Preferential processing: a factor with implications

Personality traits as explanatory factors

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Abstract

Preferential processing favouring threatening information has received increased attention because cognitive formulations have placed increased emphasis on its role as a key cognitive factor underlying vulnerability to and maintenance of anxiety disorders. The present dissertation comprises four empirical studies within the area of preferential processing. Two different outcome measures were used to index preferential processing of threat-related information: Skin conductance responses (SCRs) were used in Studies I, II, and III. The emotional Stroop task was used in Study IV. The main focus has been on preferential processing of threat-related information that occurs outside awareness, thus *preferential preattentive processing*. Study I investigated the role of traumatic combat experience with regard to preferential processing among UN soldiers following a presentation of threat-related pictures. Results indicated that soldiers with combat experience consistently reacted with lower SCRs compared to soldiers without combat experience. One issue addressed in the individual studies was the association between preferential preattentive processing and trait anxiety. Studies II, III, and IV showed that elevated levels of trait anxiety promote preferential preattentive processing of negatively valenced information, whereas elevated levels of social desirability generally prevent preferential preattentive processing of negatively valenced information. Study II highlighted the importance of including the social desirability factor when studying effects of trait anxiety on preferential processing. In addition, Studies III and IV explored the relationship between preferential processing and emotional vulnerability. The main findings support the notion of preferential preattentive processing of threat representing an underlying predisposition to heightened emotional vulnerability in response to stressful events.

Keywords: Preferential preattentive processing, trait anxiety, emotional vulnerability, SCR, evolutionary preparedness

List of papers

This doctoral thesis is based on the following studies, which will hereafter be referred to by means of their Roman numerals.

- I. Najström, M., & Högman, L. (2003). Skin conductance response in Swedish United Nations soldiers exposed to fear-relevant stimuli. *Cognitive Behaviour Therapy*, 32, 161-165.
- II. Najström, M., & Jansson, B. (2006). Unconscious responses to threatening pictures: The interactive effect of trait anxiety and social desirability on skin conductance responses. *Cognitive behaviour Therapy*, 35, 11-18.
- III. Najström, M., & Jansson, B. (2007). Skin conductance responses as predictor of emotional responses to stressful life events. *Behaviour Research and Therapy*, 45, 2456-2463.
- IV. Jansson, B., & Najström, M. (submitted for publication). Information-processing and emotional responses to stress: An investigation using self-report and physiological measures of stress.

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Abbreviations

ANS	-	Autonomic Nervous System
EMG	-	Electromyography
EN	-	Emotional Numbing
fMRI	-	functional Magnetic Resonance Imaging
GAD	-	Generalised Anxiety Disorder
PET	-	Positron Emission Tomography
PTSD	-	Post Traumatic Stress Disorder
SCL	-	Skin Conductance Level
SCR	-	Skin Conductance Response
SCV	-	Skin Conductance Variability
SOA	-	Stimulus Onset Asynchrony
TES	-	Threat Evaluation System

I. Introduction

In our daily lives, we are faced with a vast amount of environmental information. Some information is processed consciously and decisions are made about which actions to take in response to the incoming information. Some information is not consciously processed but still influences our behaviour. From evolutionary perspective, this evaluation of information is a key function of emotions, guiding our movement towards or away from emotion-evoking stimuli. This function also engages the autonomic nervous system to ensure metabolic resources are ready for action (e.g., Lang, Bradley, & Cuthbert, 1997; Öhman & Wiens, 2003). For example, consider the experience of the seemingly automatic focusing of attention on the snake hiding in the grass a few steps ahead along a walking path. One may immediately turn and run, or freeze for a fraction of a second, only to realize that the snake was merely a twig. This is a typical example of preferential processing which promotes survival from a potential attacking predator. The aim of this thesis was to examine factors that could be of help in understanding individual differences in preferential processing of threat-related information in non-clinical populations.

Preferential processing of threatening emotional information

During the past several decades, emotion and psychopathology researchers have devoted a great deal of attention to the study of emotions, for example, fear and anxiety. Not only fear and anxiety as experienced in the normal range but also in more extreme manifestations, such as anxiety disorders and phobias. From an evolutionary perspective, anxiety and fear are emotions that are central to mammalian evolution (Öhman & Mineka, 2001). Emotionally significant events may be heralded by subtle cues to receive priority for processing. Thus, stimuli related to reoccurring survival threats in the environment may have become more or less automatic triggers of attention, from an evolutionary perspective (Tooby & Cosmides, 1990). Given the survival contingencies implied by potential threats in the external and internal environments, it is a natural assumption that threatening stimuli are prioritized in preferential processing. A vast amount of research supporting this reasoning can be found in the extensive work of Öhman and colleagues (e.g., Lundqvist & Öhman, 2005; Öhman, Flykt, & Esteves, 2001; Öhman & Soares, 1993; 1994).

Today, there is considerable evidence demonstrating that preferential processing of emotional information is associated with the emotions of fear and anxiety. Using

cognitive outcome measures, researchers have shown that threat-related stimuli compared to neutral stimuli are processed in a preferred way by both clinically anxious individuals (e.g., Bradley, Mogg, Millar, & White, 1995; Williams, Watts, MacLeod, & Mathews, 1997) and non-clinical individuals with elevated levels of anxiety (Mogg & Bradley, 1999, for a review). Using physiological outcome measures, researchers have also convincingly demonstrated preferential processing of threat-related stimuli. For example, Öhman and Soares (1993, 1994) found effects even when the stimulus was presented outside conscious awareness, referred to as *preferential preattentive processing*. Similar effects have been found with emotional responses elicited even before persons becoming aware they are experiencing fear, suggesting that preferential preattentive processing is sufficient for fear activation (e.g., Öhman, 1986; Öhman, Dimberg & Esteves, 1989; Öhman, Flykt & Lundqvist, 2000).

Personality traits and mood states

The origin of individual differences in preferential processing of threatening emotional information is an important aspect. Is preferential processing best described as an effect of stable personality characteristics, such as trait anxiety, and what role has temporary anxious states in determining individual differences?

Spielberger, Pollans and Worden (1984) define trait anxiety as a vulnerability to respond anxiously to stress and psychological threat. Individuals scoring high on measures of trait anxiety have been suggested as predisposed to respond with fear and anxiety to a wide range of stressors (e.g., McNally, 1989). According to some cognitive models of anxiety (Mathews & Macintosh, 1998; Mogg & Bradley, 1998), trait anxiety could be conceptualized as a stable factor that determines outcome measures on preferential processing. Hence, higher levels of trait anxiety enhance the subjective appraisal of threat that, in turn, produces preferential processing in favour of threat. Both clinically diagnosed anxious individuals and individuals scoring high on trait anxiety continued to display preferential processing for negative information even when exposure conditions eliminated their ability to consciously recognize the stimuli, thus preferential preattentive processing (Mogg, Bradley, Williams, & Mathews, 1993). Additional support for this reasoning is found in other studies as well (e.g., Williams et al., 1997; Mogg & Bradley, 1998, for reviews).

When discussing personality traits, especially trait anxiety, it is important to include social desirability. Crowne & Marlowe (1960, p. 353) define social desirability as “the

need for subjects to obtain approval by responding in a culturally appropriate and acceptable manner”. The social desirability factor poses a major concern to researchers attempting to obtain valid data from self-report questionnaires. Stemming from an individual’s need to gain social approval or deny negative attributes, social desirability response styles have been evident in the self-reporting of anxiety, coping, and self-esteem (e.g., DiBartolo, Albano, Barlow, & Heimberg, 1998; Egloff & Schmukle, 2003). In addition, research concerning preferential processing has found among male participants that social desirability was associated with a decrease in preferential preattentive processing for threat words (Jansson, Lundh, & Oldenburg, 2005). Further, high trait anxiety/high social desirability scorers showed preferential processing toward consciously presented happy faces (Ioannou, Mogg, & Bradley, 2003). Results from these studies indicate that social desirability can be a more important factor among individuals with higher levels of trait anxiety than is generally believed. This reasoning is in line with the suggestion by Weinberger, Schwartz, and Davidson (1979) that neither low-trait nor high-trait anxious groups are homogeneous. According to the authors, scores on social desirability (e.g., MCSD: Crowne & Marlowe, 1964) are appropriate for splitting low- and high-trait anxiety groups into four groups: a) true low-trait anxious individuals with low social desirability scores; b) low-trait anxious individuals with high social desirability scores; c) true high-trait anxious individuals with low social desirability scores; d) high-trait anxious individuals with high social desirability scores.

Although preferential processing is mostly seen in individuals with high levels of enduring anxiety, state variables have also been found to exert some influence on preferential processing favouring threatening emotional information (e.g., MacLeod & Matthews, 1988; Chen, Lewin, & Craske, 1996; Egloff & Hock, 2001). Nevertheless, it seems to be most relevant to consider preferential processing in association with enduring personality characteristics rather than something that occurs to everyone while in a temporary state of anxious mood.

Preferential preattentive processing and the aetiology of psychopathology

An important aspect in the research field of preferential processing is the relevance of preattentive processes for the aetiology of psychopathology. For example, Öhman (1996) argues that components of a phobic response (i.e. fear) are initiated before the eliciting stimulus is represented in consciousness. Öhman suggests that this is part of an evolved defence mechanism that helps organisms avoid potential life-threatening

situations (specifically in the case of phobias). Fear is dissociated from the individual's conscious intentions and understanding, in that fear is immune to rational arguments about the lack of actual danger in the situation. In fact, preferential processing favouring fear-relevant stimuli are well documented among phobic persons (e.g., Fredrikson, 1981; Globisch, Hamm, Esteves, & Öhman, 1999; Hamm, Cuthbert, Globisch, & Vatl, 1997). In a study by Öhman and Soares (1994), participants were selected on the basis of their self-reported fear of spiders and snakes. The researchers tested if enhanced emotional responses to the participant's specific fear could be elicited when presented with pictures of snakes, spiders and other neutral stimuli. The results indicated that even if the participants did not consciously recognize the stimuli, enhanced emotional responses were found only for stimuli relevant to their specific fear, hence, preferential preattentive processing.

According to Öhman (1996), this kind of preferential preattentive processing of threat and fear dissociation could be a contributing factor in the development of anxiety disorders. He suggests that it can lead to a surplus of emotional information that has no obvious origin when it is not consciously represented. This reasoning is congruent with cognitive theories that suggest that biases in information processing play an important role in the aetiology and maintenance of emotional disorders such as Generalised Anxiety Disorder (GAD) (e.g., Eysenck, 1997; Williams et al., 1997; Mogg & Bradley, 1998). Preferential processing of emotional information has been described as a vicious circle. People, who have a tendency to selectively attend to negative information, do so at the expense of equally available positive information. This in turn influences the likelihood of experiencing a negative emotional reaction and consequently strengthens the selective processing in favour of negative information in future situations. This tendency to repeatedly experience negative emotional reactions may have an impact upon the likelihood of an impending emotional disorder. Eysenck (1997) has argued that preferential processing in trait anxiety, in addition to external sources of information, are concerned with internal sources. More specifically, individuals with high-trait anxiety would show preferential processing to their own physiological activity, behaviour, and thoughts. This would in turn magnify their tendency to selectively attend to negative information and interpret it accordingly.

Consequently, researchers whose experimental studies have demonstrated the presence of preferential processing in anxious individuals have justified the importance of their work by postulating that the tendency to preferentially process the more threatening aspects of the environment may directly cause the pattern of elevated anxiety

reactions. These reactions are characteristic of high-trait anxious individuals in non-clinical populations and clinically anxious patients (e.g., Mogg et al., 1993; van den Hout, Tenney, Huygens, Merckelbach, & Kindt, 1995). Additionally, there is considerable evidence that patients suffering from most of the anxiety disorders have elevated levels of trait anxiety (e.g., Clark, Watson, & Mineka, 1994; Zinbarg & Barlow, 1996). This suggests a continuum between high-trait anxiety in normal populations and anxiety disorders in patients. This continuum has been accounted for mainly in terms of cognitive vulnerability, thus high-trait anxiety and anxiety disorders would reflect the same underlying processes, which are concerned with hyper-vigilance to threat-related information (e.g., Eysenck, 1997).

In an early prospective study, MacLeod and Hagan (1992) used a non-clinical sample of women awaiting colposcopy after a positive cervical test. The authors found that preferential preattentive processing for masked threat words (i.e., words presented outside conscious awareness) was a significant predictor of emotional distress in response to diagnoses. This effect was replicated in a sample consisting of women undergoing fertility treatment (Verhaak, Smeenk, van Minnen, & Kraaimaat, 2004). Results indicated that preferential preattentive processing for masked stressor-specific words (not general threat words) was a significant predictor of emotional distress in response to failed treatment. Effects in the same direction have been found for high academic stress (Pury, 2002), in hypothetical stressful situations (van den Hout et al., 1995), and for laboratory-induced stress caused by inhalation of carbon dioxide-enriched air (Nay, Thorpe, Roberson-Nay, Hecker, & Sigmon, 2004). These findings indicate that preferential preattentive processing of threatening information reflects a vulnerability factor; individuals who have an enduring tendency to be vigilant for threat may be more susceptible to developing emotional disorders while under stress. It is essential to note that all the studies above share one common feature: preferential processing favouring threatening information unavailable for conscious processing. Consequently, preferential preattentive processing remained a significant predictor of emotional response to a stressor *after* various personality variables (e.g., trait anxiety, anxiety sensitivity, and neuroticism) and state anxiety had been accounted for.

It is important to better understand the role and involvement of the component preattentive processing *in* preferential processing and information appraisal. From an evolutionary perspective, preattentive processing and emotional vulnerability is concerned with underlying biological factors (Öhman, 1996; Öhman & Mineka, 2001). From a cognitive perspective, preattentive emotional vulnerability emanates from personality characteristics (e.g., Mathews & MacLeod, 1994; Mogg & Bradley, 1998).

A common theme in these different research approaches (e.g., Eysenck, 1997; Öhman, 1996) is that individual differences in the response of preattentive and orienting mechanisms towards threatening information may underlie emotional vulnerability and the maintenance and development of anxiety disorders.

Preferential preattentive processing and evolutionary preparedness

Perhaps the most widespread explanatory framework for an evolutionary perspective on preferential processing originates from Seligman's (1970) preparedness theory. Seligman developed an argument specifically claiming that the associative apparatuses of animals are constrained by evolutionary history. Because such associations were functional in an evolutionary perspective, he argued that some types of events are more easily associated than others. Events that belong together because of selection pressures are assumed to be more easily associated than arbitrarily related events. This preparedness postulate pertains to the ease of associability between stimuli rather than to the effect of their individual features. Thus, evolutionary recurring fear stimuli are expected to become easily associated with aversiveness. For example, humans are more likely to fear events and situations that were threats to the survival of our ancestors, such as heights and wide-open spaces.

Seligman (1971) followed up this argument by applying it to the acquisition of fears and phobias. For example, it is assumed that common phobic stimuli, such as small animals or human facial expressions suggesting condescension or threat, easily become associated with fear and anxiety (Öhman, 1993; Öhman, Dimberg, & Öst, 1985). Once selective, prepared associations have been formed, the resulting fear is assumed to be very persistent and to resist information suggesting that the stimulus in effect is innocuous. The nonrandomness of this distribution is easier to understand from a phylogenetic perspective rather than from an ontogenetic one, according to Seligman. Commonly feared creatures or situations such as snakes, heights, or closed spaces are more easily related to threats in the ecology of our ancestors than to the dangers of modern life. Conversely, common modern survival threats such as cars, broken electrical outlets, and heavy traffic are seldom the sources of phobic fear. The basic claim of the theory is that there is a genetically determined preparedness to associate aversive outcomes with evolutionary relevant threats. Preparedness theory goes a long way toward dealing with some of the shortcomings of the traditional fear conditioning theories of anxiety, particularly that in anxiety disorders fear is not easily extinguished and is especially irrational (e.g., Öhman & Mineka, 2001).

