246, MSE = 4.146, p = .29, η_p^2 = .031, for task condition, $F_{(1,39)}$ = 0, MSE = 3.534, p = .987, η_p^2 < .01, or for shape type, $F_{(2,78)}$ = 1.854, MSE = 36.274, p = .163, η_p^2 = 0.045. It is thus evident that overall pleasantness ratings were not influenced by the task, by the shape type or over time when any of these factors are considered in isolation.

In terms of the difference in responses to the three shape types between the two attention tasks, there appears to have been no overall difference in pleasantness ratings for the shapes between the congruent and pop-out conditions, $F_{(2,78)} = 1.241$, $MSE = 3.944$, $p = .295$, $\eta_p^2 = .031$. There was, however, a significant difference in pleasantness ratings for the three shape types over time, $F_{(4, 156)} = 2.659$, $MSE = 3.164$, $p = .035$, $\eta_p^2 = .064$. To determine whether this difference was due to a MEE, a post-hoc analysis of the combined ratings of the target across the task conditions compared to the baseline novel shapes was conducted. This analysis revealed no evidence of a MEE, the difference between the pleasantness ratings for targets ($M = 5.1$) and novel shapes ($M = 4.3$) after the exposure phase was not significant, $F_{(1,39)} = 2.6$, $MSE = 13.882$, $p = .115$, $\eta^2 = .53$.

The overall interaction between the task conditions and shape types over the course of the experimental session were also not significant, $F_{(4, 156)} = 0.312$, $MSE = 3.087$, $p = .870$, $\eta_p^2 = .008$. This indicates that the difference between task conditions did not influence pleasantness responses for the shape types over the course of the exposure phase. The pattern of pleasantness ratings across the experiment is displayed in figure 13.

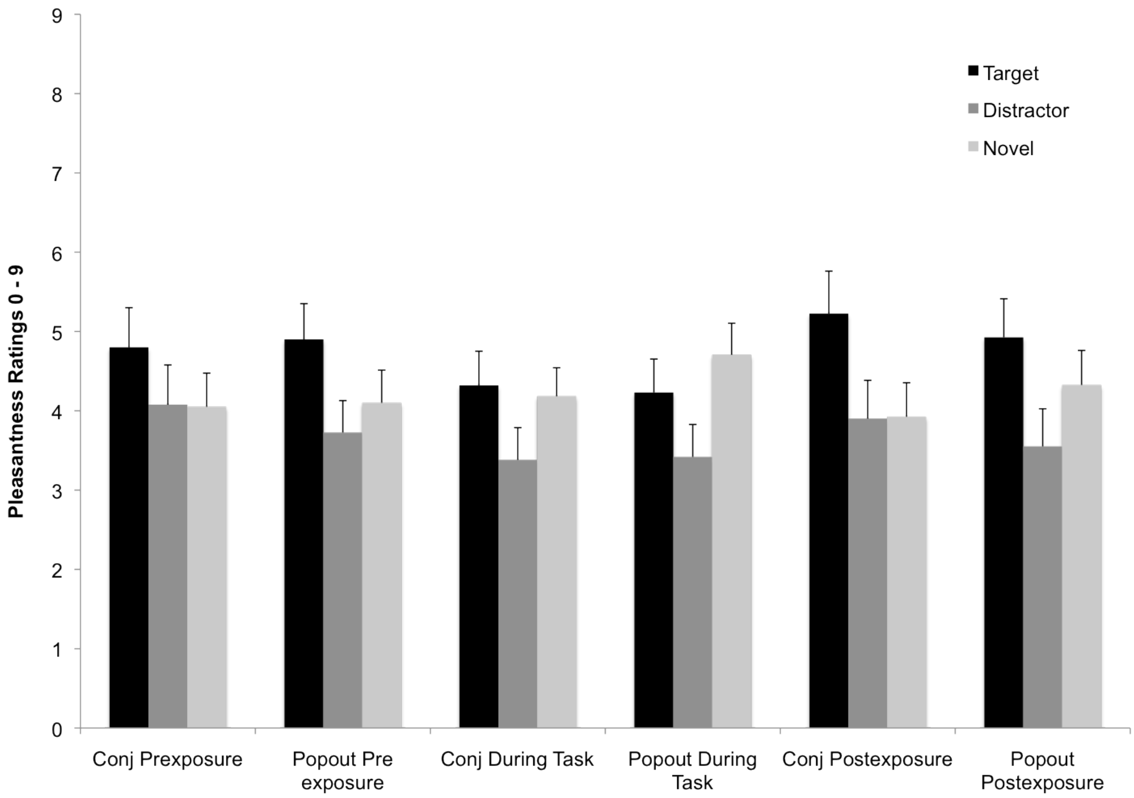


Figure 13. *Mean (SEM) pleasantness ratings for conjunction and pop-out conditions across experimental session*

Mean unpleasantness ratings across conditions over the course of the experiment session are illustrated in figure 14. As can bee seen in figure 14, the overall ratings of unpleasantness appear to have varied over time with the mean rating across shape types decreasing from 4.65 at the beginning of the session to 3.89 during the trials before increasing to 4.55 after the trials, the main effect for rating period was significant, $F_{(2,78)}$ = 12.167, *MSE* = 3.392, $p < .001$, $\eta_p^2 = 0.238$. However, neither the task condition, $F_{(1, 39)}$ = 0.253, *MSE* = 3.967, $p = .253$, $\eta_p^2 = .006$ or the shape type, $F_{(2,78)}$ = 3.062, *MSE* = 32.473, $p = .052$, $\eta_p^2 = .073$ independently influenced unpleasantness responses, though overall differences in responses to the three shape types is marginal.

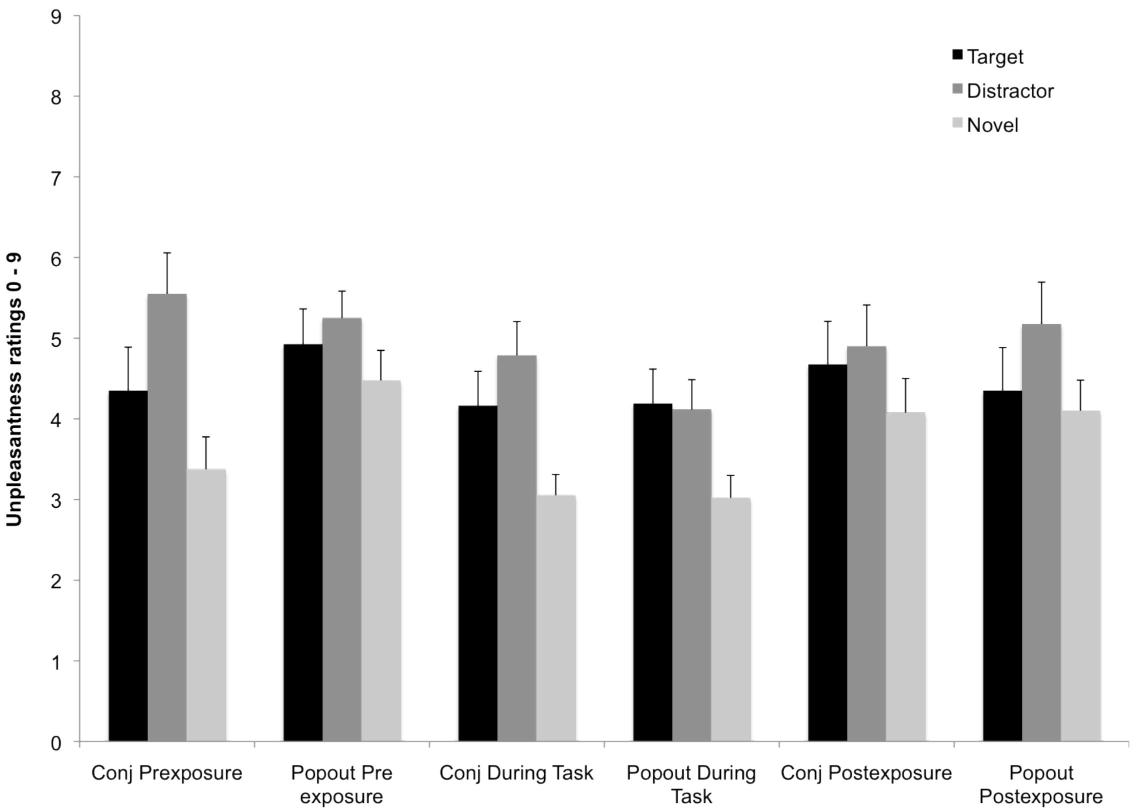


Figure 14. *Mean (SEM) unpleasantness ratings for conjunction and pop-out conditions across experimental session*

Unpleasantness responses do not appear to have been influenced by the differences between the attention tasks over time, as the interaction between these factors was not significant $F_{(2,78)}$ = 1.840, *MSE* = 3.985, p = .166, η_p^2 = .045. There is also no evidence that responses to the three shape types differed over the course of the experiment, $F_{(4, 156)}$ = 1.197, *MSE* = 3.024, p = .314, η_p^2 = .03. Similarly, the differences in unpleasantness responses to each of the shapes did not significantly differ between the two task conditions, $F_{(2,78)}$ = 1.338, *MSE* = 4.003, p = .268, η_p^2 = .033. Unpleasantness ratings also did not differ for each of the three shape types, between the task conditions, across the course of the experiment, $F_{(4, 156)}$ = 1.418, *MSE* = 3.342, p = .231, η_p^2 = .035.

In order to determine whether the concept of distractor changes attitudes towards those stimuli when they are assigned and help explain why overall unpleasantness rating changed over time, pre-exposure ratings of unpleasantness for distractors were compared to the baseline novel shapes. Unpleasantness ratings for distractors (M = 5.6) were significantly more negative than for novel shapes (M = 3.4) in the conjunction condition, $F_{(1,39)} = 10.856$, $MSE = 8.715$, $p = .002$, $\eta^2 = .218$, but not in the pop-out condition, $F_{(1,39)} = 3.563$, $MSE = 3.371$, $p = .067$, $\eta^2 = .084$. As pointed out by Nieuwenhuis, Forstmann and Wagenmakers (2011), a significant difference in one condition cannot be meaningfully compared with a non-significant difference in another, however, Hentschke and Stüttgen (2011) argue that effect size can be meaningfully compared under these circumstances. The effect size in the conjunction condition was large ($\eta^2 = .218$), while the effect size in the pop-out condition was small ($\eta^2 = .084$), thus suggesting a meaningful difference between the conditions. Participants in the conjunction condition had been given clear instructions about which shape type they were searching for, whereas in the pop-out condition, they were merely told to find red shapes. When participants are aware which stimuli are clearly not targets, those non-target stimuli are rated more negatively than novel shapes. A further comparison of unpleasantness ratings revealed that distractors (M = 4.8) continuing to be rated as more unpleasant than the novel shapes (M = 3.1) throughout the exposure phase, $F_{(1,39)} = 10.732$, $MSE = 7.463$, $p = .002$, $\eta^2 = .216$. Therefore, distractors were continually rated more negatively throughout the task, regardless of the task requirements.