The preparedness theory received strong support from research on fear learning in monkeys. Studies have shown that monkeys reared in laboratory settings do not show the fear of snakes that is typical of monkeys reared in natural settings (Mineka, Keir, & Price, 1980). However, if lab-reared monkeys observed a wild-reared monkey exhibiting fear of a snake or a snake-like stimulus, the lab-reared monkeys rapidly acquired a strong fear of snakes (Mineka, Davidson, Cook, & Keir, 1984; Mineka & Cook, 1993). Thus real snakes served as effective cues for observational conditioning of fear.

To elaborate upon Seligman's preparedness theory, Öhman and his colleagues have employed fear-relevant pictures (snakes, spiders, and angry faces) and fear-irrelevant pictures (flowers, mushrooms; and neutral and happy faces) (Dimberg & Öhman, 1996; Esteves, Dimberg & Öhman, 1994; Öhman & Mineka, 2001; Öhman & Soares, 1993). Results from these studies showed a more robust conditioning to fear-relevant stimuli than to fear-irrelevant stimuli. Without conscious stimulus recognition a fear response is elicited, especially if the stimuli are fear-relevant. These findings provide further support for the reasoning that evolutionary preparedness is of relevance when discussing preferential processing. Based on the conclusion drawn from a large number of studies, Öhman and Mineka (2001) proposed that fear activation and fear elicitation can be understood in terms of a *fear module*.

"The fear module" by Öhman and Mineka

The Öhman and Mineka's (2001) fear module is assumed to be shaped by evolution and a relatively independent behavioural, psychophysiological, and neural system. The fear module evolved to solve adaptive problems related to potentially life-threatening situations and consists of four main characteristics: *Selectivity* - relatively selective with regard to the input to which it responds, particularly sensitive to stimuli associated with survival threats in the evolutionary past; *Automaticity* - can be automatically activated by fear stimuli without any conscious recognition of the stimulus; *Encapsulation* - once activated, it runs its course relatively resistant to conscious cognitive influences; and finally, a *specific neural circuitry* - controlled by an independent specific neural circuit organised around the amygdala and incorporating a series of subcortical structures that mutually control fear responses.

The evolution shaped fear module and its main characteristics fit well with the neurological findings of LeDoux (1996, 2000). LeDoux suggest that there is a neural circuit located in evolutionarily old parts of the brain such as in the limbic structures, rather than in the more recently evolved neocortex. Because the neural circuit is subcortical, it operates automatic and is relatively impenetrable to cognition. LeDoux is discussing the existence of two different pathways that contribute to emotional processing, with the amygdala playing a central role: a slow operating cortical pathway and a quickly operating subcortical pathway. The second pathway is operating in a “quick and dirty” fashion in the sense that information bypasses the thalamo-cortical and cortical-amygdala pathways. Stimuli are relayed directly from the thalamus to the amygdala, which facilitates an immediate initiated fear response (quick) and bypasses the cortex with the consequence that emotional stimuli are not fully processed (dirty). Thus, it was concluded that cortical processing is not necessary for sensory information to reach the amygdala. This reasoning has received a vast amount of support in later studies (Öhman, 2005, for a review). Öhman and Mineka (2001) suggested that the “quick and dirty” thalamo-amygdala route has a survival value in dangerous situations, which call for immediate action, parallels with their proposed fear module.

Fear, anxiety and preferential processing

This thesis has thus far focused on how the organism from an evolutionary perspective is prepared for threat-relevant stimuli through associability and how psychophysiological and emotional responses to such information may differ depending on type of personality, emotional disorder and state of mood. In this context is it also important to stress Beck’s influential schema theory (e.g., Beck & Clark, 1997), which has been an explanatory cognitive model concerning these phenomena. According to the authors, it is the dysfunctional nature of cognitive schemata in anxiety that is sensitive to information associated with threat or danger. The activation of such schemata is responsible for selective processing of schemata-congruent information. They further suggested that individual differences in the operation of such schemata underlie vulnerability to emotional disorders. For example, it is the dysfunctional nature of cognitive schemata in anxiety that direct information processing in favour of early detection of incorrectly presumed threat.

Mechanisms underlying preferential processing towards threat

So, how can the underlying perceptual processes in preferential processing be understood and explained? To be able to detect threatening stimuli outside of focused conscious attention, there have to be perceptual processes that automatically scan and analyze the perceptual field. The common assumption among researchers is that in attentional tasks such as in picture perception tasks, the stimulus is automatically processed for meaning independent of conscious strategy, and responses are elicited because attentional resources are consumed. Emanating from this are theoretical formulations concerning the existence of a perceptual system that automatically and preattentively focuses attention on potentially threatening stimuli. This perceptual system is supposed to have a bias for threat that has a likely origin in biological evolution. In the following section three models, chosen because of their emphasis on unconscious perception and the sharing of some common features of emotional information, will be briefly presented.

A model of threat, anxiety and preferential processing by Öhman

In a model of threat, anxiety and preferential processing by Öhman (1993), it is proposed that incoming information is first processed by what is labelled as a set of “feature detectors” that provide a first segregation of stimuli before they are fully analyzed in the second step involving the “significance evaluation system”. Evolutionary prepared stimuli or stimuli with high threat value may result in enhanced attention from feature detectors and the significance evaluation system. If stimuli have previously been associated with aversiveness, the arousal system is activated without the need of further processing. Otherwise, information is, after significance evaluation passed on to a “conscious perception system”, which allows a slower conscious appraisal via interaction with emotional memories stored in an “expectancy system”. If a threat is detected at this stage, autonomic arousal is elicited via this slower conscious processing route. According to this model, evolutionary derived threatening features receive preferential access to the “significance evaluation system” as well as to the arousal system. This way priming the further processing of the stimuli of which they are parts, eventually if possible even up to a conscious perception of threatening stimuli. This greater priority leads to attentional bias effects. The model implies that increases in an individual’s anxious mood have the effect of setting the significance evaluator into a more sensitive mode, increasing its output.

Like Öhman, Mathews and Mackintosh (1998) proposed a model that includes the automatic processing of emotional meaning, independent of conscious strategy. According to the Mathews and Mackintosh model, preferential processing favouring potentially threatening stimuli is increased by input from a *threat evaluation system* (TES), which is similar to Öhman's significance evaluator. An evaluation of the threat value of an encountered stimulus is computed automatically and at a very early stage of processing, with representation of stimulus attributes being automatically matched against stored information about attributes associated with danger. Representations of these emotional danger-related attributes, acquired via biological preparedness, conditioning or symbolic processes, are assumed to be stored in the TES, and are accessed at a very early and nonconscious stage of processing. The authors proposed that there is a survival value in having perceptual cues associated with threat identified rapidly and attended to swiftly. This reasoning corresponds largely to the earlier mentioned preparedness theory (Seligman, 1971) and the neurological findings of LeDoux (1996). Suggesting that the threat value of a stimulus event can be evaluated and matched in two different pathways, via either higher-level cortical processes or a "quick and dirty" thalamo-amygdala route. Hence, previously learned (through conditioning or with an evolutionary origin) cues attract attention via, as LeDoux puts it, the "quick and dirty" thalamo-amygdala route and novel events via higher-level cortical processes. Mathews and Mackintosh further proposed that the activation from the TES is greater in highly trait-anxious individuals for two reasons. First, these individuals have permanently lower TES output thresholds than others do. Second, they have more frequent activation and a wider range of threat representations in the TES. Further, emphasis is made regarding the impact of an individual's current anxious state: increases in anxious state trigger threat cues previously insufficient for significant output from the TES, in other words lowering the TES output threshold.

Despite the similarities concerning automatic processing of emotional information on a nonconscious level, the two models differ on one major assumption. The model presented by Öhman implies that information is passed serially from the significance evaluator to a conscious perceptual system rather than, as proposed by Mathews and Mackintosh, all aspects of a stimuli (their attributes, meaning, etc.) being processed in parallel, prior to full awareness of their identity. Initial representations of these attributes are thus activated simultaneously and compete for attentional resources.

Another influential model of attentional bias is described by Wells and Matthews (1994) and partly resembles the model of Öhman (1993), in that conscious expectations of threat can set up conditions for attentional bias. Wells' and Matthews' model, termed the *self-regulatory executive function*, attributes attentional bias to top-down processes, related to an individual voluntarily executed plan, which specifies the monitoring of threat-related stimuli intruding into awareness. When such stimuli come into awareness, individuals may "lock onto" them, especially if this voluntarily "threat-monitoring" plan is under the influence of state anxiety. This model differs from the Öhman model in the sense that it assumes that the threat-monitoring plan is initiated voluntarily and is "locked onto" threatening stimuli of which the individual is consciously aware. Thus, making it difficult to apply to, and explain for, nonconscious emotional processing. Wells and Matthews argue that even if a stimulus cannot be consciously recognised, the individual reaction itself to such a stimulus might still be influenced by a top-down control. This infers that anxious people may voluntarily adopt a specific threat-monitoring plan with the consequence that all threatening stimuli attract attention, including those not available for conscious perception.

Fear versus anxiety

In this thesis, fear and anxiety have been used rather intermixed on purpose, due to the lack of evidence of a clear distinction between these two emotions. Nevertheless, it is useful to shed some light on this ongoing discussion. From an evolutionary perspective on emotion, fear is defined as an aroused, aversive state, prompting escape from and avoidance of particular situations that threaten the survival or well-being of an organism. Fear is thus postulated to result from the operation of defence systems of ancient evolutionary origin. These defence systems are thought to have evolved because they helped keep organisms away from potentially deadly contexts and situations. Fear is closely related to another emotional phenomenon, anxiety; both are reactions to harmful or potentially harmful situations.

Anxiety is usually distinguished from fear by the lack of an external stimulus eliciting the reaction – anxiety comes from within us, fear from the outside world. Although similar to fear in experiential quality and physiological correlates, anxiety typically cannot be straightforwardly attributed to an external threat. Epstein (1972) argued that external stimuli are insufficient for distinguishing between fear and anxiety. He

proposed that fear is related to action, and particularly to escape and avoidance, but when the action is blocked or thwarted so that the situation in fact becomes uncontrollable, fear is turned into anxiety. According to Epstein, at that point “fear is an avoidance motive”. If there were no restraints, internal or external, fear would support the action of flight. Anxiety can be defined as unresolved fear, or alternatively, as a state of undirected arousal following the perception of threat (Epstein, 1972). In genuine fear, a physiological mobilization is channelled into escape and avoidance behaviour, whereas anxiety is left in the system because appropriate action is for some reason ruled out. The sight of a snake elicits fear, but the remembrances of some unpleasant experience with a snake or the anticipation that you may encounter a snake are conditions of anxiety. Fear and anxiety are normal reactions to dangers and are not themselves pathological conditions. When fear and anxiety are more recurrent and persistent than what is reasonable under the circumstances, and when they impede normal life, a fear/anxiety disorder exists (Öhman, 1992).

Fear eliciting via evolution or culture

There is today, based on a large amount of research, compelling evidence for preferential processing of emotional valence of a stimulus, independent of conscious strategy, as well as a relative consistency of results showing superior conditioning to fear-relevant as compared to fear-irrelevant stimuli. Even so, there is an ongoing discussion concerning the ontogenetic or phylogenetic origin of stimuli that has been used as fear eliciting in studies concerning fear conditioning of human autonomic responses. The preparedness hypothesis (Seligman, 1970) implies that the associative apparatus of organisms is constrained by evolution. Accordingly, the concept of an evolved fear module (Öhman & Mineka, 2001) very much rests on the assumption that there is a phylogenetic or evolutionary basis for autonomic responses towards fear-relevant stimuli. Research concerning this issue when using human participants is not conclusive. Mainly because participants do have prior ontogenetically based associations to the fear-relevant stimuli used, with the consequence that the fear-relevance could derive from culturally or ontogenetically based influences rather than having only a phylogenetic origin. In an attempt to distinguish between these competing interpretations of stimuli presented, studies have been performed using classical conditioning paradigms. In several studies, aversive conditioning to fear-relevant stimuli with only an ontogenetic origin, such as damaged electrical outlets and pointed guns, has been compared with aversive conditioning to stimuli such as snakes and spiders, also with such connotations but for which, in addition, phylogenetic

factors are likely to operate (e.g., Hugdahl, & Kärker, 1981; Cook, Hodes, & Lang, 1986; Hugdahl, & Johnson, 1989; Tomarken, Sutton, & Mineka, 1995). Results from these studies have generally indicated better conditioning to phylogenetically based fear-relevant stimuli than to ontogenetic ones (for an extensive review see Öhman, & Mineka, 2001), hence, preferential processing favouring fear-relevant stimuli. Further support for an evolutionary bias is found in a recent study by Mühlberger, Wiedeman, Herrmann and Pauli (2006). Their results indicate that phylogenetic fear-relevant stimuli are processed in a preferred way compared to ontogenetic ones. However, the strongest support for the phylogenetic perspective of preferential processing in fear conditioning is found in research on fear learning in monkeys. Mineka and Cook (1993) showed that lab-reared monkeys did not display the fear of snakes that is typical of monkeys reared in the wild, but after observational fear conditioning the monkeys rapidly acquired a strong fear of snakes, which was not the case with other stimuli, such as flowers, conditioned in an identical procedure.

Having said this, in a study by van den Hout, van Jong and Kindt (2000), data indicated that the emotional meaning of unconsciously presented words had an influence on preferential preattentive processing. Specifically, among a group of spider phobics results indicated enhanced preferential preattentive processing favouring threat words presented outside of conscious awareness. Similar effects were found among normal participants facing negatively valenced words (Silvert, Delplanque, Bouwalerh, Verpoort, & Sequire, 2004). Words used as visual stimuli are not phylogenetically relevant to the same degree as fear-relevant pictorial stimuli. Consequently, preattentive processing of lexical information cannot rely only on perceptual features. Some kind of analysis of symbolic meaning must be included in the process. Van den Hout et al., (2000), are proposing a semantic processing on a global level along a positive – negative dimension being sufficient for preferential preattentive processing to occur.

Nevertheless, as can be understood from the discussion above, there is today no convincing evidence of a distinction between phylogenetic and ontogenetic highly potent fear-relevant stimuli regarding fear conditioning in humans. Tooby and Cosmides (1992) assume that culture is shaped by evolution and phylogenetic and ontogenetic factors should thus be mutually supportive in predisposing humans to learn to fear and avoid potentially dangerous situations. This assumption is supported by results presented by Flykt, Esteves and Öhman (2007), indicating similar effects being obtained from fear-relevant stimuli of cultural origin as from biologically fear-relevant stimuli.

The measuring of preferential processing

In line with the reasoning by Öhman and Mineka (2001) concerning the fear module, a central function of emotions such as fear, is to modulate the readiness to act; they tune the autonomic nervous system to ensure metabolic resources for action. This bridge between emotion and the autonomic nervous system provides the basis for autonomic responses as indicators of emotion. When confronted with a fearful object, humans react by showing distinct autonomic psychophysiological responses such as heart rate acceleration, blood pressure increase and increased sweating.

Skin conductance responses (SCRs)

The swiftest psychophysiological reaction is increased sweating, which is measured thru skin conductance responses (SCRs). Skin conductance response (SCR) has now been used for over a century as a non-verbal measure of cognitive and emotional processes in general psychophysiology. The methodology is today widely accepted as one of the main techniques for measuring emotional responses to different types of stimuli in research concerned with fear and anxiety (Öhman Mineka, 2001, for a review). A common method of eliciting SCRs is using a picture perception task. In this task, participants are exposed to pictorial stimuli with different content categories, such as threatening and neutral ones. Simultaneously, a recording of the participants SCR is conducted, showing different emotional responses elicited corresponding to the exposure to the different picture categories. There are two basic methods of recording SCR, attributed to the French neurologist Féré (1888, as cited in Dawson, Schell, & Fillion, 1990) and Russian psychologist Tarchanoff (1890, as cited in Dawson, Schell, & Fillion, 1990). The exosomatic method (Féré, 1888) of recording SCR is based on measuring an external current flow through the skin in response to a constantly applied voltage, whereas the endosomatic method (Tarchanoff, 1890) is based on recording skin potential responses without involving an external current. The exosomatic method is by far more prevalent in contemporary research (Fowles et al., 1981) and will be the method in focus in the following.

The method is based on measuring changes in SCRs related to the activity in the eccrine sweat glands. These glands cover most of the body and are most dense on the palms and soles of the feet, with thermoregulation as its primary function. Vaporisation from the skin is mainly considered with respect to its thermoregulatory

function, but in psychophysiology research the focus is on what Shields, MacDowell, Fairchild, and Campbell, (1987) classified as “emotional sweating”. This refers to sweat gland activity as a concomitant of psychological and especially emotional states elicited in high activation or under stress. “Emotional sweating” is observed mainly on palmar and plantar sites in accordance with the area of dense location of the eccrine sweat glands

The dominant view explaining how the activity in an eccrine sweat gland is related to SCR has in the past been a two-effector model explained by Edelberg (1972).

According to this model, two peripheral activities contribute to SCR: the filling of the sweat duct and the activity of a selective membrane that lies in the epidermis. This reasoning has been revised, with Edelberg (1993) proposing a single effector model that focuses on the secretion of sweat from the sweat gland and the attendant filling of the sweat duct. To understand how electrodermal activity is related to the sweat glands, it is useful to think of the long tubular sweat ducts as a set of variable resistors wired in parallel. The higher the sweat rises in a given gland, the lower the resistance in that variable resistor, hence higher SCR.

As useful as SCR is for indexing psychological processes it has been more difficult to identify specific brain centres and pathways, given its diffuse levels of control. Historically, both the sympathetic and parasympathetic divisions of the autonomic nervous system were considered possible mediators of SCR. However, later research has provided convincing evidence for SCR reflecting sympathetic nervous system activity, with studies measuring sympathetic action potentials in peripheral nerves while simultaneously recording SCR. Results have shown that, within normal ranges of ambient room temperature and subject thermoregulatory states, there is a high correlation between bursts of sympathetic nerve activity and SCRs (e.g., Wallin, 1981; Shields et al. 1987). Further, from an evolutionary context, Fanselow (1994) argued that different defence responses are activated depending on the closeness of the predator. Using a notion of “predatory imminence” to specify the dynamics of the defence responses, it was divided into three main stages: first orientation, then freezing and finally fight-or-flight response. Inspired by Fanselow’s model, Lang, Bradley and Cuthbert (1997) identified different patterns of psychophysiological response, such as SCR, with these stages and their association with the autonomic nervous system (ANS). They proposed that the parasympathetic branch of the ANS was dominant in the orientation and freezing stages and that the sympathetic branch was dominant in the fight-or-flight stage.

SCRs have been, and are today, very common as a measure of emotional arousal but have been the subject of some criticism, directed mainly at the SCR's relative insensitivity to the emotional valence of stimuli. Large SCRs are found not only to negative-arousing stimuli; even positive-arousing stimuli elicit the same kinds of response, thus it is obvious that SCR provides a direct index of the attention value of emotional stimuli presented (Lang, Greenwald, Bradley, & Hamm, 1993). However, because emotion and attention are so closely intertwined it is difficult to determine whether enhanced SCR to threatening stimuli occurring outside conscious awareness, as in Öhman and Soares (1994), reflects merely a general relationship with attention or a relationship that is specific to fear. In a study using electromyography (EMG) by Dimberg (1982) it was found that participants tended to mimic the emotional expressions of stimulus faces and differentiate their own facial muscle activity depending on the emotional expression of stimuli faces presented. Based on that study Dimberg, Elmehed and Thunberg (2000), also using EMG, examined facial responses to facial stimuli presented outside of conscious awareness. It was found that the participants showed differential facial EMG responses depending on preceding stimulus face. Thus, it appears that more specific emotional responses, corresponding to stimuli presented, could be elicited even by stimuli occurring outside of conscious awareness.

Additional data supporting the use of SCR as an emotional index were reported by Whalen et al. (1998) in a study focusing on the role of the amygdala as the central structure of the fear circuit, in accordance with LeDoux (1996). Using functional magnetic resonance imaging (fMRI) to measure responses of the amygdala, results showed reliable increases in amygdala activation related to the presentation of fearful faces compared to happy ones, even though conscious recognition of the stimuli was prevented. Additionally, in a study by Furmark et al. (1997), a strong correlation was found between SCRs to pictures and conditioned regional cerebral bloodflow in the right amygdala. These researchers used electric shock as the unconditioned stimulus and conditioning pictures of snakes and spiders, and scanned coincident regional bloodflow in the brain with positron emission tomography (PET). To summarize, even though SCR shares variance with both attention and emotion (Lang et al., 1993), the results from the above mentioned studies provide strong support for its use as a measure of emotional responses. Today SCR is considered as a measure of the state of human interaction with its environment, a concept covering both emotional (affective) and cognitive (orienting processing, attention) responding (Kilpatrick, 1972; Siddle, 1991).

The emotional Stroop task

An alternative method of measuring preferential processing is the frequently used colour-naming procedure of the emotional Stroop task. In this task, participants are presented a series of words of differing emotional valence, printed in a variety of colours. Instructions are given to name the colour as quickly as possible while ignoring the meaning of the word. It has been proposed (e.g., Mathews, 1990) that all words are automatically processed for meaning and when a word is matching a participant's particular fear, the colour naming becomes slower compared to neutral words. This is consistent with the hypothesis that people with heightened vulnerability to anxiety are less able to ignore negative information. It has commonly been observed that such individuals display disproportionately long colour-naming latencies on more negative words. This effect has been demonstrated by patients suffering from a wide range of clinical anxiety disorders (e.g., Mattia, Heimberg, & Hope, 1993; Kaspi, McNally, & Amir, 1995). It has also been observed in non-clinical samples reporting elevated levels of trait anxiety (e.g., van den Hout et al., 1995). Because the present thesis mainly employed the psychophysiological measure of SCR as a measure of preferential processing, the emotional Stroop task will not be discussed in greater detail.

II. METHOD

Distinguishing unconscious from conscious processing

The focus in this thesis is on preferential preattentive processing and it is therefore important to shed some light on the question of what is meant by unconscious versus conscious processing of information. The distinction between conscious and unconscious psychological processes has been debated over a century and was even one of the more important issues for early psychologists such as William James and Sigmund Freud. For example, one of the cornerstones of classic Freudian theory is the viewing of the unconscious as a reservoir containing complex motives, desires, preferences and so forth. Later, in the strong movement of American behaviourism, it became increasingly clear that conscious and unconscious psychological processes were greatly intertwined and were therefore difficult to define and study. Therefore temporarily causing this issue to lose its appeal to a large part of the community of experimental psychologists. The emergence of the “New Look” in perception (Bruner & Goodman, 1947), introducing a constructivist view of perception including motivational factors as its determinants did stimulate studies of unconscious influences on perception, such as perceptual defence (e.g., McGinnies, 1949).

When introducing motivational factors, attention and perception into the experimental psychology concerning conscious versus unconscious psychological processes, the debate regarding the distinction between what consciousness and unconsciousness is surfaced again. Ever since James (1890, as cited in Dawson, Schell, & Filion, 1990), whose appealing definitions of attention are based on people’s introspective reports of their inner states, the concept of consciousness has been intertwined with that of attention. Some help originated from research on attention when Posner (1978) introduced a distinction between automatic and conscious processes as a parallel to conscious and unconscious and Shiffrin and Schneider (1977) proposed automatic and controlled information processing, together making use of the concept of “limited cognitive resources”. Automatic processes were believed to be capable of operating outside of awareness, not requiring cognitive capacity. Unlike controlled processes, which consume resources, automatic ones proceed effortlessly, without mutual interference with other concurrent processes (Shiffrin & Schneider, 1984). This implies that awareness is low for automatic processes and high for controlled processes. Thus, these processes provided a potential distinction between attentional control systems, which appear to be related to unconscious and conscious

psychological processes. Chalmers (1996) argues in a similar way, that being conscious of a stimulus allows the perceived information to be used for the basis of action. Unconscious processing of a stimulus results in automatic reactions that cannot be consciously controlled.

Emphasizing that unconscious processing results in automatic reactions outside conscious control, one can argue that a demonstration of unconscious effects requires a dissociation between the perceptual and emotional impacts of a stimulus. Implying a lack of perceptual awareness but nevertheless an automatic response, such as a physiological response like SCR. This dissociation is consistently demonstrated in several studies, for example in Öhman & Soares (1994), which showed that subjects were unable to distinguish between fearful and non-fearful visual stimuli in a forced choice discrimination task. Nevertheless, the participants showed enhanced SCRs when exposed to fearful stimuli, suggesting that emotional activation did not require full perceptual awareness of the stimulus presented. The question of what we mean by “unconscious” is crucial for interpreting and explaining data in experimental psychology, and an attempt to make an operational definition of this phenomenon will summarize this discussion.

There have been two general approaches. The first is to simply rely on participants’ self-reports. Dixon (1981) advocated asking the participant if they were “consciously aware” of the stimulus. If the participant says they were not consciously aware then this is taken, by definition, as evidence of lack of subjective awareness. The second approach, first advocated by Eriksen (1960), is that awareness is the ability to make a discriminatory response - the participant is objectively aware. According to Erikson, the participant is only unconscious of the stimulus when they are unable to make a discriminatory response.

Subjective versus objective threshold

These two approaches correspond with the two kinds of threshold that should be considered, according to Cheesman and Merikle (1984): subjective and objective. A subjective threshold refers to the level of discriminative responding at which participants claim not to be able to identify or recognise perceptual information. Additionally, subjects may vary in their confidence and willingness to report, and when forced might detect it at a better than chance level of performance. An objective threshold is the level of discrimination responding to chance level performance.

According to Cheesman and Merikle (1986), the subjective threshold is the “transition between unconscious and conscious processing”. It is the point in perceptual processing when a stable, integrated percept is formed that allows conscious report and phenomenal awareness. At the objective threshold no perceptual records have been formed, but at the subjective threshold adequate information has been accumulated for stable integrated percepts to be formed. If a subjective threshold is adopted, a consequence is that the distinction between unconscious and conscious processing comes more in line with the contrast proposed between automatic and strategic processing (Shiffrin & Schneider, 1984).

However, there will always be the problem of determining what exactly is meant by “unconscious” and the difficulty of setting the prime stimulus duration so that we can be sure that the subject was truly “unconscious”. Another, perhaps more productive, way of viewing the distinction between unconscious and conscious psychological processes is as Merikle and Daneman (2000) propose. Instead of being preoccupied with a technical discussion of levels of awareness during unconscious and conscious processing, their more interesting research approach is to examine whether unconscious and conscious perception lead to qualitatively different consequences.

This discussion underlines that there is no rough-and-ready method available to delineate unconscious from conscious processes. However, it is a theoretical background and plausible explanation of why unconscious processes in studies (e.g., Öhman & Soares, 1994) often are defined using a subjective threshold methodology with a focus on a dissociation between the perceptual and emotional impacts of a stimulus as a demonstration of unconscious effects.

Methodological issues regarding unconscious versus conscious SCR responses

What is needed is a methodological tool to ensure that the stimulus of interest is subjected to a preattentive perceptual analysis, yet is denied access to conscious cognitive processing. There are several techniques available for nonconscious presentation of stimulus, each more or less dependent on below-threshold stimulus exposure. For example, stimuli may be presented below the threshold of conscious perception either of because low applied energy or short duration, or the stimuli may be hidden in a nonattended channel, e.g. in a dichotic listening task (see Holender, 1986, for a critical review).

One of the more frequently used and preferred methods of dissociating unconscious from conscious processing is backward masking (e.g., extensive work by Öhman and colleagues). Using this technique, the *target* stimulus is presented briefly and is then followed by another stimulus, the *mask*, either immediately or after a very short empty interval. Making it possible to manipulate the participant's recognition of the target stimulus from not better than chance performance to correct recognition by varying the stimulus-onset asynchrony (SOA) between target and mask. Given that information processing is something that unfolds over time, introducing the mask disrupts the participant's processing of the target stimulus and provides an active control of the amount of processing allowed. This is important, considering that the sensory icon that may persist several hundred milliseconds after the physical termination of a stimulus this way is disrupted by the introduced mask using the backward masking technique (Massaro, 1985).

Marcel (1983) introduced a theory of unconscious and conscious perception with a theoretical perspective supporting the backward masking technique for dissociating unconscious from conscious processing. According to this theory, unconscious perceptual mechanisms redescribe sensory data into a representational form familiar and understandable to the organism. These redescribed sensory data are in turn input to further processing mechanisms in the form of a data-driven bottom-up type of processing on an unconscious level. This data-driven bottom-up processing meets a conceptually driven, top-down derived hypothesis in a perceptual recovery process, which selects one of the very many potential percepts among the unconscious sensory data. A conscious concept is formed when these processes meet. Backward masking is assumed to disrupt the act of recovery in the top-down processing, leaving perceptual data unconsciously within the organism where it may connect to response mobilization processes initiating emotional responses.

Several studies have been performed concerning the effect of the SOA on a participant's ability to recognize stimuli presented using forced-choice scales as an indication of detection (Esteves & Öhman, 1993; Öhman & Soares, 1993; Öhman & Soares, 1994). Findings indicate that a 30-ms SOA produces effective masking, thus stimuli presented occurred outside of conscious awareness. Furthermore, it is important to note that the character of the target stimulus, fearful or neutral to the participant, did not significantly influence their ability to recognize the target. Nevertheless, it is important to ascertain the effectiveness of the masking procedure for each study, because masking is affected by numerous variables such as picture size, brightness and contextual circumstances.

General aim of the thesis

The general aim of the present thesis was to examine factors that could be of help understanding individual differences in preferential processing of emotional information in a non-clinical population with a specific focus on preattentive processing. One main question has been, foremost using an evolutionary perspective on emotions, whether individual differences in preferential processing of threatening emotional information can be described as an effect of stable personality characteristics such as trait anxiety. A further question seeks the extent to which individual differences in preferential preattentive processing of emotional information play a role in emotional vulnerability in response to emotionally stressful events.

III. THE EMPIRICAL STUDIES

Specific aims

- (1) To examine the potential influence of strong negative emotional experiences on individuals' preferential preattentive processing when exposed to threat-relevant stimuli. (Study I)
- (2) To study the effects of trait anxiety on preferential preattentive processing during exposure to threatening pictorial stimuli and also explore the potential mediating effects of social desirability (Study II)
- (3) To explore the relationship between autonomic responses elicited by preferential processing of threatening pictorial stimuli and emotional responses to naturally occurring stressful life events (Study III)
- (4) To investigate the predictive value of preferential processing in emotional responses to a laboratory stressor using both subjective and objective measures of emotional responses (Study IV)

General methods and design

Participants

The participants in Study I were recruited among military personnel in the process of performing their basic military training in order to be enrolled in the Swedish UN military force, and also among military personnel with prior experience of emotionally charged war situations from military service abroad. In Studies II and IV the participants were undergraduate psychology students from Stockholm University. In Study III the participants consisted of police recruits selected from the Police Academy at Sörentorp, Stockholm, due to enrol in active duty within two to four months. Informed consent was obtained before participation in the study.