Discussion

The current experiment confirmed the transient nature of distractor devaluation. Distractors in this experiment were rated more negatively than targets or novel shapes in the conjunction condition immediately after they were assigned as distractors, they were not rated any more negatively in the pop-out condition. Moreover, distractors were rated more negatively during the exposure phase in both conditions. There was no corresponding increase in positive responses towards targets. The results of experiment 7 therefore suggest a number of important factors determine the nature of the DDE. First amongst these is that the effect appears to be associated with the concept of a 'distractor' and this appears to drive the inhibitory processes thought to underlie the effect rather than resulting from these inhibitory processes. This is the simplest explanation for the finding that distractors were devalued even before there was any need to inhibit the processing of these stimuli. Participants appear to dislike distractors simply because they are not targets. Participants were instructed to search for rounded or straight-edged shapes that were also red in the conjunction task but only told to search for red shapes in the pop-out task. If distractors are marked negatively due to their status as distractors, there should be a significant difference between negative attitudes towards distractors in the conjunction condition but not in the pop-out condition and that is precisely what these results indicate.

Targets did not appear to be hedonically marked in the same way as distractors in this study and there was no evidence that targets were liked any more than novel or distractor shapes after the exposure phase. There are a number of reasons why no MEE was observed. Firstly, each type of shape (targets, distractors and novel) were exposed and rated during the pre-exposure phase of the experiment. The only shape type that was merely exposed in the most traditional manner were the novel shapes. From figure 12 it is clear that there was little change in positive responses between pre and post test exposure for novel shapes, however, there was an increase in the unpleasantness of the novel shapes and this is most likely due to boredom (see Bornstein, Kale & Cornell, 1990). As opposed to the target and distractor shapes, novel shapes were not task relevant and it has been found that a large number of exposures to shapes sharing certain features without being associated with a task can decrease liking for those shapes, resulting in a "craving for novelty" (Tinio & Leder, 2009, pg. 249). Targets and distractors were likely to have been spared this “massive familiarisation” (Tinio & Leder, 2009, pg. 241) effect by being relevant to the task at hand. As with the previous experiment, there is also the possibility that the exposure to the shapes in the RSVP streams is the reason participants can easily bring the stimulus to mind. The subjective experience of fluency is most likely to lead to an increase in liking when it is surprising (Whittlsea & Williams, 1998) which was not the case in this experiment. The pre-exposure of the stimuli in the pre-test makes it obvious to participants why the shapes seem familiar, and thus less likely that they will misattribute fluency as liking.

Overall, these results generally reflect distractor devaluation studies to date. The results from this experiment add to the data from a number of other studies showing a devaluation of non-relevant stimuli in search tasks. The novel finding in this experiment is that the devaluation appears even before the exposure phase begins. This devaluation is thought to be due to the distractors being the antithesis of the goal of finding the target. Similarly, the motivational value that is attached to the target is therefore reversed for distractors. This associative mechanism is also hypothesised to assist in making a search more efficient. By having a negative hedonic value attached to distracting stimuli, selective attention is then not only guided by a cognitive system, but also by an evaluative system, thus making the search more efficient (see also Ferguson & Bargh, 2004). This idea fits well with the subliminal DDE. Low-level unconscious evaluation of distractors occurs rapidly and can lead to a dislike developing for subliminal distractors. From an evolutionary perspective, this makes sense. As discussed, stimuli that have some adaptive emotional value are processed rapidly, ostensibly without conscious top-down input (Vuilleumier, 2005). Considering this, it is conceivable that the same evaluative system could be engaged to speed up search for goal-related targets and, as a by-product of this, obvious non-target stimuli are devalued.

General Discussion – Experiments 5, 6 and 7

Experiments 5, 6 and 7 suggest a number of important differences in approach and methodology are responsible for inconsistencies found in research examining the effect of exposure on liking. Results from experiment 5 indicate that processing fluency is feature based, or alternatively, that additional exposure to distractors similar to targets does not lead to a lower level of liking of those targets but rather an increase in liking compared to when distractors are dissimilar to targets. Even though it can be argued that these experiments are not an example of a situation whereby stimuli are ‘merely’ exposed, experiment 5 does support the effects of the misattribution of increased processing fluency on liking.

Results from experiment 6 suggest that increased attentional load does not necessarily lead to a devaluation of distractors and that the DDE is not related to differences in global or local feature processing. In contrast, the results of experiment 7 indicate that the effects of distractor devaluation could be transitory in order to assist in task completion but are not evident at a later rating of the stimuli. The devaluation of distractors could therefore be due to an evaluative mechanism that potentially facilitates search capacity by negatively hedonically tagging stimuli and features that are to be ignored. In this vein, Dittrich and Klauer (2011) asked participants to rate stimuli designated as to be accepted or to be rejected in a visual search task and found that a negative value is attached to stimuli designated as to be ignored regardless of the stimulus being a ‘target’ in the task. This negative valence could potentially tie into avoidance behaviour, which would further contribute to increased search efficacy.

The results of these experiments indicate that inhibition thought to underlie distractor devaluation is related to the effect but is not necessarily solely responsible for it. Results from experiment 7 suggest instead that distractors are hedonically marked to add an emotional element to enhance search efficacy. There is some evidence that having motivational value attached to a stimulus can enhance attention. For example, Raymond and O'Brien (2009; see also Rutherford, O'Brien & Raymond, 2010) found that stimuli with reward value presented in RSVP streams were more likely to be correctly identified. Attaching a hedonic component to distractors therefore appears to lead to the rapid emotional system influencing search efficacy. This proposal is consistent with accumulated evidence showing that stimuli that have biological emotional valence and relevance draw attention. For example, snakes and spiders draw and hold attention when compared to other stimuli presented in a similar manner (e.g. Öhman et al. 2001). Although much of the evidence of emotional modulation of attention comes from biologically relevant stimuli, it is likely that the same evaluative system is brought to bear on other search scenarios where the stimuli have conceptual hedonic value.

Despite the parallels between stimuli with an assigned motivational value and biologically relevant stimuli, target stimuli in an attentional task may not have hedonic value attached to them in the same way. Theories of goal pursuit and motivation explain the attitude towards a target as being related to its utility. It would be interesting to examine whether attitudes towards a target are marked positively in the same way that distractors are marked negatively. There was no evidence of increased liking for targets in the current experiment suggesting a distinct process. Most likely, any positive value attached to targets is directly related to task completion (Prescott et al., 2008). Another possible explanation for the inconsistent positive and negative evaluations revealed in the current research comes from mounting evidence suggesting that the utility of a stimulus generates a different kind of positive response than what is usually considered 'liking' (Dai et al., 2010). Berridge (1999, 2004) argues that there are two distinct systems responsible for preference formation based on 'liking' and 'wanting' independently. This raises a number of questions about whether the positive responses to merely exposed stimuli are 'liking', as makes the most intuitive sense, and how these responses are altered by making exposed stimuli goal-relevant inducing 'wanting'. Perhaps the different approaches to examining the mere exposure and distractor devaluation effects are also being confounded by these disparate systems. Perhaps distractor devaluation is about 'not wanting' whereas the MEE is about a persistent increase in liking. Whatever mechanisms underlie the emotional influence on search efficacy, it is apparent that motivational value is an important consideration in the DDE and MEE.

The results of experiments 5, 6 and 7 have broad implications for the understanding of both the MEE and the DDE. As discussed, it appears that the DDE is as much about the motivational value attached to the distractor because it is the antithesis of the target as it is a result of inhibitory processes. That is not to say that the two do not work together to influence preference responses and this is something that requires further investigation. The implication that there is some element of an association between the distractor and the motivation to complete the task contributing to the DDE means that this effect can contribute little to the understanding of the MEE. The MEE is, by definition, about the affective consequences of non-associative exposure to a stimulus (Kruglanski & Stroebe, 2005; Zajonc, 1968). Hedonic value appears to be attached to targets and distractors due to their being either sought or something that is getting in the way of what is being sought and this may explain why the DDE and the MEE are based on different underlying processes. This hypothesis was tested using a typical distractor devaluation experiment presented in the next chapter.

Chapter 6. Replicating and rethinking the distractor devaluation effect

Experiments presented thus far have tested a number of variables within both the mere exposure and selective attention realms. The first two experiments tested the modulating effect of selective attention on the MEE and found that, although selective attention can modulate the effect, there was no evidence of a DDE. Results from experiments 3 and 4 suggest that the presentation of subliminal distractors can contribute to a devaluation of distractors and that this devaluation also appears to be feature based. Experiments 5, 6 and 7 suggest that processing fluency is important, even for ignored distractors and that the DDE is based on the motivational value of the exposed stimuli based on their relevance to the task.

Although evidence for the involvement of an association between motivational value and distractor devaluation has been observed in experiments thus far, these results need to be replicated under conditions known to reliably elicit a DDE. The experiments presented thus far have used methods more akin to those examining the MEE and selective attention and therefore leave unanswered the question of whether they are comparable and relevant to previous examinations of the DDE. In order for a complete understanding of the implications of the current research to existing models of the DDE, the hypotheses generated by the current research must be applied to a standard distractor devaluation experiment. The DDE raised questions about the processes underlying the effects of exposure on preference. It is imperative to replicate the conditions from which these questions were raised in order to understand how the motivational mechanisms uncovered in experiment 7 contribute to the overall picture of the effects of exposure on evaluations.

Experiment 8

What remains unclear after the experiments conducted thus far is whether the DDE represents a reciprocal relationship between emotion and attention, or whether the effect is an artefact of motivational factors (see also Buttaccio & Hahn, 2010). That is, the negative ratings of distractors might result from the motivational factor of it being the ignored or rejected stimulus in the search task. This interpretation is consistent with the results of experiment 7 but the hypothesis has not been tested within an experiment more like those typically used in distractor devaluation studies.

Thus, while there is evidence suggesting devaluation is the result of inhibition applied to the distractor during the task, it is unclear if there is any influence of top-down goal related motivation on this devaluation. Wanting, as opposed to liking, is more about the utility of a stimulus, that is, the stimulus is related to current or future goals (Berridge, 1999). Liking does not necessarily have a clear relationship with a goal and is instead related to sensory pleasure (Berridge, 2003). For example, one might like cheesecake but might not want to eat cheesecake because of a goal to lose weight. Separating the differences between rejection or not wanting and disliking is important because it is becoming apparent that the two 'types' of emotional representation are distinct (Dai et al., 2010). Thus, in the DDE, is it that the unattended distracting stimulus is just rejected or is it truly disliked? Should a genuine dislike develop for non-target stimuli, this could have implications for marketing that relies on incidental exposure to increase affiliation with brand names, logos or other messages aimed at influencing consumers (for review see Ferraro, Chartrand & Fitzsimons, 2009).