Instruments

Spielberger's Trait-State Anxiety Inventory (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983). The trait version (STAI-T) consists of 20 items that assess enduring

symptoms of anxiety. The STAI-T was used in Studies II, III and IV. The state version (STAI-S) is a 20-item scale that measures current subjective reports of worry and anxiety. The STAI-S was used in Study IV.

Impression management (IM). This instrument consists of 12 items assessing social desirability and was selected from the 16PF Fifth Edition Questionnaire (Cattell, Cattell, & Cattell, 1993), and comprised elements of both self-deception and other-deception. This instrument has adequate psychometric properties ($\alpha = .65$) (Russell & Karol, 1997) and was strongly correlated ($r[41] = .78$) with a short form of the MCSD scale (Crowne & Marlowe, 1964) in a recent pilot study conducted in our laboratory.

Subjective emotional response (SER). In Study IV, immediately after the problem-solving task participants were asked to complete six visual analogue scales in answer to the question “How did you feel during the task?” The items were derived from the STAI-S, paraphrasing some original items, and included statements such as “I felt tense”, “I was nervous” and “I was calm”. Levels of stress were indicated by a mark on a 100 mm-long line with the left endpoint labelled “not at all” and the right endpoint “maximum”. The internal consistency for this scale was satisfactory ($\alpha = .85$).

Karolinska Scales of Personality: the Social Desirability scale (KSP-SD). This scale, developed by Schalling and co-workers (e.g., Schalling, 1985), is a short form of the MCDS (Crowne & Marlowe, 1964) and has demonstrated adequate psychometric properties (Gustavsson, Weinryb, Göransson, Pedersen, & Åsberg, 1997).

Impact of Event Scale (IES). This instrument consists of two dimensions, intrusion (seven items) and avoidance (eight items). The intrusion dimension included symptoms such as intrusive memories, thoughts and emotions. The avoidance dimension included symptoms related to avoiding memories and places, as well as denial. Symptom frequencies evaluated on a four-point scale with non-equidistant levels: 0, 1, 3, and 5, indicating a range from “not at all” to “often” (Horowitz, Wilner, & Alvarez, 1979).

Stimulus material

Studies I, II and III employed pictorial stimuli, a collection of standardised colour photographic materials taken from the International Affective Picture System (IAPS),

(Lang, Bradley, & Cuthbert, 1999). There were fourteen pictures chosen on the basis of their normative pleasure and arousal rating, seven unpleasant and arousing pictures mainly of a physical threat nature (e.g., mutilated bodies, battered woman) and seven pleasant and calm pictures that differed in nature (e.g., book, mushroom). In Study IV a total of 48 words from Språkbanken (2003) were used, with the following characters: ego threat words, ego positive words, positive words and neutral words.

Procedure

In Study I the picture perception task involved one subliminal (5 milliseconds) and one supraliminal (2 seconds) exposure condition. The pictures were presented to the participants in one of three different ways: (1) 6 neutral followed by 6 threatening; (2) 6 threatening followed by 6 neutral; (3) neutral and threatening pictures in random mixed order. There was a pause of 20 seconds between each exposure. In all cases, subliminal presentation preceded supraliminal presentation.

The picture perception task in Studies II and III involved one unmasked and one masked exposure condition. A trial entailed a presentation of a picture that remained on the screen for 6 milliseconds, immediately followed by a mask (consisting of picture fragments of the original picture) that remained on the screen for another 200 milliseconds. Then, the screen was blanked for 16 seconds until a white dot appeared on the screen four seconds prior to the presentation of the next picture. In the unmasked exposure condition, a trial was identical to a trial in the masked condition, except this time the picture remained on the screen for 2 seconds before it was masked. There were two different presentation orders and participants were randomized to one of them. The pictures were presented in one of two different ways: (1) 7 neutral followed by 7 threatening; (2) 7 threatening followed by 7 neutral. In all cases, masked presentation of pictures always preceded unmasked presentations.

Study IV contained an emotional Stroop task consisting of a presentation of both masked and unmasked coloured stimulus words. In the subliminal exposure condition, a trial consisted of the presentation of a letter string of Xs used as a forward mask (17ms) followed by a stimulus word shown for the appropriate exposure duration, considering an earlier individually established threshold. Then, a letter string of Xs used as a backward mask replaced the stimulus word and remained on the screen until the participant's verbal colour naming response triggered the voice key. A blank screen then followed for 2 seconds until the presentation of the next trial. Both the

forward and backward masks used in the trials consisted of an equivalent length of Xs and were the same colour as the presented stimulus word. In the supraliminal exposure condition, a trial consisted of the presentation of a coloured stimulus word that remained on the screen until the participant's verbal colour naming response triggered the voice key. A blank screen then followed for 2 seconds until the presentation of the next trial.

Measurement of preferential processing

As a dependent variable in Studies I-III, to measure preferential processing based on autonomic responses, an individual SCR threat index was used. These indices were calculated for each individual by subtracting the mean range value (defined as the distance between the lowest and the highest skin conductance levels during the measurement period) for neutral pictures from the mean range value of threat pictures. A positive value indicates stronger autonomic responses in favour of threatening pictures relative neutral pictures, whereas a negative value indicates the opposite. In Study IV, as dependent variables targeting selective attention, Stroop interference indices were calculated for each individual by subtracting the mean colour latency for neutral words from the mean colour latency for threat words. This was done in both masked and unmasked stimulus exposure conditions. Similar to the SCR threat index, a positive index indicates a slower colour naming response for threat words as compared to neutral words.

Statistical analyses

A 2-by-2 mixed ANOVA was used in Study I, with the purpose of comparing the different groups in order to investigate whether the mean values in the dependent variable differed significantly from each other. Hierarchical multiple regression was used in Studies II-IV. An *a priori* hierarchical structure to build the model is used in hierarchical regression, enabling an examination of the influence of several predictors in a sequential way. The purpose of the analysis is to see not only how well the predictor variables acting together can predict the criterion variable, but also if some of the other predictor variables are significantly better predictors than others, once mutually shared variance has been taken into consideration. The focus is on the changes in predictability associated with predictors entered later in the analysis, over and above the contribution by predictors entered earlier in the analysis. The reasons

for using multiple regression analyses in these studies are twofold. Interaction effects were tested, and using an ANOVA would likely cause an unequal number of participants in each group and a design with continuous variables makes it possible to use all available information (Cohen & Cohen, 1983).

Detection of outliers

A univariate outlier is an extreme, unusual observation on one variable, which obviously deviates from the rest of the distribution for that variable in that it lies outside the interval of ± 3 standard deviation units from the mean. The presence of outlier cases may distort the result of a statistical analysis compared to what it would be with those outlier cases removed, and thus they can lead to serious misinterpretation of the investigated relationship. The detection of univariate outliers by means of scatter plots revealed no such cases in the samples of this thesis. A multivariate outlier is a case in a data file that may have reasonable values on the separate variables, but has an unusual combination of values on the different variables. In this thesis, multivariate outliers were defined as those having standardized residuals $\geq Z = \pm 2.5$, and were excluded from the analyses (Statsoft, 1994).

Summary of the studies

Study 1

Skin conductance response in Swedish United Nations soldiers exposed to fear-relevant stimuli.

Background

Having strong negative emotional experiences may influence later emotional reactions to fear-relevant information, as has been seen in the complex problems surrounding posttraumatic stress disorders (PTSD). Physiological responses such as enhanced skin conductance responses (SCRs) have been found in individuals with a diagnosis of PTSD, when they were exposed to cues with relevance to their traumatic experiences, compared with individuals without a PTSD diagnosis (Blanchard, Kolb, Gerardi,

Ryan, & Pallmeyer, 1986; Orr, Pitman, Lasko, & Herz, 1993). We have chosen to view earlier strong emotional experiences as a form of conditioning in this study, taking into consideration the findings of Orr et al. (1993). This is in line with Pitman (1988), who provides a framework for understanding the process through which trauma-related cues could acquire the capacity to evoke large emotional responses in some individuals. Thus, the present study was designed to investigate the role of traumatic combat experience with regard to SCRs following a subliminal and supraliminal presentation of threat-related pictures. In accordance with previous findings (e.g., Blanchard et al., 1986; Orr et al., 1993), the hypothesis was that there would be a measurable difference in SCR between two groups when exposed to threat-relevant pictures, due to former traumatic combat experiences, but not when they were shown neutral ones. This would be accounted for on both a subliminal and supraliminal level.

Method

The sample consisted of 20 males divided into two groups. The “combat experience” group comprised 10 men (mean age 25.5, SD 3.17) with prior experience of emotionally charged war situations from military service abroad. The “comparison” group comprised 10 men (mean age 24.3, SD = 2.79) who had undergone basic military training for service abroad but had experienced neither such service nor any genuinely disturbing emotional experience of any kind during the past five years. An individual baseline check was conducted prior to the picture perception task to establish a subjective threshold, in accordance with Cheesman and Merikle (1986). The participants were then presented with coloured pictures, which consisted of threat-relevant (e.g., war victims, mutilated bodies) and neutral (e.g., summer meadow, book) pictures; this was done on both a subliminal and supraliminal level. Individual SCRs to the pictures presented were measured using a max-min value, defined as the amplitude of the response curve during the measurement period. To examine the main effect of picture type, a 2- (group) by-2 (picture type) mixed ANOVA was performed for each exposure condition.

Main results

In accordance with our expectations, there was a main effect of group in the subliminal exposure condition, but contrary to our prediction, the main effect was due to the

comparison group showing stronger mean SCRs to subliminal exposed stimuli, $F(1, 18) = 7.94, p < .012$. There was also a significant interaction between group and picture type, $F(1, 18) = 4.74, p < .044$, revealing a strong increase in SCRs for the comparison group towards threat-relevant pictures compared to neutral ones. This response pattern was not found in the combat experience group. Further analysis of the response pattern in the comparison group showed that the increase in SCR depending on picture type was significant, $t(9) = -2.277, p < .05$. In the other exposure condition, supraliminal level, there was again a main effect of group, with the comparison showing stronger mean SCRs than the combat experience group, $F(1, 18) = 6.80, p < .018$. There was also a main effect of picture type, $F(1, 18) = 5.59, < .030$, with both groups reacting more strongly to threat-relevant pictures than to neutral ones, the comparison group accounting for most of this effect.

Discussion

The most robust finding in the present study was that the combat experience group consistently reacted with lower SCRs compared to the comparison group, to the pictures presented on both a subliminal and supraliminal level, regardless of picture type. The absence of difference in SCR to neutral and threat-relevant pictures on a subliminal level in the combat experience group is not in line with previous research concerning SCRs to conditioned stimuli (e.g., Öhman & Soares, 1994; Öhman & Soares, 1998). One possible interpretation of this can be found in a study by Amdur, Larsen, and Liberzon (2000), who studied emotional numbing (EN) and found that a group of participants with earlier combat experience spent more time viewing stimuli that evoke angry, sad and disgusted emotions compared with other groups without this specific experience. The authors discussed this in terms of increased processing time – more time was needed to process stimuli that evoke specific emotions. Hence, in the present study, it could be that the set exposure time was too short to activate an emotional response in the combat experience group. Further, the lack of difference in SCRs towards threat-relevant compared to neutral pictures could be a part of avoidance strategies serving to prevent stimuli occurring outside conscious awareness from activating traumatic memories. This phenomenon has been found in a study concerning information processing in combat veterans by Creamer and Kelly (2000). This is in line with the reasoning by Flack et al. (2000), who proposed that avoidance behaviour plays a role in reports of EN and also corresponds with the lack of SCRs towards threat-relevant stimuli on both a subliminal and supraliminal level for the combat experience group in the present study.

Study II

Unconscious responses to threatening pictures: The interactive effect of trait anxiety and social desirability on skin conductance responses.

Background

There are relatively consistent data supporting the occurrence of elevated skin conductance responses (SCRs) to fear-relevant pictorial stimuli (relative to neutral ones) in different types of phobia (e.g., Fredrikson, 1981; Globisch, Hamm, Esteves, & Öhman, 1999). Similar results have been found even when the pictorial stimuli occurred outside conscious awareness (Öhman & Soares, 1993; Öhman & Soares, 1994), and much emphasis has been placed on the role of preattentive processing of threat in the development of phobic fear and anxiety disorders (Öhman, 1996). In the research paradigm using cognitive outcome measures, it has been shown that anxiety-prone individuals exhibit preferential processing favouring threatening information not available for conscious perception (e.g., Eysenck, 1997; Williams et al., 1997). In fact, individuals high in trait anxiety have been suggested as likely candidates among those who are disposed to respond with fear and anxiety to a wide range of stressors (e.g., McNally, 1989); thus, this could be one factor that determines the SCRs to masked threatening pictures. There is as yet no direct evidence of a relationship between physiological autonomic responses and cognitive outcome measures when studying preferential processing favouring threatening information.

The main purpose of this study was to explore whether trait anxiety exerts influence on physiological autonomic responses due to perception of pictorial threat, similar to studies using cognitive outcome measures (e.g., Williams et al., 1997). Furthermore, social desirability (i.e., defensiveness) was also included in the analyses due to the fact that social desirability is appropriate to use for splitting the two groups, low and high trait anxious, into four groups in accordance with Weinberger et al. (1979). Thus, the present study was designed to study the effects of trait anxiety on SCRs during exposure to threatening pictorial stimuli, controlling for social desirability, in a non-clinical sample. On the basis of previous findings (Najström & Högman, 2003) we expected significantly stronger SCRs to threatening pictures compared to neutral ones in the masked exposure condition, and in accordance with the reasoning above, higher trait anxiety scores were expected to be largely responsible for these effects.

Method

A total of 79 undergraduate psychology students (48 men and 31 women, mean age 27.6 years, $SD = 6.6$) volunteered to participate in the study. The psychometric data, consisting of STAI-T (Spielberger et al., 1983) and social desirability (16PF IM scale; Cattell et al., 1993), were collected prior to the laboratory session. The session started with a pre-test to establish an individual subjective threshold for each participant, in correspondence with Cheesman and Merikle (1986). Then followed a settling of each participant's baseline skin conductance level (SCL) before the picture presentation itself started. Individual SCR threat indices were calculated by subtracting mean range value of the seven neutral pictures from the mean range value from the seven threatening pictures. This was done in both the unmasked and masked exposure conditions. Mean range value is defined as the distance between the lowest and highest SCL during the measurement period. To examine the main effect of trait anxiety and social desirability, a stepwise multiple regression analysis was conducted on the SCR threat indices separately for each exposure condition. Controlling for basic individual variation in SC, baseline SCL (square-root transformed) was entered in step 1. Trait anxiety and social desirability were entered in step 2, and the interaction term (cross product) of trait anxiety and social desirability (mean centred scores) was entered in step 3.

Main results

As expected, there was a main effect of stimulus type, with stronger SCRs towards masked (i.e., subliminal) threatening pictures relative to neutral ones ($t = 5.77$, $p < .0001$). A large amount of explained variance to this effect ($\Delta R^2 = .39$, $p < .0001$) could be derived from trait anxiety and social desirability. Of interest here were the opposite directions of the two factors; higher trait anxiety was associated with increased SCRs for threatening pictures (compared to neutral ones) whereas higher scores on social desirability were associated with decreased SCRs for threatening pictures. Further, when entering the interaction term between trait anxiety and social desirability ($\Delta R^2 = .04$, $p < .048$) it became obvious that the main effect of trait anxiety was mainly accounted for by those participants who simultaneously scored low on social desirability ($p < .0001$ and $p = .012$, for the low and high, respectively). A main effect of stimulus type was found in the unmasked exposure condition, again with stronger SCRs towards threatening pictures relative neutral ones ($t = 5.12$, $p <$

.0001). Again, trait anxiety and social desirability accounted for a significant amount of explained variance to this effect ($\Delta R^2 = .10$, $p = .019$). This was due to a positive association between threat index and trait anxiety ($\beta = .36$, $p = .006$) and also a positive association between threat index and social desirability ($\beta = .26$, $p = .051$). This means that higher scores of both trait anxiety and social desirability, independent of each other, were associated with increased SCRs to threatening pictures (compared to neutral ones).