If distractor devaluation is about task relevance, it will be observable when it is most applicable (i.e. during the task) but should diminish after the task is completed as was evident in experiment 7. In contrast, the opposite is typically observed in the MEE, with liking for exposed stimuli peaking after the exposure phase (see Bornstein, 1989). Mere exposure of a stimulus can result in it becoming preferred compared to a novel stimulus, even when it is irrelevant to the goals or motivations of the observer (Zajonc, 1968). This increase in liking requires no association, no reinforcement and appears to be due to nothing more than the stimulus becoming easier to bring to mind through more fluent mental processing (Bornstein & D'Agostino, 1992). The results of experiments 6 and 7 suggest however that there must be scope for the feeling of fluency to be misattributed in order for an increase in liking to occur.

Liking resulting from mere exposure becomes most apparent after a wait period, if distractor devaluation represents a persistent dislike for the distractor based on the same underlying mechanisms, the effect will be evident after a wait period as it is with the MEE. The following experiment therefore examined the devaluation of distractors over time within a standard distractor devaluation experiment (as per Raymond et al., 2003) to determine if the effect is about goal-relevance.

If the DDE is just a function of the motivational value of the distractor, these stimuli will be disliked during the task but attitudes toward them will return to neutral after the search task is completed, similar to the results found in experiment 7. On the other hand, if the distractors become generally disliked then the effect should persist beyond the end of the exposure phase. Emotional reactions to the targets are harder to predict. If a wanting-related positive attitude towards the target stimulus exists and is based on its relevance to the goal of the task, then targets should be rated more positively during the task. Targets are also essentially not 'merely' exposed in this experiment so, as per experiment 1, there is less chance of an increase in liking being observed in this experiment.

These attitudes will again be measured using pleasantness and unpleasantness scales. Although these are not directly assessing 'wanting', which could be achieved using a behavioural measure, there is sufficient evidence to suggest that the hedonic impact of motivation can be detected using measures of pleasantness (Audi, 1973; Berridge, Robinson & Aldridge, 2009; Grabenhorst, D'Souza, Parris, Rolls & Passingham, 2010). Moreover, Berridge and Aldridge (2008) argue that although divergent processes, 'liking' and 'wanting' are inextricably linked to pleasantness. Studies investigating the results of behavioural action on affective evaluation have also consistently used pleasantness as a measure (e.g. Buttaccio & Hahn, 2010; Centerbar & Clore, 2006), suggesting that the motivations driving actions in these studies can be detected using measures of pleasantness (see also Ping, Dhillon & Beilock, 2009). In keeping consistent with the research presented thus far and with previous research on the DDE (for example, see Goolsby et al., 2009), pleasantness measures were retained in this experiment, as subjective pleasantness appears to be influenced by both liking and wanting.

Methods

Participants

Twenty-eight psychology students (18 female) volunteered for this research and received course credit for participation. The sample included participants 17 to 48 years of age with a mean age of 23.7 years old. Participants all reported normal or corrected to normal vision.

Materials

Materials were the same as those used in previous experiments.

Procedure

The search array used in this experiment consisted of two shapes, one straight-edged and the other rounded, which were presented to the left and right of a central fixation point as per a number of distractor devaluation studies (see for example Raymond et al., 2003). The task consisted of subjects locating a target, with either straight or rounded edges. Half the participants had to search for targets with round edges while the other half had to search for straight-edged targets. Targets and distractors were counterbalanced across conditions; targets for some participants were distractors for others. Each of the 20 targets and distractors appeared six times throughout the trials.

Each trial began with the word 'Ready' appearing on the screen in 18 point black font for 1000 ms. This was followed by a fixation cross for 500 ms, after which the target and distractor stimuli were presented for 500 ms. The eccentricity of each stimulus was approximately half the width of the stimulus. As soon as the stimuli disappeared a question mark appeared on the screen and participants indicated the location of the target by pressing the 'Z' key if the target appeared on the left and 'M' key if it appeared on the right. After each search trial, participants rated either the pleasantness or unpleasantness of one of the two exposed shapes or a novel shape (from the same set of novel shapes used in previous experiments). Only one rating was made after each trial, the shape to be rated was randomly determined by the computer. Ratings were made on a scale with anchor points at 0 (neutral), 5 (moderately pleasant or unpleasant) and 9 (extremely pleasant or unpleasant). Pressing the key to make the rating initiated the next trial.

Participants completed trials until they had rated each of the 20 targets, 20 distractors and 20 novel shapes three times for pleasantness and three times for unpleasantness, making 120 trials in total. These ratings were also randomly dispersed throughout the trials. As each trial only assessed one of the shape types (i.e. targets, distractors or novel shapes) each of the 20 shapes of each type were only rated once each for pleasantness or unpleasantness, as per numerous distractor devaluation studies.

Five minutes after the completion of the search trials the participants rated a distractor, target and novel shape each again on both pleasantness and unpleasantness using the same rating scales as those within the exposure phase. Participants were all asked to guess the hypothesis of this experiment.

Results

Although a number of participants guessed that this experiment was specifically about preferences due to exposure, none were able to clearly explain the hypothesis and no data were excluded on this basis. This experiment was designed to replicate a standard distractor devaluation study incorporating the findings of the previous experiments. In keeping with this approach, the analysis was also conducted in a manner similar to that in other studies examining the DDE with positive and negative ratings kept separate. The mean rating scores for each shape during and after the task are displayed in table 8.

Table 8.
Mean (SD) ratings of pleasantness and unpleasantness during and after exposure to stimuli in the search task

	Pleasantness		Unpleasantness	
	During task	After task	During task	After task
Target	4.71 (2.23)	4.83 (3.18)	3.87 (2.12)	4.53 (3.37)
Distractor	3.44 (1.97)	3.60 (2.50)	4.72 (2.28)	4.10 (3.25)
Novel	3.53 (1.82)	4.03 (2.45)	3.54 (1.90)	4.00 (2.85)

Due to the difference in mean ratings of the novel shapes during and after the task, difference scores for each condition were calculated. Difference scores were used in this case in order to determine how much the mean ratings of pleasantness and unpleasantness differed from the baseline novel shapes. The analysis was conducted in this way to emulate as close as possible the methods used in distractor devaluation studies while also conserving the independence of the positive and negative scales. These difference scores are illustrated in figure 16.

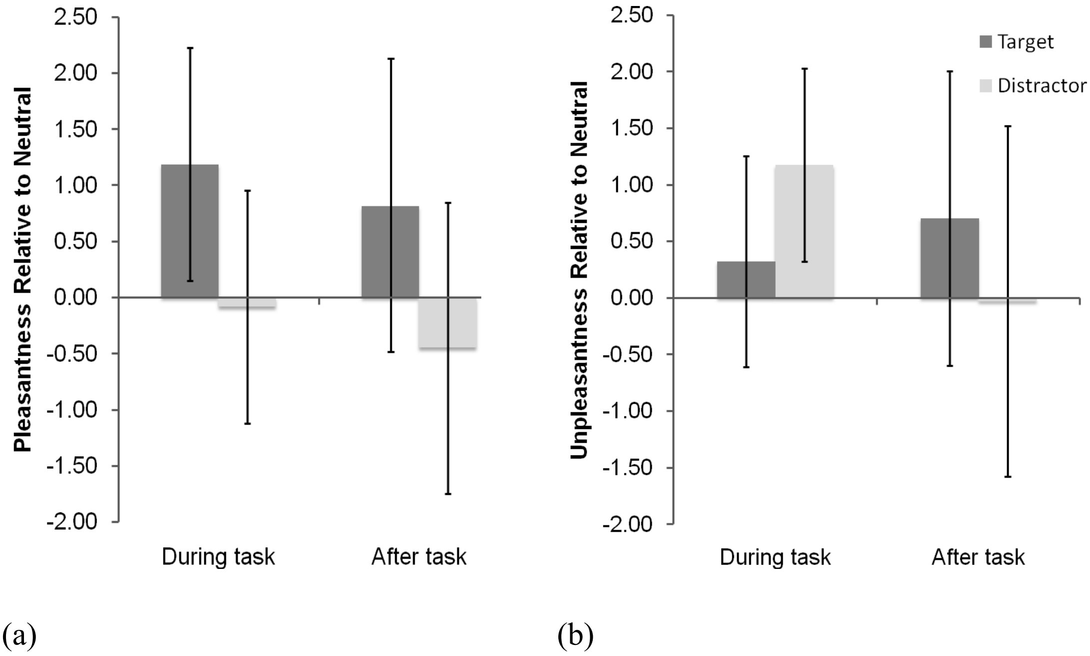


Figure 15. Mean (95%CI) pleasantness (a) and unpleasantness (b) ratings for exposed shapes compared to neutral during task/exposure phase and post-exposure.

As can be seen in Figure 16, pleasantness ratings of the target during the task (M = 4.71) were higher relative to the baseline (M = 3.53), M = 1.19, 95% CI [0.15, 2.23]. Ratings of unpleasantness for the distractor (M = 4.72) were similarly higher relative to the baseline (M = 4.03) during the task, M = 1.17 95% CI [0.32, 2.02]. These differences were not evident when participants were again asked to rate the shapes after the task.

Discussion

The results of this experiment suggest that the DDE represents rejection rather than a persistent dislike for distractors. As predicted, distractors were rated more negatively than novel shapes during the exposure phase and targets were rated more positively. These negative and positive biases for targets and distractors were not evident when participants were again asked to rate each type of shape five minutes after the exposure phase. What was somewhat surprising is that positive responses were greater for target shapes than novel shapes during the task. This is not what was predicted based on the results of experiment 7 and this could indicate that some positive value is also attached to the target during the task to assist with successful task completion. It is also noteworthy that there was no evidence of a MEE in this experiment. As with experiment 1, it would appear that engaging in the task has altered the way in which the shapes are processed. Generally, the results of experiment 8 suggest that the effects of distractor devaluation are transitory and related specifically to the task. Longer term likes and dislikes due to exposure are potentially influenced by a number of competing factors as is evident from the mixed results of previous experiments in the current research.

The results of this experiment are also interesting in terms of what they mean for theories of visual search. The results suggest a top-down emotional element can be engaged to assist visual search. Although it is apparent that biologically relevant stimuli can draw attention (Öhman et al., 2001), there is evidence here to suggest that stimuli given an arbitrary goal-related value can also help to guide attention towards targets and away from distractors. Top-down, goal related information appears to drive an evaluative system that potentially assists with increasing efficiency of search and leads to distractor devaluation. Given that Kiss et al. (2007) found a relationship between efficient searching and distractor devaluation and that the brain structures involved have a reciprocal relationship (Vuilleumier et al., 2004), it is entirely plausible that arbitrarily defined goal-related stimuli can develop a hedonic value to make the task of finding a stimulus more efficient.

Considering the amount of visual information there is in any given environment, it makes adaptive sense that we can quickly adjust to an environment by using all available resources to effectively find stimuli we are interested in whether it is because we like it, want it or otherwise want to avoid it (see also Bradley, 2009). Future research into distractor devaluation could look at the influence of this top-down, evaluative system on search efficiency. The downstream consequences of this evaluation on decision-making processes would also be worth investigating.

The other implication of experiment 8 is that the DDE appears to have little to contribute overall to the literature seeking an explanation of the development of persistent likes and dislikes due to exposure. Ultimately, it appears that distractor devaluation is related to not wanting distractors. There is also some evidence to suggest that positive attitudes towards targets are enhanced to assist with task completion, however, this proposition is not supported by the results of experiment 7. As opposed to these transient processes, the longer-term development of a preference is at the mercy of a number of factors that appear to have contradictory implications for what is liked and not liked. Despite the apparent complexity evident in preference formation, this experiment supports dual evaluation systems based on goal-related motivation and persistent preference formation. Motivational factors appear to contribute to increased search efficiency by marking targets with positive affective value and distractors with negative value.

The dislike attached to the DDE appears to be transient. In terms of broader implications of this transience, these short-term affective responses could be problematic for effective marketing strategies. Much of the exposure to advertising occurs in situations where consumers are engaged in a search task of some description (Nielsen, Shapiro & Mason, 2010). An example of this is incidental advertising presented during sporting events. Following the play during a football match is analogous to a search task in that only certain features of the visual display are attended to while others, including advertising, are ignored. Should ignoring have resulted in an ongoing dislike for distractors, it would suggest that the large investment in this type of advertising would be wasted and, in fact, counterproductive. Distractor devaluation appears to be a phenomenon related directly to task-relevance, it would appear that likes and dislikes are the result of numerous competing factors and this investment in incidental advertising remains a relatively uncertain option. The implications of this research will be discussed further in the general discussion to follow.

Chapter 7. Summary, general discussion and conclusions

The aim of the experiments presented here was to shed light on the relationship between the mere exposure and distractor devaluation effects. This research was intended to determine whether these effects are based on the same underlying mechanisms as proposed by Tavassoli (2008) and whether observations of the DDE really do call into question explanations of the MEE based on perceptual fluency as inferred by Fenske et al. (2004). The exploration of the DDE cast doubt on findings associated with the extensive literature on the MEE and raised questions about the possible influence of selective attention on the effect. As discussed in the introduction, a number of experimental observations suggest that repeated, non-reinforced exposure to a novel and neutral stimulus reliably leads to a preference for that stimulus. The DDE called this into question simply by being an example of unreinforced exposure leading to a dislike.

The effect of attention on the MEE was also unclear, as was the effect of attention on emotion in general. However, the influence of attention did provide a possible explanation for inconsistencies in theories attempting to explain the MEE. Thus, the aim of this research was to provide a clearer understanding of what the more recent phenomenon (distractor devaluation) can contribute to the understanding of the more established research field (the MEE). This research has consequently examined the most important variables within the mere exposure, selective attention and distractor devaluation paradigms.

This chapter will address the most relevant features of each of these paradigms and elucidate the implications of the current research with respect to each. The first of these arenas that will be addressed is that of the MEE.

Modulation of the mere exposure effect

The first two experiments in this research program examined the question of whether or not selective attention can modulate the MEE. In terms of developing an understanding of the relationship between the two effects, this was a necessary first step in the process. By establishing that engaging selective attention in a task could influence the MEE, there was common ground on which to examine the MEE and DDE to determine under what circumstances exposure to a stimulus results in liking or disliking.

The outcome of these experiments strongly suggests that the MEE can be modulated by selective attention. Participants undertook a colour naming and a visual search task and, in both cases, the MEE was attenuated when participants were engaged in the task. These results generally support those of Prescott et al. (2008) and Yagi et al. (2009). Thus, engaging selective attention appears to decrease the likelihood that an exposed stimulus will become preferred over a novel stimulus. A modulation of the MEE by selective attention is not surprising considering it has been observed in other studies. What is still debatable is whether or not these findings contribute to a better understanding of the mechanisms responsible for the effect.

The observation that the MEE can be altered through attentional processes is consistent with the assertion that cognitive processes are involved in the effect or at least that cognitive processes can modulate it. Whittlesea and Price (2001) argue that cueing different recall methods aimed at catering to analytic or synthetic processing of stimuli can alter the MEE. Similarly, Craver-Lemley and Bornstein's (2006) mere exposure study with an ambiguous duck/rabbit stimulus provided some evidence that higher cognitive processes can modulate the MEE. The idea that the nature of the task and the processing strategies they cater to are responsible for divergent recognition and preference responses has also received some support (Willems & Van der Linden, 2009). The experiments presented here suggest that the top-down influence appears to affect stimulus encoding via attention or inattention early in the perceptual process. Given the evidence that perceptual priming can be modulated by manipulation of selective attention (Stevens et al., 2008), it is possible that the same top-down influence over perceptual processing is behind the modulation of the MEE. Although it seems counter-intuitive that previous experience can influence the way a stimulus is processed at the lowest levels of perception, there is evidence to suggest that the perception of stimuli is influenced by top-down processes early in the perceptual process (Palmeri & Tarr, 2008). This is particularly so when selective attention is engaged and stimuli are repeatedly exposed (Paffen, Verstraten & Vidnánszky, 2008). Ultimately, whether or not this previous experience, perceptual learning or goal-driven process represents a real top-down influence on perception is still under debate, as the process always begins with pre-attentive processing of stimulus features (Theeuwes, 2010).

Whether or not the MEE occurs due to pre-attentive or feature processing, if the conceptual status of ‘target’ attaches some level of goal achievement to that stimulus, it could be changing the inherent value of the stimulus. Experiment 1 suggests that the situation is a little more complicated than that. Preference and familiarity were assessed in terms of features of the stimulus. However, the features on which preference choices were made were irrelevant to the task in experiment 1. Thus, the fact that selective attention was engaged, rather than whether the stimulus had the status of target or distractor, modulated responses to exposed stimuli. The results of experiments 6 and 7 add to this explanation by suggesting that it is not necessarily a change in attentional load or differences in processing strategy that is altering the MEE, but rather the engagement of selective attention per se that is varying liking responses.

The MEE is ultimately forwarded as the best example of non-associative learning in preference formation (Hermans, Baeyens & Eelen, 2003; Kruglanski & Stroebe, 2005). Given that the results of the current experiments suggest that the engagement of selective attention can modulate the effect, it is essential to question whether the results presented here are relevant at all to the understanding of the basic phenomenon of the MEE. The alternative argument is that this modulation causes the stimulus to have a hedonic value associated with it and it therefore is no longer just being 'merely' exposed.

In terms of understanding the current studies within existing explanations of the MEE, the results in a number of experiments in this research would suggest that misattributed perceptual fluency is producing preferences for exposed stimuli. Experiments 2 and 3, in particular suggest that perceptual fluency can influence preferences for supraliminal and subliminal exposure to a stimulus and experiments 6 and 7 indicate that these preferences are attenuated when the source of the fluency is obvious. The exact implicit nature of the processes underpinning preference formation are still to be determined as the affective priming results of experiments 3 and 4 and those of Ying and Renlai (2008) are yet to be replicated and explained. Ultimately, as the results of this research support the positive influence of perceptual fluency through exposure, it is reasonable to assume that increased perceptual fluency misattributed as liking is still the most parsimonious explanation for the effect (see also Dechêne, Stahl, Hansen & Wänke, 2009). No observations in any of the experiments presented here suggest otherwise.

Given that there appears to be a motivational value attached to targets and distractors in selective attention tasks, it is arguable that the modulation of the MEE presented here and supported elsewhere (see Prescott et al., 2008; Yagi et al., 2009), is not merely the result of an alteration in the mechanisms underlying the MEE but due to two distinct processes working concurrently. Taking experiment 1 for example, the condition where stimuli were presented passively without requiring any response is typical within the mere exposure paradigm and fits well with the 300 or so other reported observations of the effect. The other condition, where participants were asked to name the colours of the shapes presented, changed the nature of the processing of those stimuli. A negative (or at least less positive) value appears to have been attached to irrelevant dimensions of distractors. Seitz and Watanabe (2003) found that motivational value can be attached to irrelevant stimulus features pre-attentively via an internal reward mechanism and such a mechanism could explain the differences in preference responses between conditions in experiment 1. How this motivational value becomes attached to irrelevant characteristics of distractors remains to be seen, however the ‘internal reinforcement’ system proposed by Seitz and Watanabe provides one possible explanation.

Alternatively, Wegener and colleagues (Wegener, Ehn, Aurich, Galashan & Kreiter, 2008) reported that non-relevant features of target objects are suppressed in a similar way to the attentional inhibition underlying the DDE. In experiment 1, colour was the target feature and thus stimulus complexity was irrelevant. Therefore, these stimuli were processed in a different way to those presented in the passive viewing session based on the association each of the features had with the goal of identifying the colour of the stimulus. By attaching a goal-related value to the stimulus, they are no longer being merely exposed. However, the positive affect associated with increased fluency may have opposed the inhibitory mechanism enough to ensure that the exposed shapes were still preferred over novel shapes.

The results of experiments 7 and 8 confirm that attaching a goal related value to a stimulus changes the hedonic value of the stimulus and, therefore, the stimulus is no longer neutral. The results of experiment 7 imply that this motivational value has a greater influence over liking than mere exposure does. Although mere exposure can alter attitudes towards stimuli, their motivational value is more likely to influence the affective response to the stimulus. How attitudes towards goal relevant stimuli can be altered through mere exposure and whether goal-relevant motivation or mere exposure is likely to lead to stronger and more persistent preferences remains to be seen. Although it was beyond the scope of the present research, this is a question that warrants further examination. The issue of hedonic marking of targets and distractors will be discussed further in relation to the subliminal DDE.

One factor that was explicitly examined in this research, and is important for understanding the relationship between the MEE and the DDE, is the subjective experience of familiarity. Familiarity appeared to contribute to positive responses to stimuli in experiments 1 and 2. This familiarity appears to have been attached to the number of points of the shapes in these first experiments and suggests that this feature was being used to form a global, non-analytic assessment of preference as would be predicted by Whittlesea and Price (2001). There was no such subjective experience of familiarity in experiment 3 when the distractors were presented subliminally and there was consequently no evidence of a subjective increase in liking. Taken together, the results suggest that a subjective feeling of familiarity could be important for the MEE but not in the DDE. Indeed, Hansen and Wänke (2009) have argued that at least an implicit familiarity with a stimulus is necessary for increased positive attitudes due to exposure, particularly in the subliminal MEE. It is difficult to know whether the affective priming task in the current experiments detected familiarity or affect. Kinoshita and Peek-O'Leary (2005) examined the very similar Implicit Association Test (IAT) and found that biases in responses in this test were the result of salience associated with familiarity and not an affective bias. Nevertheless, it appears that familiarity is not related to the DDE in the same way it is to the MEE.