Discussion

The main effect of stimulus type is very much in line with earlier research (e.g., Öhman & Mineka, 2001; Öhman et al., 2001). Of significance in this study was the strong effect of trait anxiety (in combination with low social desirability) on SCRs to masked threatening pictures. Preferential preattentive processing of threat is a prominent feature in anxiety (e.g., Williams et al., 1997), and this finding provides additional evidence to support the notion that preattentive processing of threat may be a vulnerability factor in trait anxiety that predisposes to anxiety disorders (e.g., Eysenck, 1997). However, what makes the finding in the masked condition even more interesting is that the effect of trait anxiety on SCRs was greatly dependent on the level of social desirability. Individuals who were moderately high-anxious and at the same time had elevated levels of social desirability did not exhibit enhanced SCRs, thus high levels of social desirability eliminated the effect of trait anxiety. This finding seemingly leads to the conclusion that the importance of social desirability is quite crucial for those scoring higher on trait anxiety.

Further, it is of theoretical interest why this contradiction exists; subjectively reporting elevated levels of trait anxiety while simultaneously not responding physiologically accordingly. Nonetheless, it seems safe to conclude that higher social desirability scores prevent elicitation of autonomic responses following the perception of environmental threat cues occurring outside conscious awareness. In the unmasked condition, the main effect of stimulus type was approximately equal in effect size to that in the masked condition but was less dependent on the two variables. In conclusion, this study suggests that it could be important to consider the two variables trait anxiety and social desirability when preferential preattentive processing of threatening stimuli is in focus.

Study III

Skin conductance responses as predictor of emotional responses to stressful life events.

Background

A wealth of evidence originating mainly from two research paradigms, the colour naming procedure of the emotional Stroop task paradigm (e.g., Williams, Mathews, & MacLeod, 1996) and the paradigm of perceptual influence on autonomic responses as measured with skin conductance activity (e.g., Öhman & Soares, 1994), has accumulated over the past two decades supporting the presence of an anxiety-linked preferential processing of emotionally negative information. Data from these two paradigms have convincingly demonstrated that preferential processing occurs even under conditions in which the emotional stimuli are masked in order to prevent conscious identification. This suggests that anxiety prone individuals exhibit preferential preattentive processing for threatening information, as measured with two different outcome measures (cognitive and physiological). Preferential processing favouring threatening information has received increased attention because cognitive formulations have placed increasing emphasis on its role as a key cognitive factor underlying vulnerability to and maintenance of anxiety disorders (Eysenck, 1997; Mogg & Bradley, 1998; Williams et al., 1997). In line with this reasoning, several studies have been conducted and results have shown that Stroop interference for masked threat words was a significant predictor of emotional distress (MacLeod & Hagan, 1992; Verhaak et al., 2004; van den Hout et al., 1995; Nay et al., 2004). Considering that effects of preferential preattentive processing have been observed on two different outcome measures, the question posed in the current study is whether an autonomic physiological measure such as SCR could be used to predict emotional responses to stressful events in the same way as the above mentioned studies in the emotional Stroop task paradigm have.

Method

Participants consisted of 136 police recruits from the Police Academy at Sörentorp, Stockholm (mean age 27.6, SD = 2.9), due to enrol in active duty within two to four months. Informed consent was obtained before participation in the study. Prior to the

laboratory session, trait anxiety (STAI-T; Spielberger et al., 1983) data were collected from each participant. The session in the laboratory started with a pre-test to establish an individual subjective threshold for each participant, in correspondence with Cheesman and Merikle (1986). Then followed a settling of individual baseline skin conductance levels (SCLs) before the picture presentation itself started. To target preferential processing of threat, threat indices were calculated for each individual by subtracting mean range value of the seven neutral pictures from the mean range value of the seven threatening pictures. This was done in both the unmasked and masked exposure conditions. Mean range value is defined as the distance between the lowest and highest SCR during the measurement period.

After approximately 24 months a follow-up phase was administered, involving the collecting of emotional distress data (IES; Horowitz et al., 1979) from the same participants, who now had been on active duty as police officers for approximately 22 months. Of 136 possible participants, a total of 73 completed the questionnaires. To examine the main effects of trait anxiety and threat indices and their interaction, hierarchical multiple regression analyses were conducted on IES scores. Trait anxiety was entered in step 1 and masked threat index in step 2, unmasked threat index in step 3 and finally, in step 4, the interaction terms (cross product) of trait anxiety and threat indices (centred scores) for both masked and unmasked pictures were entered.

Main results

Firstly, there was a significant main effect of stimulus type in both the masked ($t = 3.43, p = .001$) and unmasked ($t = 6.13, p < .0001$) exposure condition, supporting the large amount of research showing biased processing of threat-related stimuli occurring on both subliminal and supraliminal exposure conditions (Öhman & Mineka, 2001, for a review). Focusing on predicting emotional responses, in accordance with our expectations, there was a significant effect of trait anxiety in step 1. Even more interesting, in step 2 when the threat indices for masked pictures were included as predictors, there was a significant increment in explained variance, $\Delta R^2 = .25, F(1, 70) = 30.18, p < .0001$. Descriptively, higher SCRs for masked threatening pictures (compared to neutral ones) were associated with higher IES scores. Further, there was no significant increment in explained variance due to the inclusion of either the unmasked threat index or the two interaction terms. The final regression equation (step 2) with trait anxiety ($\beta = .18, p = .073$) and the threat index for masked pictures ($\beta =$

.55, $p < .0001$) as predictors in the model was significant, $R^2 = .41$, $F(2, 70) = 24.46$, $p < .0001$.

Discussion

The main finding in this study is that individual differences in SCRs following exposure to masked threatening stimuli have the ability to predict later individual differences in emotional reactions to subsequent stressful life events. This supports the notion of preferential preattentive processing of threat representing an underlying predisposition to heightened emotional vulnerability. Specifically, elevated levels of preferential preattentive processing of threat were strongly associated with heightened emotional distress in response to stressful events, this being the case even after prior levels of trait anxiety was accounted for. The present results are also in line with previous findings (e.g., Pury, 2002; Verhaak et al., 2004; van den Hout et al., 1995) showing that Stroop interference for subliminally presented (i.e., preattentive bias) threat words significantly predict the subjective emotional response to stressors. This suggests that the association between preferential preattentive processing of threat and emotional distress in response to stressful events is not merely observable on cognitive outcome measures, but can also be seen on a physiological outcome measure. It is noteworthy that the unmasked threat index (i.e., pictures available for conscious processing) was far from significantly associated with emotional distress in this study. Yet, again, this is in line with previous emotional Stroop task studies (e.g., MacLeod & Hagan, 1992; Verhaak et al., 2004; van den Hout et al., 1995), in which the absence of significant effects for Stroop interference consistently appeared for unmasked words. Thus, whereas a masked threat index seems to be a marker for emotional vulnerability, this is certainly not the case for an unmasked threat index. Additionally, the near-zero correlation between the masked and unmasked threat indices in the current study (see also Najström & Jansson, 2006) provides additional support for the view that the two indices measure different kinds of processes. Finally, despite the fact that preferential preattentive processing is related to emotional distress in response to stressful events, whether this processing style is ultimately sufficient for the development of clinical anxiety, and to what extent this processing style translates specifically to one anxiety disorder over another, remain to be clarified.

Study IV

Information-processing and emotional vulnerability: Using preattentive bias to predict self-reported and physiological responses to a stressor.

Background

Preferential processing favouring threatening information has received increased attention because of its role as a potential key cognitive factor in the development and maintenance of anxiety disorders (e.g., Eysenck, 1997; Mogg & Bradley, 1998). Others have suggested that various trait factors, such as negative affectivity (e.g., Clark, Watson, & Mineka, 1994) and anxiety sensitivity (McNally, 1990), are central components in explaining the development of clinical anxiety. However, it is important to note that preferential processing and trait factors are by no means independent of each other. A number of studies emanating from the emotional Stroop task methodology, using non-clinical samples, have provided evidence that high levels of trait anxiety are associated with preferential processing favouring threatening information in both masked and unmasked exposure conditions (e.g., MacLeod & Rutherford, 1992; Rutherford, MacLeod, & Campbell, 2004; Dalgleish, 1995).

The relationship between preferential processing favouring threatening information and subjective emotional responses to stressors seems to be established, but its possible relationship to physiological autonomic responses to stressors has yet to be explored. Thus, the main purpose of the present study was to investigate the relative contributions of trait anxiety and Stroop interference for masked threat words to emotional responses (subjective responses and autonomic reactivity) following exposure to a laboratory stressor. A laboratory stressor in the form of a problem-solving task performed under time pressure. It should be emphasised that the focus in the present study once again is on the response patterns to subliminally presented stimuli, hence preferential preattentive processing.

Method

The sample consisted of 42 students (36 women and 6 men, mean age 24.4, SD = 5.2). Psychometric data consisting of trait anxiety (STAI-T; Spielberger et al., 1983) and social desirability (KSP-SD; Schalling, 1985) were collected from each participant

before the laboratory session, and prior to the stress task individual state anxiety (STAI-S; Spielberger et al., 1983) data were collected. The laboratory sessions started with performing the emotional Stroop task, which consisted of masked and unmasked presentation of ego threat words (e.g., stupid, worthless), physical threat words (e.g., cancer, lethal), ego positive words (e.g., gifted, smart), and neutral words (e.g., letter, number). Then followed, in another laboratory, a stress task during which the participants' skin conductance activity was recorded continuously. Electrodermal measures included were skin conductance variance (SCV) and skin conductance level (SCL). The variables were defined as follows: SCV as the variance of SC activity over the measurement period and SCL as the mean tonic SC activity. Immediately after the stress task, the participants reported their subjective emotional experiences by completing the subjective emotional response scale (SER).

To examine reactivity to the stressor, residual scores were used to index each individual's changes in anxious state and SC activity (SER was regressed on pre-task state anxiety, and the two SC task variables were regressed on their baseline value). Stroop interference indices were calculated for each individual by subtracting the mean colour-naming latency for neutral words from the mean colour-naming latency for emotional words (ego threat, ego positive, physical threat). This was done for both exposure conditions. To examine main effects and interaction effects of trait anxiety and Stroop interference, hierarchical multiple regression analyses were conducted on SER and skin conductance reactivity data (SCV and SCL). Trait anxiety was entered in step 1. In step 2, masked Stroop interference index was entered. In step 3, unmasked Stroop interference index was entered. Finally, in step 4, the interaction terms (cross product) of trait anxiety and Stroop interference (centred scores) for both masked and unmasked words were entered. This procedure was performed for each emotional word category and exposure condition.

Main results

When the SER was used as a criterion and Stroop interference indices for ego threat words were included as predictors, there were no significant effects of trait anxiety but a significant increment in explained variance from step 1 to step 2, $\Delta R^2 = .19$, $F(1, 39) = 9.68$, $p = .003$. Similarly, when including Stroop interference for physical threat words as predictors, there was a significant increment in explained variance from step 1 to step 2, $\Delta R^2 = .22$, $F(1, 39) = 11.19$, $p = .002$. The significant increment in explained variance in these two cases was due to the effect of Stroop interference for

masked ego threat and masked physical threat words, respectively. Descriptively, higher Stroop interference scores were associated with higher levels of self-reported emotional distress (SER) in response to a stressor. Further, there was no significant increment in explained variance due either to the inclusion of Stroop interference for unmasked ego threat or unmasked physical threat words, or to the inclusion of the two interaction terms of trait anxiety and Stroop interference for threat words (masked, unmasked).

When the SCV (skin conductance variance) variable was used as a criterion, and Stroop interference indices for ego threat words were included as predictors, there was a significant increment in explained variance from step 1 to step 2, $\Delta R^2 = .16$, $F(1, 39) = 7.54$, $p = .009$, due to the effect of Stroop interference for masked ego threat words. Similarly, when including Stroop interference for physical threat words as predictors, there was a significant increment in explained variance from step 1 to step 2, $\Delta R^2 = .15$, $F(1, 39) = 7.28$, $p = .010$, due to the effect of Stroop interference for masked physical threat words. Descriptively, higher interference scores being associated with lower autonomic reactivity (as measured by the SCV) in response to the stressor. Again, there was no significant increment in explained variance due to the inclusion of Stroop interference for unmasked ego threat or unmasked physical threat words, nor due to the inclusion of the two interaction terms of trait anxiety and Stroop interference for threat words (masked, unmasked).

Finally, when the SCL (skin conductance level) variable was used as a criterion, a significant increment in explained variance from step 1 to step 2 ($\Delta R^2 = .12$, $F(1, 37) = 5.08$, $p = .030$) was found when Stroop interference indices for physical threat words were included as predictors. This was due to the effect of Stroop interference for masked physical threat words, higher interference scores being associated with lower scores on SCL. Stroop interference indices for ego positive words were not significantly associated with any of the emotional response variables (i.e., SER, SCV and SCL).

Discussion

The obtained results are consistent with a body of earlier research (e.g., Nay et al., 2004; van den Hout et al., 1995) showing that Stroop interference for subliminally presented (i.e., preattentive bias) threat words significantly predicts the subjective emotional response to a laboratory stressor. That is, elevated levels of preattentive bias

were consistently significantly associated with an increase in emotional distress. Interestingly, when exchanging the subjective measure of emotional response with the objective one, SCV, the effect of preattentive bias was diametrically opposite – Stroop interference for masked threat words was negatively associated with autonomic responding during exposure to the very same stressor. Taking into consideration that individuals with higher levels of trait anxiety were highly overrepresented among those at higher levels of preattentive bias for threat words, there is a strong similarity with findings showing inflexibility in skin conductance responses among anxiety patients compared to non-anxious controls when exposed to moderately stressful events (Hoehn-Saric & McLeod, 2000, for a review). Furthermore, similar effects were found in high-trait anxious participants when they were confronted with a psychosocial stressor (e.g., Jezova, Makatsori, Duncko, Moncek, & Jakubek, 2004).

The fact that the diminished variability seen on measures of peripheral physiological activity among anxiety patients is not disorder specific, since it has been observed across different anxiety disorders, points to the possibility of the existence of one common underlying responsible factor. This may be a failure of inhibition; Kindt and co-workers proposed that inadequate inhibition of threatening information is a factor that could account for the development of clinical anxiety (e.g., Kindt & van den Hout, 2001). Brosschot (2002) suggested that when cognitive bias for threatening information is excessively and chronically manifested, it can be viewed as preservative cognition, or worry. Further, Thayer and Friedman (2002) regarded cognitive preservative processes as a failure of inhibition. Considering the autonomic inflexibility seen in GAD and worry, the inability to effortlessly inhibit the negatively valenced verbal thought activity seen in worry could perhaps correspond to the effect of preattentive bias (the inability to automatically inhibit the processing of threatening language cues). If so, this may well be the underlying vulnerability marker in worry and anxiety.

IV. GENERAL DISCUSSION

The aim of this thesis was to examine factors that could be of interest in understanding individual differences in preferential processing of emotional information. Given the central role of trait characteristics in this kind of research, the main focus was on personality factors such as trait anxiety and social desirability. A focal point was to explore the association between preferential processing favouring emotionally negative information and emotional vulnerability. Using cognitive outcome measures this association has been well demonstrated (MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002, for a review). Effects of preferential preattentive processing have been observed using both cognitive and autonomic physiological measures. The question posed is whether or not an autonomic physiological measure, such as SCR, could be used to predict emotional responses to stressful events in a similar way.

Personality characteristics as an explanatory factor for preferential processing

A question raised in the introduction was whether or not preferential processing could be understood as an effect of stable personality characteristics, such as trait anxiety and social desirability. From the overall response pattern for those participants with higher levels of trait anxiety in Studies II, III, and IV it is obvious that there is a strong association between trait anxiety and preferential *preattentive* processing of threatening information. Higher trait anxiety scores were associated with increased preferential *preattentive* processing of threatening information. More specifically, in Study II, higher trait anxiety scores were associated with increased SCRs to masked threatening pictures (relative to neutral pictures). Higher scores on social desirability were associated with decreased SCRs. Interestingly, the effect of trait anxiety was found mainly among participants who simultaneously scored low on social desirability. However, elevated levels of social desirability among these participants virtually eliminated the effect of trait anxiety on SCRs. In Study IV, the most significant finding was that higher scores on trait anxiety were strongly associated with enhanced preferential preattentive processing favouring masked threat words. This was found among high-trait anxious participants who simultaneously scored low on social desirability. These findings correspond with results in Study II.

What makes these findings even more interesting is that this seemingly leads to the conclusion that the importance of social desirability is quite crucial for individuals who score high on trait anxiety. Elevated levels of trait anxiety promote preferential preattentive processing of negatively valenced information, whereas elevated levels of social desirability generally prevent preferential preattentive processing of negatively valenced information, independent of the outcome measure used. These findings also suggest that the same underlying mechanisms may be responsible for the outcome on measures of preferential preattentive processing - on Stroop interference (Study IV), originating from the Stroop paradigm, and autonomic physiological responses (SCRs) (Study II), originating from the picture perception task. The negative association between social desirability and preferential preattentive processing among individuals with higher levels of trait anxiety could be of importance from a methodological perspective. Namely, social desirability should be considered as a factor of vital importance and thus be incorporated into the design when the focal interest of a study is the effects of trait anxiety. Doing this creates a more “clean” measure of trait anxiety (Weinberger et al., 1979).

Further, a question that arises is how to explain why individuals who score high on both trait anxiety and social desirability are trait anxious despite that their preferential preattentive processing of threat suggests the opposite. One explanation could be that social desirability is acting as a defensive process to avoid further processing of external threat cues and thus, mediating autonomic responses. Support for this reasoning could be found in a study by Martin, Williams, and Clark (1991). Patients who were diagnosed with Generalised Anxiety Disorder (GAD) were compared with high trait anxious individuals on an emotional Stroop task. Although the two groups showed comparable levels of trait anxiety, only the GAD group were slower in colour-naming threatening words than colour-naming neutral words. It could be that social desirability has an explanatory value for the difference between the two groups.

Personality characteristics and evolutionary preparedness in preferential processing

There is evidence suggesting that conditioned fear responses are more readily acquired and more difficult to extinguish by means of biologically relevant stimuli (e.g., Öhman & Soares, 1993; Öhman & Soares, 1994). In these studies, they exposed a group of snake- and spider-fearful participants and “non-fearful” participants to masked pictures of snakes, spiders, and non-threatening control stimuli. Interestingly, the

“non-fearful” group did not exhibit any differential SCRs between fearful and non-threatening control stimuli.

Viewing these results from an evolutionary perspective, it remains to be explained why there was no evidence of evolutionary fear-relevant stimuli (snakes and spiders) activating significantly stronger emotional responses (SCRs) than non-threatening stimuli (flowers and mushrooms) in the “non-fearful” group. With the explanatory framework from an evolutionary perspective (e.g., Seligman 1971; Öhman & Mineka, 2001), one would expect that evolutionary fear-potent stimuli such as snakes and spiders in Öhman and Soares (1993, 1994) would have a higher threat value than flowers and mushrooms. Perhaps the explanation lies in the domain of personality characteristics. Masked threatening pictorial stimuli are not sufficient to trigger enhanced SCRs unless trait anxiety levels are elevated and social desirability is considered. One could speculate that fear conditioning is dependent on trait anxiety and social desirability based on results that enhanced SCRs to masked threatening pictures were found principally among individuals with higher levels of trait anxiety in combination with low social desirability (Studies II, IV). This suggestion would only be valid if one assumed that the responses were of the same kind. It could be that the stimuli (pictures of snakes and spiders) used in the Öhman and Soares (1993, 1994) studies evoke genuine fear responses whereas the stimuli (pictures of mutilated bodies and battered woman) used in Studies II and IV elicit anxiety responses. However, as noted in the introduction, empirical evidence that points to the existence of a distinction between fear and anxiety is presently scarce and is the subject of an ongoing debate (Rapee, 1996).

It is noteworthy that the threatening pictorial stimuli used in Studies I, II and III actually had the ability to activate the arousal system eliciting significantly stronger SCRs compared to neutral stimuli when subliminal presentation was used, hence preferential preattentive processing. The character of the stimuli used in these studies was not of a distinct phylogenetic origin compared to the pictures of spiders and snakes used in the Öhman and Soares (1993, 1994) studies. This would again support an explanation emphasising the importance of personality characteristics in studying preferential preattentive processing, despite previous claims (e.g., Öhman, 1996), which focuses on the importance of evolutionary relevant stimuli.

Physiological responses as predictor of emotional vulnerability

Effects of preferential preattentive processing have been observed on both cognitive outcome measures (e.g., Bradley et al., 1995; Williams et al., 1997) and autonomic physiological outcome measures (e.g., Öhman, 1986; Öhman, et al., 1989; Öhman et al., 2000). Research with a focus on the relationship between preferential processing and emotional distress in response to emotionally stressful events has commonly used cognitive outcome measures. Results from these studies have consistently demonstrated an association between preferential preattentive processing and heightened emotional vulnerability to stressful life events (e.g., Pury, 2002; Nay et al., 2004; Verhaak et al., 2004). Similar results were found in Study III when an autonomic physiological outcome measure was used. The results were that preferential preattentive processing of masked threatening pictures (relative to neutral pictures) significantly predicted subjective emotional responses to later naturally occurring stressors. Specifically, the calculated threat index for masked pictures was strongly correlated with emotional vulnerability. The IES measures ranged from $r = .50$ to $.62$, ($n=73$). Accordingly, the results in Study IV are consistent with other cognitive outcome measure (e.g., Pury, 2002) studies; preferential preattentive processing of threat cues significantly predicts the subjective emotional response to a laboratory stressor.

At a theoretical level, the overall findings in Studies III and IV provide strong support for the hypothesis that individual differences in preferential preattentive processing of emotional information can play a casual role in mediating emotional vulnerability, in a non-clinical population. These findings are also consistent with the proposal offered by many clinical theorists; preferential processing plays a casual role in the mediation of anxiety pathology (e.g., Williams et al., 1997; Mogg & Bradley, 1998; Öhman, 1996). Additionally, the results in Studies III and IV indicate that the same underlying mechanisms may account for the results on both cognitive and autonomic physiological outcome measures.

In Study III, it is noteworthy that there was a strong association between trait anxiety scores prior to the stressor (i.e. stressful life events), preferential preattentive processing, and higher scores on the IES measure. The significant effects found were that higher scores on trait anxiety were associated with enhanced preferential preattentive processing favouring threatening pictures and with higher scores on the IES measure. However, when the threat index (based on preferential preattentive processing) for masked pictures was entered in the hierarchical regression analysis, the

significant effect ($p = .001$) of trait anxiety on IES scores was eliminated ($p = .073$). Thus, the predictive power of trait anxiety on emotional distress was due to its association with preferential preattentive processing favouring threatening masked pictures. Similarly, in Study IV, preferential preattentive processing of threat words, relative to neutral words, significantly predicted emotional responses to a laboratory stressor after trait and pre-task state anxiety had been accounted for.

This raises an interesting issue regarding the association between trait anxiety and preferential preattentive processing. The existence of a relationship is, as previously discussed, well documented. Nevertheless, the findings from cognitive outcome measures and, as in Study III, autonomic physiological outcome measures only demonstrate that an association between trait anxiety and preferential preattentive processing exists. It does not clarify whether preferential preattentive processing is a cause or an effect of anxiety. Thus, it remains possible that some stable third variable may independently mediate both preferential preattentive processing and emotional distress in response to emotionally stressful events.

The question concerning causality has been addressed in a study by MacLeod et al. (2002). They proposed that non-anxious participants who were trained to develop preferential processing of threat cues responded with a more negative mood state when exposed to a stressful task than did participants who did not receive such training. This suggests that manipulation of preferential processing has an impact on emotional vulnerability and, according to the authors, contributes most directly to the mediation of trait rather than state emotions. The findings clearly provide support for the hypothesis that preferential processing towards negative information can exert a causal influence on emotional vulnerability and anxiety. However, MacLeod et al. (2002) did not find preferential *preattentive* processing effects. It is plausible that the effects of preferential preattentive processing found among high-trait anxious individuals and clinical anxiety patients do not originate as preferential preattentive effects. Rather, becoming preattentive as a result of their extended execution.

Finally, in Study IV, the direction of effects was reversed in the relationship between preferential preattentive processing and the autonomic physiological indicator (i.e., skin conductance variance (SCV)). Stroop interference (cognitive outcome measure) for masked threat words being negatively associated with the physiological indicator (SCV) responding to the same stressor. Individuals with higher levels of preferential preattentive processing of threat words who simultaneously exhibited reduced autonomic physiological responding (SCV) were predominantly true high anxious

individuals (according to the Weinberger et al., 1979 classification). Similar response patterns have been found among clinical anxiety patients, showing smaller *changes* in SCRs than those of non-anxious controls when exposed to moderately stressful events (Hoehn-Saric & McLeod, 2000, for a review). The authors argued that autonomic inflexibility found among clinical anxiety patients reflects a less adaptive response to stress, in terms of ineffective emotional regulation and behavioural inflexibility. Support for this is also found in non-clinical samples. For example, in a study by Jezova, Makatsori, Duncko, Moncek, and Jakubek (2004), high trait-anxious participants, compared to low trait-anxious responded with a blunted increase in frequency of SCRs when confronted with a psychosocial stressor.

Preferential processing as a factor in the development of anxiety disorders

One topic raised in the introduction was the potential importance of preferential processing as a contributing factor in the development of anxiety disorders. It is well established that preferential preattentive processing favouring threatening information is casually related to emotional distress in response to stressful events (e.g., Mathews & MacLeod, 2002; Nay et al., 2004; Verhaak et al., 2004). However, whether or not this biased processing style is sufficient enough for the development of anxiety disorders is unclear. Preferential processing favouring threatening information has been shown to occur in a wide range of anxiety disorders, for example GAD (e.g., Mogg, Bradley, & Williams, 1995; Bradley et al., 1995), panic disorder (e.g., Hope, Rapee, Heimberg, & Dombeck, 1990), and specific phobia (e.g., Öhman, & Soares, 1994; Kindt, & Brosschot, 1999). There is also evidence of preferential processing favouring threatening information among non-clinical high-trait anxious individuals (e.g., Bradley, Mogg, & Lee, 1997; Fox, 1996). This is also indicated by results in Studies II, III and IV.

According to Eysenck's (1997) theory, there is continuity in terms of preferential processing between clinically anxious patients and non-clinical high-trait anxious individuals. High-trait anxious individuals are more vulnerable to the development of generalised anxiety disorders; they have a tendency to process information in a threatening manner, especially when exposed to stressful life events. This tendency in and of itself may not be sufficient to trigger the onset of an anxiety disorder, but lead to a preferred processing style resulting in a disproportionately intense anxious responding to such stressful events. This way of processing threatening information could seemingly lead to an overrepresentation of threat cues within the information

that high anxious individuals encode from their environment, creating a vicious circle. Threatening material is selectively processed and becomes more easily accessible, therefore, anxiety levels increase and threat cues further selective processed. This pattern of behaviour is similar to the behaviour exhibited by patients with GAD (Bradley et al., 1995). If this in extension is sufficient for the development of clinical anxiety is an issue requiring future prospective studies to determine.

One critical issue that remains to be addressed is why people possess a processing style favouring negative information in the first place. This is a question that will be in focus in the next section.

Applying an evolutionary perspective on preferential processing

There are individual differences in preferential preattentive processing of negative information. This is found even after accounting for individual differences in trait anxiety and social desirability (as highlighted in Study II). Rapee and colleagues (Hudson & Rapee, 2000; Rapee & Heimberg, 1997) suggested that genetic factors might account for the general tendency to process information in a threatening manner. Cultural and contextual environmental factors could also be determinants of which specific cues would receive increased attention. Accordingly, LeDoux (1996) distinguishes between natural triggers and learned triggers of emotional systems in the brain. Natural triggers could be the stimuli selected by evolution to activate fear because the stimuli represent a recurrent threat to survival in the ecology of a particular species, which supports the preparedness theory of Seligman (1971). Learned triggers, on the other hand, have acquired their power to activate the fear system through Pavlovian conditioning; that is, being present when the system is activated by a natural trigger, learned triggers acquire potency to trigger the system by themselves. Similarly, in the Mathews and Macintosh (1998) cognitive model, the threat evaluation system (TES) contains a wide range of threat representations.

They proposed that genetic factors influence the amount of natural triggers and, consequently, learned triggers that have the ability to activate the TES. This would imply that an evolutionary preparedness, according to Seligman, is of relevance when studying preferential processing and anxiety disorders. High-trait anxious individuals are supposed to have lower TES output thresholds compared to low-trait anxious individuals. Mathews and Macintosh also propose that there is a more frequent

activation and wider range of threat triggers in the TES among high-trait anxious individuals.

According to Öhman's (1993) model, incoming information is first processed by a set of "feature detectors" and then more fully analysed in a second step by the "significance evaluation system". Stimuli with high threat value and evolutionary prepared stimuli receive greater attention from the "feature detectors", which activate the arousal system without further processing by the significance evaluation system. The model implies that increases in an individual's anxious mood have the effect of setting the significance evaluator into a more sensitive mode. Therefore, there is an increased activation of the arousal system. In relation the Mathews and Mackintosh (1998) model, increases in anxious state activate threat cues that were previously insufficient for significant output from the TES, thus lowering the TES output threshold. This implies that anxious mood mediates preferential preattentive processing.

Returning to LeDoux (1996, 2000), a central point in his argument is that the fear system can be activated unconsciously; new stimuli can become learned triggers of the fear system without any conscious representation of the learning episode. The fear system is independent of the conscious memory system, centred on the hippocampus that records episodes for later conscious retrieval. LeDoux's argument corresponds with two of the main characteristics in Öhman and Mineka's (2001) fear module, *automaticity* and a *specific neural circuitry*. There is a dissociation between implicit emotional memories, which activate the fear system/module, and explicit memory of the emotional situation. Therefore, a scenario is created where a person may become emotionally aroused by situational cues without conscious recollection of the reason for the arousal. This would be applicable to results seen in masking studies in which autonomic responses have been measured (e.g., Öhman, 1996; Öhman & Soares, 1994).

In part, this is contradictory to Öhman's (1993) model. According to this model, the "feature detectors" do not interact with memory to provide meaning to situational cues. Instead, the feature detectors are assumed to act upon perceptual characteristics of the situational cues. This aspect of Öhman's model is difficult to apply on results emanating from studies using lexical threat stimuli (e.g., van den Hout et al., 2000). Results indicated that the emotional meaning of masked presented words did have the ability to activate the arousal system. From this perspective, the arousal system can be

activated by stimuli, by their very nature, share no perceptual characteristics with evolutionary feared stimuli.