Although implicit familiarity was not directly assessed in these experiments, the results of the current research suggest that familiarity is more likely to lead to a preference for exposed stimuli. Familiarity has been proposed as a necessary prerequisite for the MEE by a number of authors (e.g. Hansen & Wänke, 2009; Wang & Chang, 2004; Zizak & Reber, 2004). There is also evidence suggesting that familiarity itself is experienced as affectively positive (de Vries, Holland, Chenier, Starr & Winkielman, 2010) and, alternatively, positive affect can lead to a sense of familiarity, highlighting the intrinsic and bi-directional relationship between them (Garcia-Marques, Mackie, Claypool & Garcia-Marques, 2010; Monin, 2003). Further examination of the role of familiarity in the DDE and subliminal DDE is needed to determine exactly how subjective and implicit familiarity contributes to these effects. For the purpose of this research, it appears that familiarity does contribute to the MEE but perhaps not to the DDE and is one of a number of differences in the factors contributing to each effect.

The subliminal distractor devaluation effect

Following the confirmation of the modulating effect of selective attention on the MEE, it was necessary to determine if distractors presented subliminally lead to a devaluation of or a preference for the exposed stimulus. One of the strengths of the perceptual fluency model of the MEE is that it can account for the subliminal MEE while a number of other models cannot (Winkielman et al., 2003). Thus, it was necessary to examine the consequences of exposure to a subliminal distractor. The perceptual fluency model of the MEE would lead to the prediction that subliminal exposure to the stimulus would reliably produce a preference for it. This is particularly so as the exposure should have led to an unexpected subjective experience of fluent processing (as per Whittlesea & Williams, 1998). Despite there being some evidence for more positive appraisals of the distractor in the affective priming task, subliminal exposure to a distractor did not lead to it being selected as more preferred. Both experiments 3 and 4 found a devaluation of the subliminally exposed stimulus and shapes like it in comparison to novel shapes. This supports the concept that low-level inhibitory mechanisms might underlie the DDE. Similarly, Zhou and colleagues (2007) found devaluation using artificial grammar learning, which generalised to novel stimuli sharing the same underlying structure as inhibited distractors. This suggests that, like reports of the DDE to date, this effect is feature based. Moreover, a feature-based model is also consistent with a number of theories of selective attention that specify pre-attentive processing of stimulus features (see Wolfe, 2007).

Overall, the current research into the subliminal DDE leads to the conclusion that pre-attentive inhibitory processing of distractors also produces a dislike of those distractors and similar stimuli. As opposed to the other observations of the DDE, in the current experiments, this devaluation was evident some time after the exposure phase. Perhaps this is due to some form of processing disfluency causing surprise in the same way the feeling of fluency is more effective at leading to a preference for exposed stimuli in the MEE when it is surprising. The alternate hypothesis is that the distractors became disliked through some form of implicit evaluative conditioning. It is plausible that participants found the task in experiments 3 and 4 frustrating and developed a negative attitude towards it. This attitude may have then become associated with the distractor, leading to it also becoming disliked through association with the task. Despite Hofmann and colleagues (2010) arguing that evaluative conditioning relies on contingency awareness and thus cannot be implicit, evaluative conditioning has been known to occur implicitly (de Houwer, Hendrickx & Baeyens, 1997; Hütter, Sweldens, Stahl, Unkelbach, & Klauer, 2011) and associations have been formed between subliminally exposed stimuli and task-related affect (Custers & Aarts, 2005). What remains unclear is why this effect should only be observable for ratings of the distractor. If evaluative conditioning is involved, the negative affect that results could potentially imprint on all stimuli associated with the experiment. Future research could examine why subliminal distractors lead to a more resilient dislike of distractors that does not appear to influence other stimuli presented in a similar way.

The results of these two experiments lead to some interesting implications. Firstly, it is possible that the hedonic tagging of distractors can occur outside of conscious awareness. If this is the case, this is something that the distractor devaluation and mere exposure effects share and suggests that pre-attentive perceptual processing could lead to both liking and devaluation. Experiments 3 and 4 provide evidence that distractor devaluation, like preferences through mere exposure, can occur in situations where participants have no conscious recollection of being exposed to the stimulus. In both cases, it provides compelling evidence that the affective component of perception works rapidly and that evaluation does not require conscious processing of the stimulus. This is supported by the results of numerous subliminal mere exposure experiments, priming experiments and neurological studies (see Duckworth, Bargh, Garcia & Chaiken, 2002). However, there is very little other research suggesting that a dislike can develop based on pre-attentive exposure to a stimulus. In this case, the engagement of attention in the letter search task led to a pre-attentive devaluation of the distractors. Importantly, there is evidence in the current experiments suggesting that this devaluation is linked to feature processing and is persistent beyond when the negative affect is likely to enhance search efficacy.

When looking at the potential parallels between models of the DDE and the feature integration theory of selective attention, it is not surprising that evidence for a subliminal feature-based DDE was observed. Feature integration theory (Treisman & Gelade, 1980) is based on pre-attentive processing of stimulus features, in this case the pre-attentive processing also appears to be evaluative: distracting features are marked as negative which we argue makes the search more efficient. Considering that evaluative mechanisms are presumably rapid processes, it is also not surprising that hedonic marking of the distractor has an effect pre-attentively. The observation that distractor devaluation can occur unconsciously is also interesting because, as opposed to conditions leading to a MEE, there is no evidence of a subjective sense of familiarity with the distractors.

Another implication of the subliminal DDE is that it can potentially explain why a number of studies failed to find an enhanced MEE for subliminal stimuli. For example, Newell and Shanks (2007) presented subliminal faces and geometric shapes in an RSVP stream and found no evidence of a subliminal MEE. Participants were instructed to pay attention to the supraliminal stimuli and were hence ignoring subliminal faces and shapes, which therefore became distractors. Given the results of experiments 3 and 4 of this research, the results of their study are not surprising. The subliminal distractors were not goal-relevant and would have also been prone to attentional inhibition, hence nullifying the effect of the exposure on persistent liking. It is possible that the devaluation of the distractor due to engagement in the selective attention task and the increase in fluency caused by the subliminal exposure occurred in parallel and cancelled each other out. The subliminal DDE therefore could potentially account for these findings, however, this would require further investigation.

Motivational mechanisms and distractor devaluation

The results of experiment 7 strongly suggest that a hedonic marking of distractors contributes to the DDE. This was confirmed in experiment 8 within a characteristic distractor devaluation experiment. These results contribute substantially to the fledgling field of distractor devaluation studies and support the conjecture originally forwarded by

Prescott and colleagues (2008) that the DDE is the result of motivational mechanisms. Raymond and Fenske (2006) have made a case that distractor devaluation is based on inhibitory processes and, although there was some evidence to suggest that the exposure to distractors did enhance the effect, distractor devaluation was evident from the point when target or distractor status was set. This was highlighted particularly by experiment 7 where the task relevant feature in the conjunction condition led participants to dislike shapes that clearly did not meet the criteria for a target in comparison to a pop-out condition where the feature by which preference judgements were made was not task relevant.

The hedonic marking of distractors has some interesting implications for the visual search paradigm. These results suggest that visual search is guided not only by the mechanisms outlined in the selective attention literature, but is also guided by an evaluative based system (see Krieglmeyer, Deutsch, De Houwer & De Raedt, 2010; Vuilleumier & Huang, 2009). This system attaches a negative hedonic value to distractors that appears to increase search efficacy. Vuilleumier and Driver (2007) argue that the interconnectedness of the visual cortex, amygdala and fronto-parietal regions evident from psychophysiological research provides strong evidence that the areas responsible for attentional and emotional processing fundamentally influence each other. Although there are many studies indicating that attention is biased towards biologically significant stimuli, there is little research to date that suggests that an emotional system guides attention and visual search for arbitrarily assigned distractors and targets. Neurological evidence does however support this conjecture. Padmala and Pessoa (2008) found evidence that learned emotional significance of a visual stimulus led to faster and more accurate responses to the stimulus than to neutral stimuli. Functional magnetic resonance imaging (fMRI) demonstrates that this enhanced performance corresponds with increased activation in the parts of the visual cortex dealing with the earliest stages of visual processing (V1). Serences (2008) replicated this finding with motivationally relevant stimuli and argued that the value-related modulation of the visual system occurs not only early in visual processing but also implicitly. Furthermore, Kiss, Driver and Eimer (2009) found that manipulating the reward value of a single feature of a stimulus influences selective attention and Raymond and O'Brien (2009) presented evidence that stimuli with some sort of motivational value are more likely to be recognised than equally exposed stimuli presented in RSVP streams. Together these studies provide persuasive evidence that a learned emotional response to a stimulus can influence perception and attention at the earliest stages of processing.

Enhancing visual search capacity via the emotion system could lead to an evolutionary advantage. There are many distracting stimuli in any environment and the visual system needs to filter out a large proportion of these stimuli in order to effectively deal with relevant information (Cisek & Kalaska, 2010). Being able to assess and react rapidly to potential threats such as snakes and spiders is of obvious survival value. Not all stimuli in the environment are as obvious as a snake or spider in terms of the salience for the allocation of attentional resources – many stimuli have learned value and these can also become processed preferentially (Della Libera & Chelazzi, 2009). The added efficacy that this hedonic marking of distractors gives to any search situation, be it something of biological significance or not, has great adaptive advantages. Having the emotional system engaged in these situations allows for a rapid response because the emotional system also hastens action (Öhman et al., 2000).

Attending to threatening stimuli in the environment must be driven by top-down processes to ensure rapid and relevant action. Rolls (2005) suggests that different approaches are taken to drive approach or avoidance of stimuli and that this requires sufficient information to effectively choose the right action. Storbeck, Robinson and

McCourt (2006) argue that an action that is relevant for dealing with a mosquito (swatting) is not going to work for a bear, yet both stimuli are likely to elicit a negative emotional response when encountered. Therefore, top-down processing must influence the perceptual information in order for the right action to be elicited. It is thus possible that this same pathway can drive attention towards or away from other goal-relevant stimuli. Attaching emotional value to a stimulus through a motivational process is plausible and supported by the current research. However, it remains to be seen how this ultimately contributes to identification of a stimulus to allow an appropriate action to be taken when the stimulus is not biologically relevant. Indeed, Dijksterhuis and Aarts (2010) present a review of psychophysiological and behavioural research suggesting that guidance towards goals through engaging attention often occurs outside awareness. If nothing else, hedonic marking of distractors allows for a more efficient location of targets. The experiments in the current research, when combined with previous research on the DDE, suggest that hedonic marking is not just relevant in spatial search tasks but also in temporal tasks.

The concept of hedonic marking also has indirect support from a number of broader neurological studies. As mentioned, there is an abundance of psychophysical and neuroscientific data confirming the close relationship between attention and emotion (Pessoa, 2008; Vuilleumier, & Brosch, 2009) The orbitofrontal cortex is one brain structure contributing extensively to goal-driven selective attention (Rolls, 2000; Winstanley et al., 2010). The orbitofrontal cortex is also closely linked with limbic structures such as the amygdala (Rolls, 2005: Weierich & Barrett, 2010). Connections between these structures do not, in themselves, prove that hedonic value can drive efficient visual search but the results of a number of studies with impaired patients can add weight to the argument. For example, patients with damage to the amygdala have more difficulty with goal related search as well as associative learning (Baxter & Murray, 2002; Liu, Fu & Fu, 2009).