In an appealing attempt to summarize the evolutionary perspective, Cosmides and Toby (2000) noted that fear and anxiety serve as “superordinate programs”, or modules of the mind, which are responsible for setting priorities. When an emotion is elicited, it activates some subordinate mechanisms (e.g., attention, heuristic processing, or action-readiness programs) and deactivates other subordinate mechanisms (e.g., systematic processing, and higher level goals). Emotions become a “mode of operation for the entire psychological architecture”. Understanding the factors in preferential preattentive processing is complex and much is still to be done in highlighting this issue. As discussed in relation to Study II, personality traits such as trait anxiety and social desirability are important factors in preferential preattentive processing. However, their concurrent interaction with other factors, such as evolutionary preparedness and environmentally contextual influences, remains to be studied.

Limitations and methodological issues

There are a number of limitations and methodological aspects that may have affected the results presented in this thesis, on which deserve commenting. For example, using SCR as a measurement of emotional responding has its limitations. This is an issue that already have been discussed in the introduction. However, in addition to what previously have been said, a reflection regarding the different kinds of sources that may produce artefacts when recording SCRs is appropriate. One common physiological artefact is movement. Not only skin movements beneath the electrodes, but also there is muscular activity at body sites not directly included in the electrodermal recording, for instance leg movements. In addition, Edelberg (1967) points to four other main sources of movement artefacts: (1) disturbance of the electrolyte concentration near the solid-liquid electrode interface; (2) change in the intimacy of contact between electrode and skin; (3) pressure-induced local changes in SCR; (4) movement of the appendage across an electromagnetic field. To avoid sudden movements during the SCR reading in Studies I-IV, instructions were explicitly given to the participants to make an effort to remain as still as possible and to relax during the picture presentation task.

SCR recording is a sensitive methodology and great attention must be paid to the procedure in order to minimize sources of measurement errors. Nevertheless, as pointed out by Dawson, Shell, and Filion (1990), SCRs provides a direct and undiluted representation of sympathetic nervous system activity. The eccrine sweat glands are controlled by the sympathetic branch of the autonomic nervous system (ANS), which, in turn, is regulated from the frontal cortex via hypothalamic-limbic pathways.

As mentioned in the introduction, SCR is sensitive to such a wide variety of stimuli that it is difficult to identify an isolated SCR as an “anxiety” response or a “fear” response. The psychological meaning, however, of an SCR becomes interpretable by taking into account the stimulus condition or experimental paradigm in which SCR was measured (e.g., Öhman & Soares, 1993; 1994). Finally, heart rate variability has been used in some studies (e.g., Friedman & Thayer, 1998) investigating physiological reactivity in response to stressful events in clinical samples. However, as Turpin (1991) discusses, different physiological measures are usually not highly correlated and no single measurement has yet been identified as a psychophysiological index of choice for anxiety. Thus, future prediction studies may benefit from incorporating a variety of physiological outcome measures in the design.

Sample reduction is a problem in longitudinal studies (Bergman & Magnusson, 1990). In Study III, an analysis of drop-outs was not included, and it is possible that those who chose to drop out of the study between the waves of data collection may have affected the results in some systematic way. These drop-outs decreases the size of the sample, and the longitudinal sample becomes smaller the original one. This may lessen the power of the study or/and the ability to identify those relationships that actually occur in the population, and thereby increase the risk of Type-II error. However, considering the strength in the independent effect of the masked threat index on emotional distress in study III ($R^2 = .41$, $F(2, 70) = 24.46$, $p < .0001$), the risk for Type-II error would not be overwhelming. In addition, the results in Study III are congruent with previous findings (e.g., Nay et al., 2004; van den Hout et al., 1995). Nevertheless, given the above mentioned limitations of Study III and the novelty of the findings, the results should be replicated and elaborated in order to achieve a better understanding and knowledge of the relationship between preferential preattentive processing and emotional vulnerability.

Future directions

There are limitations of the studies included in this thesis and also difficulties that generally arise when using this type of methodology. However, an increase in emotional vulnerability could be attributed to preferential preattentive processing and not pre-existing anxiety levels. This may be an important feature in understanding the relationship between anxiety and preferential preattentive processing.

There are many issues that awaits testing in order to better understand preferential preattentive processing and its consequences on the development of anxiety disorders. It would be of interest to further explore the continuity proposed by Eysenck (1997) between high trait anxious people and clinically anxious patients using the Weinberger et al., (1979) methodology, splitting groups in accordance to individual levels of trait anxiety and social desirability. Eysenck explicitly proposed that individuals who score low on trait anxiety and high on social desirability (having a repressive coping style) have a cognitive bias opposed the processing of threat. However, there are inconsistent findings (e.g., Mogg, Bradley, Dixon, Twelftree, & McWilliams, 2000; Newman & McKinney, 2002), which mainly originate from the emotional Stroop task methodology. To employ a methodology using autonomic responses as measurement and focusing on preattentive processing may be of interest.

It has been proposed in this thesis that the same underlying mechanisms may affect preferential preattentive processing emanating from both cognitive outcome measures and physiological outcome measures. Support for this reasoning is found in Studies II and III. Clearly, for this to be corroborated, a study would have to be conducted comparing latency data from a cognitive outcome measure with autonomic data from physiological outcome measures. Further, as previously mentioned, it would be interesting to replicate the Öhman and Soares (1994) study with a personality trait perspective, with trait anxiety and social desirability, as in Study II.

Another issue to address is whether or not masked positive words can increase SCRs. There are findings showing preferential preattentive processing favouring threat words with SCR as the outcome measure (e.g., van den Hout et al., 2000). According to general emotion theories (e.g., Fridja, 1986), all emotions reflect “action tendencies”. If SCR is an index of these emotion-based action tendencies, then increased SCRs could also be expected for masked positively charged words. However, from an evolutionary perspective it would appear that preferential preattentive processing of

threatening information is of greater survival value. Therefore, preferential preattentive processing may be biased toward processing potential threat information.

In this context, it should also be emphasized that SCRs to masked threat words could result from other processes compared to SCRs to masked pictures. However, as previously suggested, the same underlying mechanisms may be responsible for preferential preattentive processing emanating from both latency data from an emotional Stroop task (masked word stimuli) and autonomic responses (SCRs) from a picture perception task (masked picture stimuli). A study designed to examine autonomic reactivity (SCRs) to both masked pictures and masked words would shed some light on the topic.

Finally, in Study III, there was a strong predictive value of autonomic reactivity to exposure of masked threatening material on later emotional experience to subsequent stressful life events. Therefore, this outcome measure could possibly be used as a prognostic tool to identify clinically meaningful differences in emotional vulnerability among individuals who are at risk of trauma exposure.

V. REFERENCES

- Amdur, R. L., Larsen, R., & Liberzon, I. (2000). Emotional processing in combat-related posttraumatic stress disorder: A comparison with traumatized and normal controls. *Journal of Anxiety Disorders, 14*, 219-238.
- Beck, A. T., & Clark, D. M. (1997). An information processing model of anxiety: Automatic And strategic processes. *Behaviour Research and Therapy, 35*, 49-58.
- Bergman, L. R., & Magnusson, D. (1990). General issues about data quality in longitudinal research. In D. Magnusson & L. R. Bergman (Eds.), *Data quality in longitudinal research* (pp. 1-31). Cambridge University Press.
- Blanchard, E. B., Kolb, L. C., Gerardi, R. J., Ryan, P., & Pallmeyer, T. P. (1986). Cardiac response to relevant stimuli as an adjunctive tool for diagnosing post-traumatic stress disorder in Vietnam veterans. *Behavior Therapy, 17*, 592-606.
- Bradley, B. P., Mogg, K., & Lee, S. G. (1997). Attentional biases for negative information in induced and naturally occurring dysphoria. *Behaviour Research and Therapy, 35*, 911-927.
- Bradley, B. P., Mogg, K., Millar, N., & White, J. (1995). Selective processing of negative information: Effects of clinical anxiety, concurrent depression, and awareness. *Journal of Abnormal Psychology, 104*, 532-536.
- Brosschot, J. F. (2002). Cognitive-emotional sensitization and somatic health complaints. *Scandinavian Journal of Psychology, 43*, 113-121.
- Bruner, J. S., & Goodman, C. C. (1947). Value and need as organizing factors in perception. *Journal of Abnormal & Social Psychology, 42*, 33-44.
- Cattell, R. B., Cattell, A. K., & Cattell, H. E. (1993). *Sixteen Personality Factors Questionnaire, Fifth Edition*. Champaign, IL: Institute for Personality and Ability Testing, Inc.
- Chalmers, D. (1996). *The conscious mind*. New York: Oxford University Press.
- Cheesman, J., & Merikle, P. M. (1984). Priming with and without awareness. *Perception and Psychophysics, 36*, 387-395.
- Cheesman, J., & Merikle, P. M. (1986). Distinguishing conscious from unconscious perceptual processes. *Canadian Journal of Psychology, 40*, 343-367.
- Chen, E., Lewin, M. R., & Craske, M. G. (1996). Effects of state anxiety on selective processing of threatening information. *Cognition and Emotion, 10*, 225-240.
- Clark, L. A., Watson, D., & Mineka, S. (1994). Temperament, personality, and the mood and anxiety disorders. *Journal of Abnormal Psychology, 103*, 103-116.
- Cohen, J., & Cohen, P. (1983). *Applied multiple regression/correlation analysis for behavioral sciences* (2nd ed.). Hillsdale, NJ: Erlbaum.
- Cook, E. W., Hodes, R. L., & Lang, P. J. (1986). Preparedness and phobia: Effects of

- stimulus content on human visceral conditioning. *Journal of Abnormal Psychology*, 95, 195-207.
- Corr, P. J., Wilson, G. D., Fotiadou, M., Kumari, V., et al. (1995). Personality and affective modulation of the startle reflex. *Personality and Individual Differences*, 19, 543-553.
- Cosmides, L., & Tooby, J. (2000). Evolutionary psychology and the emotions. In M. Lewis & J. M. Haviland-Jones (Eds.), *Handbook of emotions* (2nd ed.). New York: Guilford Press.
- Creamer, M., & Kelly, J. (2000). Information processing in combat veterans: The role of avoidance. In D. J. Read & D. S. Lindsay (Eds.), *Recollections of trauma: Scientific evidence and clinical practice*. NATO ASI series: Series A: Life sciences, Vol. 291. New York, NY: Plenum Press.
- Crowne, D. P., & Marlowe, D. (1960). A new scale of social desirability independent of psychopathology. *Journal of Consulting Psychology*, 24, 349-354.
- Crowne, D. P., & Marlowe, D. (1964). *The approval motive: Studies in Evaluative Dependence*. New York: Wiley.
- Dalgleish, T. (1995). Performance on the emotional Stroop task in groups of anxious, experts, and control subjects: A comparison of computer and card presentation formats. *Cognition and Emotion*, 9, 341-362.
- Dawson, M. E., Schell, A. M., & Filion, D. L. (1990). The electrodermal system. In J. T. Cacioppo & L. G. Tassinary (Eds.), *Principles of psychophysiology* (pp. 295-324). New York: Cambridge University Press.
- DiBartolo, P. M., Albano, A. M., Barlow, D. H., & Heimberg, R. G. (1998). Cross-Informant agreement in the assessment of social phobia. *Journal of Abnormal Child Psychology*, 26, 213-220.
- Dimberg, U. (1982). Facial reactions to facial expressions. *Psychophysiology*, 19, 643-647.
- Dimberg, U., Elmehed, K., & Thunberg, M. (2000). Unconscious facial reactions to emotional facial expressions. *Psychological Science*, 11, 86-89.
- Dimberg, U., & Öhman, A. (1996). Behold the wrath: Psychophysiological responses to facial stimuli. *Motivation and Emotion*, 20, 149-182.
- Dixon, N. F. (1981). *Preconscious processing*. New York, NY: John Wiley & Sons, Inc.
- Edelberg, R. (1967). Electrical properties of the skin. In C. C. Brown (Ed.), *Methods in psychophysiology* (pp. 1-53). Baltimore: Williams & Wilkins.
- Edelberg, R. (1972). Electrical activity of the skin: Its measurement and uses in psychophysiology. In N. S. Greenfield & R. A. Sternbach (Eds.), *Handbook of psychophysiology* (pp. 367-418). New York: Holt.

- Edelberg, R. (1993). Electrodermal mechanisms: A critique of the two-effector hypothesis and a proposed replacement. In J.-C. Roy, W. Bouscein, D. C. Fowles & J. H. Gruzelier (Eds.), *Progress in electrodermal research. NATO ASI series: Series A: Life sciences, Vol. 249*. (pp. 7-29). New York: Plenum Press.
- Egloff, B., & Hock, M. (2001). Interactive effects of state anxiety and trait anxiety on emotional Stroop interference. *Personality and Individual Differences, 31*, 875-882.
- Egloff, B., & Schmukle, S. C. (2003). Does social desirability moderate the relationship between implicit and explicit anxiety measures? *Personality and Individual Differences, 35*, 1697-1706.
- Epstein, S. (1972). The nature of anxiety with emphasis upon its relationship to expectancy. In C. D. Spielberger (Ed.), *Anxiety: Current trends in theory and research* (Vol. 2, pp. 291-337). New York, NY: Academic Press.
- Eriksen, C. W. (1960). Discrimination and learning without awareness: A methodological survey and evaluation. *Psychological Review, 67*, 279-300.
- Esteves, F., Dimberg, U., & Öhman, A. (1994). Automatically elicited fear: Conditioned skin conductance responses to masked facial expressions. *Cognition and Emotion, 8*, 393-413.
- Esteves, F., & Öhman, A. (1993). Masking the face: Recognition of emotional facial expressions as a function of the parameters of backward masking. *Scandinavian Journal of Psychology, 34*, 1-18.
- Eysenck, M. W. (1997). *Anxiety and cognition: A unified theory*. Hove, UK: Psychology press.
- Fanselow, M. S. (1994). Neural organization of the defensive behavior system responsible for fear. *Psychonomic Bulletin and Review, 1*, 429-438.
- Flack, Jr., W. F., Litz, B. T., Hsieh, F. Y., Kaloupek, D. G., & Keane, T. M. (2000). Predictors of emotional numbing, revisited: A replication and extension. *Journal of Traumatic Stress, 13*, 611-617.
- Flykt, A., Esteves, F., & Öhman, A. (2007). Skin conductance responses to masked conditioned stimuli: Phylogenetic/ontogenetic factors versus direction of threat? *Biological Psychology, 74*, 328-336.
- Fowles, D., Christie, M. J., Edelberg, R., Grings, W. W., Lykken, D. T., & Venables, P. H. (1981). Publication recommendations for electrodermal measurements. *Psychophysiology, 18*, 232-239.
- Fox, E. (1996). Selective processing of threatening words in anxiety: The role of awareness. *Cognition and Emotion, 10*, 449-480.
- Fredrikson, M. (1981). Orienting and defensive responses to phobic and conditioned stimuli in phobics and normals. *Psychophysiology, 18*, 456-465.