There is also evidence of emotion driven goal-related search from studies into the effect of mood on search capability. Negative mood states lead to more narrowed, local processing of stimuli whereas positive moods result in a broadening of attention and global processing (for reviews see Fredrickson, 2001; Isen, 2000). However, this effect is diminished when there is high approach motivation, which is a potential explanation for why the processing differences between task conditions in experiment 7 failed to have any effect on responses. Gable and Harmon-Jones (2008) provide an example of the effect of motivational factors over-riding other processing biases. In their research, they found that the broadening of attention did not occur when participants were exposed to a film that included high-approach motivating positive stimuli such as desserts. Gable and Harmon-Jones argue that this provides evidence that attentional processing adapts to assist in achieving goals and improves performance in cognitive tasks. In a similar vein, evidence for goal-related marking of stimuli comes from arguments concerning differences in affect related to situational variables. Berridge (1999, 2003, 2004) proposes that different brain processes are responsible for liking and wanting. The motivational value attached to a stimulus in a search task is more likely to elicit wanting, considering they are related to the goal of successfully completing the task (see also Mulckhuyse & Theeuwes, 2010).

The measure of affect in studies associated with the MEE and the DDE record responses about pleasantness, cheeriness or preference. The results of experiment 8 suggest that the DDE could be specifically about rejecting the distractors rather than just inhibition due to ignoring them. Distractors become disliked because they are ‘not wanted’ but this negative attitude does not persist beyond when it is needed in the search task. Only with subliminal distractors does a dislike for distractors appear to persist beyond the task. Again, although further investigation of this phenomenon was beyond the scope of the current research program, it raises some interesting questions about the relationship between emotional processes and the focussing of selective attention. The arbitrary assignment of 'target' or 'distractor' can change the preference for those stimuli as long as the defining feature is task relevant. However, the preference fades as soon as the feature is no longer relevant. This finding clearly deserves further investigation.

Limitations and future research

The experiments presented here were specifically conducted to answer questions about the relationship between stimulus exposure and selective attention. In that regard, the focus was to address a specific number of outstanding issues that prevented a clear understanding of the relevance of distractor devaluation to the understanding the MEE and more generally about the effect of exposure on preference. One potential weakness of the approach taken in this research is that these studies used procedures adapted from mere exposure experiments as had previous attempts at understanding the relationship between the MEE and DDE (e.g. Prescott et al., 2008; Yagi et al., 2009). Adopting this approach led to a situation where the numbers of trials in the affective priming tests in particular were constrained by the limitations created by the ideal numbers of exposures known to lead to consistent mere exposure effects (i.e. around 20; Bornstein, 1989). The number of trials used might have decreased the power of these experiments to detect significant effects in comparison to distractor devaluation studies that typically have hundreds of trials (e.g. Raymond et al., 2003). An alternate approach that should be considered in future research would be to build on the results of experiment 8 by using methods more closely aligned with those used to examine the DDE.

A second overarching consideration stemming from the current research is that there are a number of contradictory results across the experiments presented. Experiments

3 and 4 in particular produced contradictory results and highlight the need for further research into the consequences of exposure to subliminal stimuli. Dijksterhuis and colleagues (2005) discuss the controversial history of research into the persuasive power of subliminal exposure to stimuli and thus the current contradictory findings are not dissimilar to others (see also Theus, 1994). The current research is one of the first attempts at understanding the relationship between the MEE and the DDE, the results of several of the experiments are not easily reconciled and, as such, a number of questions have been raised by the results of these experiments that are yet to be explained. It is these questions that should guide directions for future research.

As mentioned, the first outstanding questions were raised by experiments 3 and 4. These experiments examined a possible subliminal DDE but did not completely explain how such an effect occurs. The hypothesis of these experiments was that a preference would develop for the exposed stimuli possibly due to an increase in processing fluency. Instead of a subliminal MEE, exposure in these experiments consistently led to a devaluation of distractors that appears to be feature based. In terms of the current research, the question of whether or not a subliminal DDE is possible and if it is feature based or not were sufficiently addressed in order to establish that multiple processes appear to be acting under these circumstances. Based on the findings of the latter experiments, it is reasonable to suggest that the effect is based on a combination of inhibitory and motivational mechanisms.

The subliminal DDE is an interesting area of research that deserves further examination. For example, the question of whether the subliminal DDE is due to a negative attitude towards the task becoming associated with the stimulus, needs to be addressed. Incidental advertising that relies on familiarity and preference development outside conscious awareness is widely used (Dijksterhuis, Aarts & Smith, 2005), however, should the subliminal DDE prove to be a robust phenomena, it suggests that this form of advertising is more likely to lead to a dislike of the product or brand rather than the intended preference. It would be interesting and relevant to examine the consequences of exposure to distracting stimuli outside of awareness over a longer period. Advertising often relies on constant repetition of a brand name, message or features thereof (Campbell & Keller, 2003; Homer, 2009). Should the long-term consequences of this exposure outside of awareness lead to less favourable responses to the brand or message, this marketing strategy will need to be reconsidered.

The second group of questions raised by the current experiments concerns the use of affective priming in research of this nature. The results of experiment 3 suggest that it is possible to detect interference caused by an emotional response to an exposed stimulus; however, this was not evident in experiments with supraliminal stimuli. The varied results obtained from using this measure in these experiments are an obvious limitation and suggest that the measure requires more examination. Although there have been reports of a number of laboratories failing to find affective priming for exposed stimuli, it has been found elsewhere (Ying & Renlai, 2008). Topolinski and Strack (2009) also provide evidence to suggest that increases in perceptual fluency can be detected using affective priming. A technique that was developed as a result of this research, the blackout masking procedure (Lodge & Cottrell, 2009), has a similar advantage to that used by Ying and Renlai whereby the mask and target are displayed simultaneously. These results suggests that it is this procedure, where stimulus onset asynchrony (SOA), or time between prime and target, is reduced as much as possible, that is most effective at detecting subtle affective changes based on exposure. This has also been the conclusion reached by other researchers using affective masked priming as a measure (Klauer & Musch, 2003; Moors, Spruyt & De Houwer, 2010). Although it was not essential in explaining the exposure/affect relationship, this procedure is potentially important for the future of research of this type and may help to elucidate the unconscious processes underlying these effects. This could be the case particularly if this approach proves to be a reliable way to measure the indirect consequences of fluent processing of a stimulus. The real advantage of this type of measure is that it is not clouded by subjective responses but is a good reflection of unconscious processes (Wittenbrink, 2007). This is another obvious direction for future research.

A further series of questions surround the motivational mechanisms underlying the DDE. Sufficient evidence has been presented here to suggest that the DDE has little to contribute to the understanding of the MEE, however, several questions remain relevant and unanswered. Approaching these experiments from within the mere exposure and selective attention paradigms necessitated the use of methods common to those paradigms. As such, delving into the motivational underpinnings of these effects was difficult without a substantial shift in the way the experiments were conducted. Raymond (2009) has suggested that motivational processes could be the bridging factor between the inhibitory processes she and her colleagues argue are behind the DDE and the negative emotional response. However, the current research shows that these motivational factors are not just important as a consequence of the inhibitory processes but are, in fact, integral to the DDE itself. This has implications for understanding the DDE and future research could include an examination of the relationship between the reported hedonic marking of distractors and inhibitory processes using methods more akin to research on motivation. An obvious example of this would be to use Berridge's (2003, 2004) approach to separate liking and wanting.

Ultimately, this research set out to answer specific questions about the distractor devaluation and mere exposure effects and the role played by selective attention in both.

This process has raised a number of other questions about each effect and about the nature of emotion in visual search. It has also raised questions about the usefulness of affective priming as a measure of affective appraisal. Answering these questions is beyond the scope of the present program but remain for future research to investigate.

Implications of the influence of selective attention on the exposure/affect relationship

The present research examined the effect of selective attention and exposure on preference. Overall the results of this series of experiments have lead to a number of suggestions about this relationship. First and foremost, it is evident that selective attention can alter preferences for exposed stimuli. This has a number of implications. As already detailed, these experiments support the argument that cognition is involved in the MEE. The results of many studies on the subliminal MEE provide evidence that conscious processing does not always need to be involved, however, experiments 1 and 2 clearly show that attention can modulate the effect. Zajonc, Pietromonaco and Bargh (1982) argued that although the subliminal MEE suggests that preferences can develop independent of consciousness and therefore cognition, this was not always the case. Cognition is often involved in the subjective experience of an emotion and further evidence to support this has been presented here.

There are practical implications for the influence of attention on liking in a number of different arenas. The most obvious implication of this research is for marketing. Exposing consumers to products or brand names whilst they are completing a task will not have the same effect as will a presentation during passive viewing. This has particular implications for advertising on the Internet. Surfing through websites for information represents a form of visual search. Consumers actively seek information on a webpage whilst ignoring other details and features of the page (Zhang, 2000). This process of engaging in a visual search has the potential to lead to a decrease in liking for the distracting elements on the page. The results presented here lead to the suggestion that when consumers are searching a webpage for very specific information, anything that is not related to the desired 'target' is going to be hedonically marked as negative. The implications for consumers who are browsing in a less focussed way are not as great. These consumers are not conducting a specific search task and are thus less likely to regard any information on a page as distracting, and thus disliked (see Pagendarm & Schaumburg, 2001). Therefore advertisers are better advised to place advertisements in forums that are less likely to require engaged searching.

The current research also suggests that non-conscious exposure to stimuli whilst engaged in a task can also lead to devaluation. Thus, consumers engaged in focussed visual search for information are also likely to develop a dislike for products or brands even if they are not aware of the exposure. Although subliminal advertising has had a controversial history (see Dijksterhuis et al., 2005), what is clear from this research is that it is not always going to be as effective as it has been claimed to be.

Another important implication of this research relates to situations where non-commercial messages are broadcast. Again, when an individual is engaged in a task requiring focussed attention, any distracting message is unlikely to have the desired effect. An example of this would be public service messages. If people are engaged in a task when a warning is issued, they may be more likely to develop a negative attitude towards the message and may be less likely to act on the warning based on this negative attitude. This is something that would require further investigation due to the complex variables involved such as the perception of risk and the nature of the situation precipitating the warning (see Slovic, 2000). Ultimately, if the development of warning systems for natural hazards does not take heed of the possibility that people could develop negative attitudes towards warning messages; it could have potentially fatal consequences. Although these types of behaviours are more complex than the simple preference choices used in the current research, a negative attitude towards the features of a message could potentially influence the likelihood of the appropriate action being taken and this warrants investigation.

Further to this, it would be worth investigating the influence of these factors on learning situations. Learning via visual means has become more important as we rely on technological innovations that display the information to be learned in a complex digital environment that is often visually dense and interactive. This is also likely to increase as a greater reliance on visual media and mobile computing replaces paper as a means of communication. In this sense, learning can also be a search task of sorts if the learner is engaged in a search for the actual information they need to do their job or to pass an exam. Finding information is becoming less and less about reading a lot of continuous text and more about rapid switching from one source to another to find the relevant and/or interesting information (see Rowlands et al., 2008). Likewise, this is not only relevant to digital learning environments but may also be true for textbooks as well. Wherever there is a case that certain information must be filtered out whilst other information is sought, there is a potential for the distracting information to become disliked and for this dislike to lead to avoidance of the information and less chance of recalling it later (see also Diemand-Yauman, Oppenheimer & Vaughan, in press). Again, this would need some investigation before it can be taken as a reliable possibility but it too at least deserves investigation based on the potential cost of the wrong information being filtered out.

Conclusions

The nature of the relationship between exposure, familiarity and liking is complex. Over the course of 300 plus experiments into the MEE and the growing body of research into the DDE, many variables have been considered and found to influence this relationship. These experiments have made an important distinction between two phenomena that had previously been thought to be intricately related and based on the same underlying processes (Tavassoli, 2008). The relationship between exposure and preference is a complex one but the MEE by definition is not within the same group of phenomena as the DDE. The former is the increase in liking based on non-associative exposure and seemingly nothing more. The DDE is based on motivational factors enhanced by inhibitory mechanisms known to assist with the filtering out of distracting non-target stimuli. Observations and research into distractor devaluation, although interesting in its own right, does not contribute to understanding the MEE, which remains best explained by the modified processing fluency model proposed by Whittlesea and Price (2001).

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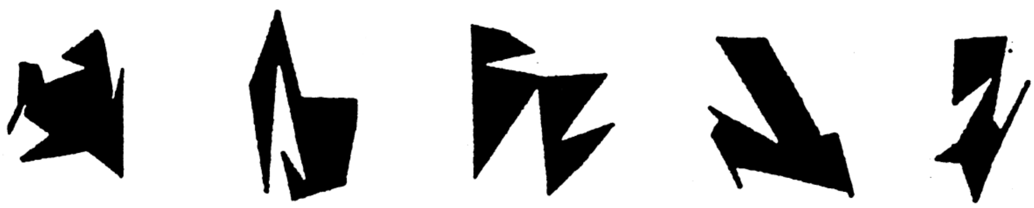
Appendix 1

Sample shapes used in experiments 1 – 8

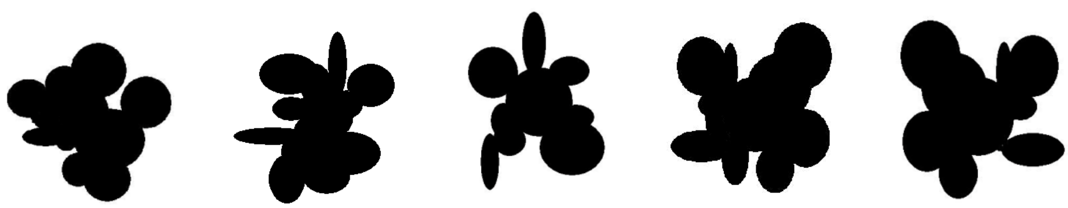
24-point straight-edged shapes

12-point straight-edged shapes



6-point straight-edged shapes

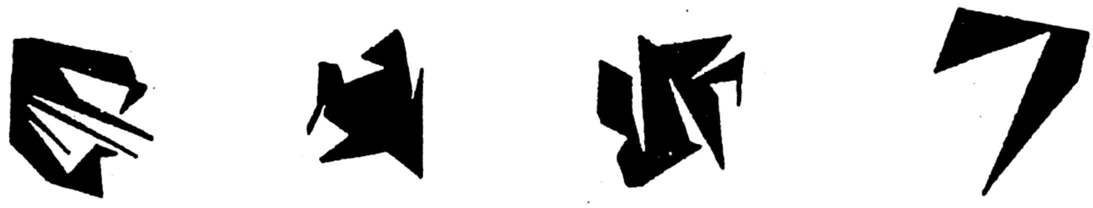
Rounded shapes



Appendix 2

Please answer the following questions as honestly as possible. If you are uncertain *please take your best guess*.

1. Which of the following shapes **did you see** during the experiment? (please circle one only)

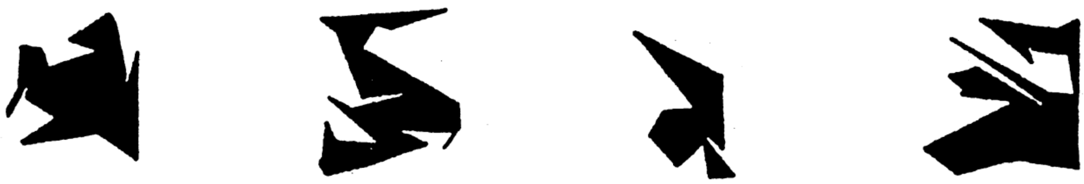


2. Which of the following shapes **did you see** during the experiment? (please circle one only)

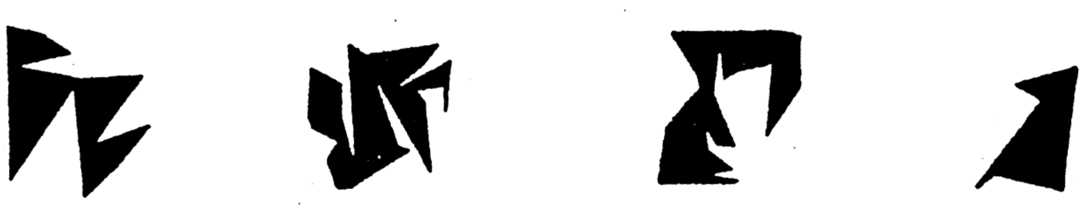
3. Based on what you saw in the experiment; which of these shapes is **most familiar** to you? (please circle one only)

4. Based on what you saw in the experiment; which of these shapes is **most familiar** to you? (please circle one only)

5. Please indicate which of the following shapes you **most prefer**. (please circle one only)



6. Please indicate which of the following shapes you **most prefer**. (please circle one only)



Appendix 3a

Experiment 1 data analysis

Table 9.
Chi-square analysis for recognition of targets – colour-naming task versus passive presentation

	Freq
Chi-Square	1.190
df	1
Asymp. Sig	.275

Table 10.
Chi-square analysis for recognition of repeatedly exposed subliminal shape versus other shapes with same complexity

	Freq
Chi-Square	0.102
df	1
Asymp. Sig	.750

Table 11.
Chi-square analysis for familiarity of target complexity versus novel complexity

	Freq
Chi-Square	60.125
df	1
Asymp. Sig	.000

Table 12.
Chi-square analysis for familiarity of repeatedly exposed subliminal shape versus same complexity

	Freq
Chi-Square	0.282
df	1
Asymp. Sig	.595

Table 13.
Chi-square analysis of preference choices of targets versus all other shapes

	Freq
Chi-Square	32.915
df	3
Asymp. Sig	.000

Table 14.
Chi-square analysis of preference choices for repeatedly exposed subliminal shapes versus all other shapes

	Freq
Chi-Square	1.390
df	3
Asymp. Sig	.708

Table 15.
Chi-square analysis of preference choices for target shape – congruent versus incongruent conditions

	Freq
Chi-Square	1.172
df	1
Asymp. Sig	.279

Table 16.
Chi-square analysis of preference choices for target complexity – congruent versus incongruent conditions

	Freq
Chi-Square	4.522
df	1
Asymp. Sig	.033

Appendix 3b

Experiment 2 data analysis

Table 17.
Chi-square analysis of most familiar choice compared to chance

	Freq
Chi-Square	22.36
df	2
Asymp. Sig	< .001

Table 18.
Chi-square analysis of least familiar choice compared to chance

	Freq
Chi-Square	3.64
df	2
Asymp. Sig	.162

Table 19.
Chi-square analysis of most preferred choices – targets versus distractors and novel shapes

	Freq
Chi-Square	19.96
df	2
Asymp. Sig	< .001

Table 20.
Chi-square analysis of least preferred choices – target versus distractor and novel shapes

	Freq
Chi-Square	23.08
df	2
Asymp. Sig	< .001

Appendix 3c

Experiment 3 data analysis

Table 21.
Chi-square analysis of recognition choices proportion compared to chance

	Freq
Chi-Square	1.255
df	1
Asymp. Sig	.263

Table 22.
Chi-square analysis of most familiar choices compared to chance

	Freq
Chi-Square	1.059
df	2
Asymp. Sig	.589

Table 23.
Chi-square analysis of least familiar choices compared to chance

	Freq
Chi-Square	.206
df	2
Asymp. Sig	.902

Table 24.
Chi-square analysis of most preferred choices compared to chance

	Freq
Chi-Square	19.471
df	2
Asymp. Sig	.00

Table 25.
Chi-square analysis of most preferred choices (collapsed for features) compared to chance

	Freq
Chi-Square	0.118
df	1
Asymp. Sig	.732

Table 26.
Chi-square analysis of least preferred choices compared to chance

	Freq
Chi-Square	14.147
df	2
Asymp. Sig	.001

Table 27.
Chi-square analysis of least preferred choices (collapsed for features) compared to chance

	Freq
Chi-Square	15.059
df	1
Asymp. Sig	> .001

Table 28.
Overall ANOVA for RT to positive words

	df	*F*	η^2	*p*
Group	2	0.569	.008	.567
Error	66	3967.007		

Table 29.
Overall ANOVA for RT to negative words

	df	*F*	η^2	*p*
Group	2	5.651	.078	.004
Error	66	5157.312		

Table 30.
ANOVA contrast RT to negative words - distractor versus novel shapes

	df	*F*	η^2	*p*
Group	1	4.519	.06	.037
Error	67	6322.90		

Table 31.
ANOVA contrast RT to negative words – distractor-like versus novel shapes

	df	*F*	η^2	*p*
Group	1	1.064	.02	.31
Error	67	3944.93		

Table 32.
ANOVA contrast RT to positive words - distractor versus novel shapes

	df	*F*	η^2	*p*
Group	1	0.440	.01	.51
Error	67	4170.97		

Table 33.
ANOVA contrast RT to positive words – distractor-like versus novel shapes

	df	*F*	η^2	*p*
Group	1	1.384	.02	.24
Error	67	3171.56		

Appendix 3d

Experiment 4 data analysis

Table 34.
Overall ANOVA RT to positive words across shape types

	df	*F*	η^2	*p*
Group	3	0.496	.052	.688
Error	27	1790.858		

Table 35.
Overall ANOVA RT to negative words across shape types

	df	*F*	η^2	*p*
Group	3	1.485	.142	.241
Error	27	1610.258		

Table 36.
ANOVA contrast RT to positive words distractor with rotated shapes

	df	*F*	η^2	*p*
Group	1	0.021	.9	.86
Error	29	1658.4		

Table 37.
ANOVA contrast RT to negative words distractor with rotated shapes

	df	*F*	η^2	*p*
Group	1	0.848	.9	.365
Error	29	1267.6		

Table 38.
Overall ANOVA pleasantness ratings across shape types

	df	*F*	η^2	*p*
Group	2	0.705	.048	.503
Error	28	3.815		

Table 39.
Overall ANOVA unpleasantness ratings across shape types

	df	*F*	η^2	*p*
Group	2	2.863	.170	.074
Error	28	4.512		

Table 40.
ANOVA comparison distractor & similar versus novel – pleasantness ratings

	df	*F*	η^2	*p*
Group	1	0.303	.01	.587
Error	29	4.124		

Table 41.
ANOVA comparison distractor & similar versus novel – unpleasantness ratings

	df	*F*	η^2	*p*
Group	1	5.709	.164	.024
Error	29	6.867		

Appendix 3e

Experiment 5 data analysis

Table 42.
Overall ANOVA RT to positive words across shape types and conditions

Source	*df*	*F*	η_p^2	*p*
Shape type	3	5.606	.231	.002
Error	174	7235.858		
Group	1	1.611	.027	.209
Error	58	44683.191		
Shape x Group	3	0.789	.041	.505
Error	56	7235.858		

Table 43.
Overall ANOVA RT to negative words across shape types and conditions

Source	*df*	*F*	η_p^2	*p*
Shape type	3	0.954	.049	.421
Error	174	9930.458		
Group	1	2.001	.033	.163
Error	58	177414.7		
Shape x Group	3	0.785	.040	.507
Error	56	9930.458		

Table 44.
ANOVA RT to positive words – comparison of targets, distractors & target like with novel shapes

	df	*F*	η^2	*p*
Group	1	11.831	.786	.001
Error	57	12597.901		

Table 45.
Chi-square analysis of overall most familiar choices compared to expected frequencies

	Freq
Chi-Square	174.45
df	2
Asymp. Sig	< .001

Table 46.
Chi-square analysis of overall least familiar choices compared to expected frequencies

	Freq
Chi-Square	6.45
df	2
Asymp. Sig	.040

Table 47.
Chi-square analysis of overall most preferred choices compared to expected frequencies

	Freq
Chi-Square	131.8
df	2
Asymp. Sig	<.001

Table 48.
Chi-square analysis of overall least preferred choices compared to expected frequencies

	Freq
Chi-Square	3.117
df	2
Asymp. Sig	.210

Table 49.
Contingency table for most familiar choices

	Target	Distractor	Novel	Totals
Congruent	$f_O = 51$ $f_E = 45$	$f_O = 7$ $f_E = 13.5$	$f_O = 2$ $f_E = 1.5$	$f_O = 60$ $f_E = 60$
Incongruent	$f_O = 39$ $f_E = 45$	$f_O = 20$ $f_E = 13.5$	$f_O = 1$ $f_E = 1.5$	$f_O = 60$ $f_E = 60$
Totals	$f_O = 18$ $f_E = 18$	$f_O = 35$ $f_E = 35$	$f_O = 67$ $f_E = 67$	$f_O = 120$ $f_E = 120$

Table 50.
Chi-square analysis of most familiar choices

	Freq
Chi-Square	8.193
df	2
Asymp. Sig	.017
Cramer's V	.261

Table 51.
Contingency table for least familiar choices

	Target	Distractor	Novel	Totals
Congruent	$f_O = 4$ $f_E = 9$	$f_O = 23$ $f_E = 17.5$	$f_O = 33$ $f_E = 33.5$	$f_O = 60$ $f_E = 60$
Incongruent	$f_O = 14$ $f_E = 9$	$f_O = 12$ $f_E = 17.5$	$f_O = 34$ $f_E = 33.5$	$f_O = 60$ $f_E = 60$
Totals	$f_O = 18$ $f_E = 18$	$f_O = 35$ $f_E = 35$	$f_O = 67$ $f_E = 67$	$f_O = 120$ $f_E = 120$

Table 52.
Chi-square analysis of least familiar choices

	Freq
Chi-Square	9.028
df	2
Asymp. Sig	.011
Cramer's V	.274

Table 53.
Contingency table for most preferred choices

	Target	Distractor	Novel	Totals
Congruent	$f_O = 49$ $f_E = 40.5$	$f_O = 7$ $f_E = 15.5$	$f_O = 4$ $f_E = 4$	$f_O = 60$ $f_E = 60$
Incongruent	$f_O = 32$ $f_E = 40.5$	$f_O = 24$ $f_E = 15.5$	$f_O = 4$ $f_E = 4$	$f_O = 60$ $f_E = 60$
Totals	$f_O = 81$ $f_E = 81$	$f_O = 31$ $f_E = 31$	$f_O = 8$ $f_E = 8$	$f_O = 120$ $f_E = 120$

Table 54.
Chi-square analysis of most preferred choices

	Freq
Chi-Square	12.890
df	2
Asymp. Sig	.002
Cramer's V	.328

Table 55.
Contingency table for least preferred choices

	Target	Distractor	Novel	Totals
Congruent	$f_O = 16$ $f_E = 18.5$	$f_O = 17$ $f_E = 16$	$f_O = 27$ $f_E = 25.5$	$f_O = 60$ $f_E = 60$
Incongruent	$f_O = 21$ $f_E = 18.5$	$f_O = 15$ $f_E = 16$	$f_O = 24$ $f_E = 25.5$	$f_O = 60$ $f_E = 60$
Totals	$f_O = 37$ $f_E = 37$	$f_O = 32$ $f_E = 32$	$f_O = 51$ $f_E = 51$	$f_O = 120$ $f_E = 120$

Table 56.
Chi-square analysis of least preferred choices

	Freq
Chi-Square	.977
df	2
Asymp. Sig	.614
Cramer's V	.090

Appendix 3f

Experiment 6 data analysis

Table 57.
Overall ANOVA RT positive words across task conditions and shape types

Source	*df*	*F*	η_p^2	*p*
Task	1	0.787	.026	.382
Error	29	26343.344		
Shape type	2	0.026	.001	.975
Error	58	2033.558		
Task x Shape	2	0.774	.025	.774
Error	58	2881.161		

Table 58.
Overall ANOVA RT negative words across task conditions and shape types

Source	*df*	*F*	η_p^2	*p*
Task	1	0.871	.028	.358
Error	29	25601.006		
Shape type	2	2.596	.08	.083
Error	58	3966.720		
Task x shape	2	0.749	.024	.477
Error	58	2679.895		

Table 59.
Overall ANOVA positive ratings across task conditions and shape types

Source	*df*	*F*	η_p^2	*p*
Task	1	0.902	.030	.350
Error	29	9.282		
Shape type	2	1.052	.035	.356
Error	58	2.762		
Task x shape	2	2.967	.059	.093
Error	58	11.011		

Table 60.
Overall ANOVA negative ratings across task conditions and shape types

Source	*df*	*F*	η_p^2	*p*
Task	1	0.085	.003	.773
Error	29	5.314		
Shape type	2	1.263	.042	.042
Error	58	5.211		
Task x shape	2	0.467	.015	.629
Error	58	11.439		

Table 61.
ANOVA – comparison pleasantness ratings of targets, conjunction versus pop-out conditions

	df	*F*	η^2	*p*
Group	1	2.536	.078	.122
Error	29	11.218		

Table 62.
ANOVA – comparison of unpleasantness ratings of distractors, conjunction versus pop-out conditions

	df	*F*	η^2	*p*
Group	1	0.599	.019	.445
Error	29	9.723		

Table 63.
ANOVA - comparison of pleasantness ratings of target versus distractor in the conjunction condition

	df	*F*	η^2	*p*
Group	1	1.484	.015	.233
Error	29	9.783		

Table 64.
ANOVA - comparison of unpleasantness ratings of target versus distractor in the conjunction condition

	df	*F*	η^2	*p*
Group	1	0.001	.000	.975
Error	29	13.049		

Table 65.
ANOVA - comparison of pleasantness ratings of target versus distractor in the pop-out condition

	df	*F*	η^2	*p*
Group	1	3.752	.111	.062
Error	29	9.496		

Table 66.
ANOVA - comparison of unpleasantness ratings of target versus distractor in the pop-out condition

	df	*F*	η^2	*p*
Group	1	1.464	.047	.236
Error	29	11.998		

Appendix 3g

Experiment 7 data analysis

Table 67.
Overall ANOVA pleasantness ratings across task and shape type

Source	*df*	*F*	η_p^2	*p*
Time	2	1.246	.031	.293
Error	78	4.146		
Task	1	0	.000	.987
Error	39	3.534		
Shape type	2	1.854	.045	.163
Error	78	36.274		
Time x task	2	0.336	.009	.0716
Error	78	3.208		
Time x shape	4	2.659	.064	.035
Error	156	3.164		
Task x shape	2	1.241	.031	.295
Error	78	3.944		
Time x task x shape	4	0.312	.008	.312
Error	156	3.087		

Table 68.
ANOVA - comparison of post task pleasantness ratings of targets and novel shapes in both pop-out and conjunction conditions

	df	*F*	η^2	*p*
Group	1	2.600	.53	.115
Error	39	13.882		

Table 69.
Overall ANOVA unpleasantness ratings across task and shape type

Source	*df*	*F*	η_p^2	*p*
Time	2	12.167	.238	.000
Error	78	3.392		
Task	1	0.253	.006	.618
Error	39	3.967		
Shape type	2	3.062	.073	.052
Error	78	32.473		
Time x task	2	1.840	.045	.166
Error	78	3.985		
Time x shape	4	1.197	.03	.314
Error	156	3.024		
Task x shape	2	1.338	.033	.268
Error	78	4.003		
Time x task x shape	4	1.418	.035	.231
Error	156	3.342		

Table 70.
ANOVA - comparison of pre-task unpleasantness ratings of distractors and novel shapes in the pop-out condition

	df	*F*	η^2	*p*
Group	1	3.563	.084	.067
Error	39	3.371		

Table 71.
ANOVA - comparison of pre-task unpleasantness ratings distractors and novel shapes in the conjunction condition

	df	*F*	η^2	*p*
Group	1	10.856	.218	.002
Error	39	8.715		

Table 72.
ANOVA - comparison of during task unpleasantness ratings of distractors and novel shapes (combined task conditions)

	df	*F*	η^2	*p*
Group	1	10.732	.216	.002
Error	39	7.463		

Appendix 3h

Experiment 8 data analysis

Table 73.
Difference in mean pleasantness ratings (CI) from novel, during and post-task

Source	During task	Post-task
Target	1.19 (1.04)	0.83 (1.36)
Distractor	-0.08 (1.04)	-0.35 (1.26)

Table 74.
Difference in mean unpleasantness ratings (CI) from novel, during and post-task

Source	During task	Post-task
Target	0.32 (0.93)	0.55 (1.34)
Distractor	1.17 (0.85)	-0.10 (1.51)

Appendix 4

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