- Furmark, T., Fischer, H., Wik, G., Larsson, M., & Fredrikson, M. (1997). The amygdala and individual differences in human fear conditioning. *NeuroReport*, 8, 3957-3960.
- Globisch, J., Hamm, A. O., Esteves, F., & Öhman, A. (1999). Fear appears fast: Temporal course of startle reflex potentiation in animal fearful subjects. *Psychophysiology*, 36, 66-75.
- Gustavsson, P., Weinryb, R. M., Göransson, S., Pedersen, N. L., & Åsberg, M. (1997). Stability and predictive ability of personality traits across 9 years. *Personality and Individual Differences*, 22, 784-791.
- Hamm, A. O., Cuthbert, B. N., Globisch, J., & Vaitl, D. (1997). Fear and the startle reflex: Blink modulation and autonomic response patterns in animal and mutilation fearful objects. *Psychophysiology*, 34, 97-107.
- Hoen-Saric, R., & McLeod, D. R. (2000). Anxiety and arousal: Physiological changes and their perception. *Journal of Affective Disorders*, 61, 217-224.
- Holender, D. (1986). Semantic activation without conscious identification in dichotic listening, parafoveal vision and visual masking: A survey and appraisal. *Behaviour and Brain Sciences*, 9, 1-66.
- Hope, D. A., Rapee, R. M., Heimberg, R. G., & Dombeck, M. J. (1990). Representations of the self in social phobia: Vulnerability to social threat. *Cognitive Therapy and Research*, 14, 177-189.
- Horowitz, M., Wilner, N., & Alvarez, W. (1979). Impact of Event Scale: A measure of subjective stress. *Psychosomatic Medicine*, 4, 209-218.
- Hudson, J. L., & Rapee, R. M. (2000). The origins of social phobia. *Behavior Modification*, 24, 102-129.
- Hugdahl, K., & Johnson, B. H. (1989). Preparedness and electrodermal fear-conditioning: Ontogenetic vs. phylogenetic explanations. *Behavioural Research and Therapy*, 27, 269-278.
- Hugdahl, K., & Kärker, A. C. (1981). Biological vs. experiential factors in phobic conditioning. *Behavioural Research and Therapy*, 19, 109-115.
- Ioannou, M. C., Mogg, K., & Bradley, B. P. (2003). Vigilance for threat: effects of anxiety and defensiveness. *Personality and Individual Differences*, 36, 1879-1891.
- Jansson, B., Lundh, L., & Oldenburg, C. (2005). Is defensiveness associated with cognitive bias away from emotional information? *Personality and individual Differences*, 39, 1373-1382.
- Jezova, D., Makatsori, A., Duncko, R., Moncek, F., & Jakubek, M. (2004). High trait anxiety in healthy subjects is associated with low neuroendocrine activity during psychosocial stress. *Progression Neuro-Psychopharmacology & Biological Psychiatry*, 28, 1331-1336.

- Kaspi, S. P., McNally, R. J., & Amir, N. (1995). Cognitive processing of emotional information in posttraumatic stress disorder. *Cognitive Therapy and Research*, 19, 433-444.
- Kilpatrick, D. G. (1972). Differential responsiveness of two electrodermal indices to psychological stress and performance of a complex cognitive task. *Psychophysiology*, 9, 218-226.
- Kindt, M., & Brosschot, J. F. (1999). Cognitive bias in spider-phobic children: Comparison of a pictorial and linguistic spider Stroop. *Journal of Psychopathology and behavioral Assessment*, 21, 207-220.
- Kindt, M., & van den Hout, M. (2001). Selective attention and anxiety: A perspective on developmental issues and the casual status. *Journal of Psychopathology and Behavioural Assessment*, 23, 193-202.
- Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1997). Motivated attention: Affect, activation, and action. In P. J. Lang, R. F. Simons & M. T. Balaban (Eds.), *Attention and orienting: Sensory and motivational processes* (pp. 97-135). Hillsdale, NJ: Erlbaum.
- Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1999). *International affective picture system (IAPS): Instruction manual and affective ratings*. Technical report A-4, The Center for Research in Psychophysiology; University of Florida.
- Lang, P. J., Greenwald, M. K., Bradley, M. M., & Hamm, A. O. (1993). Looking at pictures: Affective, facial, visceral, and behavioral reactions. *Psychophysiology*, 30, 261-273.
- LeDoux, J. E. (1996). *The emotional brain*. New York: Simon & Schuster.
- LeDoux, J. E. (2000). Emotion circuits in the brain. *Annual Review of Neuroscience*, 23, 155-184.
- Lundqvist, D., & Öhman, A. (2005). Emotion regulates attention: The relation between facial configurations, facial emotion, and visual attention. *Visual Cognition*, 12, 51-84.
- MacLeod, C., & Hagan, R. (1992). Individual differences in the selective processing of threatening information, and emotional responses to a stressful life event. *Behaviour Research & Therapy*, 30, 151-161.
- MacLeod, C., & Mathews, A. (1988). Anxiety and the allocation of attention to threat. *Quarterly Journal of Experimental Psychology: Human Experimental Psychology*, 40, 653-670.
- MacLeod, C., Rutherford, E. M. (1992). Anxiety and the selective processing of emotional information: Mediating roles of awareness, trait and state variables, and personal relevance of stimulus materials. *Behaviour Research and Therapy*, 30, 479-491.

- MacLeod, C., Rutherford, E., Campbell, L., Ebsworthy, G., & Holker, L. (2002). Selective attention and emotional vulnerability: Assessing the causal basis of their association through the experimental manipulation of attentional bias. *Journal of Abnormal Psychology, 111*, 107–123.
- Magnus, K., Diener, E., Fujita, F., & Pavot, W. (1993). Extraversion and neuroticism as predictors of objective life events: A longitudinal analysis. *Journal of Personality and Social Psychology, 65*, 1046-1053.
- Marcel, A. J. (1983). Conscious and unconscious perception: An approach to the relations between phenomenal experience and perceptual processes. *Cognitive Psychology, 15*, 238-300.
- Martin, M., Williams, R. M., & Clark, D. M. (1991). Does anxiety lead to selective processing of threat-related information? *Behaviour Research and Therapy, 29*, 147-160.
- Massaro, D. W. (1985). Special Issue: Action, attention and automaticity. *Acta Psychologica, 60*, 211-243.
- Mathews, A. (1990). Why worry? The cognitive function of anxiety. *Behaviour Research and Therapy, 28*, 455-468.
- Mathews, A., & Mackintosh, B. (1998). A cognitive model of selective processing in anxiety. *Cognitive Therapy and Research, 22*, 539–560.
- Mathews, A., & Macleod, C. (1994). Cognitive approaches to emotions and emotional disorders. *Annual Review of Psychology, 45*, 25-50.
- Mathews, A., & Macleod, C. (2002). Induced processing biases have casual effects on anxiety. *Cognition and Emotion, 16*, 331-354.
- Mattia, J. I., Heimberg, R. G., & Hope, D. A. (1993). The revised Stroop color-naming task in social phobics. *Behaviour Research and Therapy, 31*, 305-313.
- McGinnies, E. (1949). Emotionality and perceptual defense. *Psychological Review, 56*, 244-251.
- McNally, R. (1989). Is anxiety sensitivity distinguishable from trait anxiety? Reply to Lillenfeld, Jacob, and Turner (1989). *Journal of Abnormal Psychology, 98*, 193-194.
- McNally, R. J. (1990). Psychological approaches to panic disorder: A review. *Psychological Review, 108*, 403-419.
- Merikle, P. M., & Daneman, M. (2000). Conscious vs. unconscious perception. In M. S. Gazzaniga (Ed.), *The new cognitive neurosciences* (pp. 1295-1303). Cambridge; MA: MIT Press.
- Mineka, S., & Cook, M. (1993). Mechanisms involved in the observational conditioning of fear. *Journal of Experimental Psychology: General, 122*, 23-38.
- Mineka, S., Davidson, M., Cook, M., & Keir, R. (1984). Observational conditioning of

- snake fear in rhesus monkeys. *Journal of Abnormal Psychology*, 93, 355-372.
- Mineka, S., Keir, R., & Price, V. (1980). Fear of snakes in wild- and laboratory-reared rhesus monkeys (*Macaca mulatta*). *Animal and Learning Behavior*, 8, 653-663.
- Mogg, K., & Bradley, B. P. (1998). A cognitive-motivational analysis of anxiety. *Behaviour Research and Therapy*, 36, 809-848.
- Mogg, K., & Bradley, B. P. (1999). Orienting of attention to threatening facial expressions presented under conditions of restricted awareness. *Cognition and Emotion*, 13, 713-740.
- Mogg, K., & Bradley, B. P., Dixon, C., Twelftree, H., & McWilliams, A. (2000). Trait anxiety, defensiveness and selective processing of threat: An investigation using two measures of attentional bias. *Personality and Individual Differences*, 28, 1063-1077.
- Mogg, K., & Bradley, B. P., & Williams, R. (1995). Attentional bias in anxiety and depression: The role of awareness. *British journal of Clinical Psychology*, 34, 17-36.
- Mogg, K., & Bradley, B. P., Williams, R., & Mathews, A. (1993). Subliminal processing of emotional information in anxiety and depression. *Journal of Abnormal Psychology*, 102, 304-311.
- Mühlberger, A., Wiedeman, G., Herrmann, M. J., & Pauli, P. (2006). Phylo- and ontogenetic fears and the expectations of danger: Differences between spider- and flight-phobic subjects in cognitive and physiological responses to disorder-specific stimuli. *Journal of Abnormal Psychology*, 115, 580-589.
- Najström, M., & Högman, L. (2003). Skin conductance response in Swedish United Nations soldiers exposed to fear-relevant stimuli. *Cognitive Behaviour Therapy*, 32, 161-165.
- Najström, M., & Jansson, B. (2006). Unconscious responses to threatening pictures: The interactive effect of trait anxiety and social desirability on skin conductance responses. *Cognitive behaviour Therapy*, 35, 11-18.
- Nay, W. T., Thorpe, G. L., Roberson-Nay, R., Hecker, J. E., & Sigmon, S. T. (2004). Attentional bias to threat and emotional response to biological challenge. *Anxiety Disorders*, 18, 609-627.
- Newman, L. S., & McKinney, L. C. (2002). Repressive coping and threat avoidance: An idiographic Stroop study. *Personality and Social Psychology Bulletin*, 28, 409-422.
- Öhman, A. (1986). Face the beast and fear the face: Animal and social fears as prototypes for evolutionary analyses of emotion. *Psychophysiology*, 23, 123-145.
- Öhman, A. (1992). Orienting and attention: Preferred preattentive processing of potentially phobic stimuli. In B. A. Campbell, H. Haynes & R. Richardson

- (Eds.), *Attention and information processing in infants and adults: Perspectives from human and animal research* (pp. 263-295). Hillsdale, NJ: Erlbaum.
- Öhman, A. (1993). Fear and anxiety as emotional phenomena: Clinical phenomenology, evolutionary perspectives, and information processing mechanisms. In M. Lewis & J. M. Haviland (Eds.), *Handbook of emotions* (pp. 511-536). New York: Guilford Press.
- Öhman, A. (1996). Preferential preattentive processing of threat in anxiety: Preparedness and attentional biases. In R. M. Rapee (Ed.), *Current controversies in the anxiety disorders* (pp. 253-290). New York: The Guilford Press.
- Öhman, A. (2005). The role of amygdala in human fear: Automatic detection of threat. *Psychoneuroendocrinology*, 30, 953-958
- Öhman, A., Dimberg, U., & Esteves, F. (1989). Preattentive activation of aversive emotions. In T. Archer & L.-G. Nilsson (Eds.), *Aversion, avoidance, and anxiety* (pp. 169-193). Hillsdale, NJ: Erlbaum.
- Öhman, A., Dimberg, U., & Öst, L.-G. (1985). Animal and social phobias: Biological constraints on learned fear responses. In S. Reiss & R. R. Bootzin (Eds.), *Theoretical issues in behavior therapy* (pp. 123-178). New York: Academic Press.
- Öhman, A., Flykt, A., & Esteves, F. (2001). Emotion drives attention: Detecting the snake in the grass. *Journal of Experimental Psychology: General*, 130, 466-478.
- Öhman, A., Flykt, A., & Lundqvist, D. (2000). Unconscious emotion: Evolutionary perspectives, psychophysiological data and neuropsychological mechanisms. In R. D. Lane & L. Nadel (Eds.), *Cognitive neuroscience of emotion. Series in affective science* (pp. 296-327). New York: Oxford University Press.
- Öhman, A., & Mineka, S. (2001). Fears, phobias, and preparedness: Toward an evolved module of fear and fear Learning. *Psychological Review*, 108, 483-522.
- Öhman, A., & Soares, J. J. F. (1993). On the automatic nature of phobic fear: Conditioned electrodermal responses to masked fear-relevant stimuli. *Journal of Abnormal Psychology*, 103, 1221-1232.
- Öhman, A., & Soares, J. J. F. (1994). "Unconscious Anxiety": Phobic responses to masked stimuli. *Journal of Abnormal Psychology*, 103, 231-240.
- Öhman, A., & Soares, J. J. F. (1998). Emotional conditioning to masked stimuli: Expectancies for aversive outcomes following nonrecognized fear-relevant stimuli. *Journal of Experimental Psychology*, 127, 69-82.
- Öhman, A., & Wiens, S. (2003). On the Automaticity of Autonomic Responses in Emotion: An Evolutionary Perspective. In R. J. Davidson, K. R. Scherer & H. Hill Goldsmith (Eds.), *Handbook of Affective Sciences* (pp. 256-275). New York: Oxford University Press.

- Orr, S. P., Pitman, R. K., Lasko, N. B., & Herz, L. R. (1993). Psychophysiological assessment of posttraumatic stress disorder imagery in World War II and Korean combat veterans. *Journal of Abnormal Psychology, 102*, 152-159.
- Pitman, R. K. (1988). Posttraumatic stress disorder, conditioning and network theory. *Psychiatric Annals, 18*, 182-189.
- Posner, M. I. (1978). *Chronometric explorations of mind*. Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.
- Pury, C. S. (2002). Information processing predictors of emotional response to stress. *Cognition and Emotion, 16*, 667-683.
- Rapee, R. M. (1996). Information-processing views of panic disorders. In R. M. Rapee (Ed.), *Current controversies in the anxiety disorders* (pp 77 - 93). The Guilford Press.
- Rapee, R. M., & Heimberg, R. G. (1997). A cognitive-behavioral model of anxiety in social phobia. *Behaviour Research and Therapy, 35*, 741-756.
- Russell, M. T., & Karol, D. L. (1997). *16PF: Manual 5th version*. Stockholm: Psykologiförlaget AB.
- Rutherford, E. M., MacLeod, C., & Campbell, L. (2004). Negative selectivity effects and emotional selectivity effects in anxiety: differential attentional correlates of state and trait variables. *Cognition and Emotion, 18*, 711-720.
- Schalling, D. (1985). Personality correlates of elevated blood pressure. Anxiety, unexpressed anger, and lack of assertiveness. In C. D. Spielberger, I. G. Sarason & P. B. Defares (Eds.), *Stress and Anxiety* (volume 9, pp. 241-251). Washington: Hemisphere.
- Seligman, M. E. P. (1970). On the generality of the laws of learning. *Psychological Review, 77*, 406-418.
- Seligman, M. E. P. (1971). Phobias and preparedness. *Behavior Therapy, 2*, 307-320.
- Shields, S. A., MacDowell, K. A., Fairchild, S. B., & Campbell, M. L. (1987). Is mediation of sweating cholinergic, adrenergic, or both? A comment on the literature. *Psychophysiology, 24*, 312-319.
- Shiffrin, R. M., & Schneider, W. (1977). Controlled and automatic information processing: II. Perception, learning, automatic attending and a general theory. *Psychological Review, 84*, 127-190.
- Shiffrin, R. M., & Schneider, W. (1984). Automatic and controlled processing revisited. *Psychological Review, 91*, 269-276.
- Siddle, D. A. (1991). Orienting, habituation, and resource allocation: an associative analysis. *Psychophysiology, 28*, 245-259.
- Silvert, L., Delplanque, S., Bouwalerh, H., Verpoort, C., & Sequire, H. (2004). Autonomic responding to aversive words without conscious valence

- discrimination. *International Journal of Psychophysiology*, 53, 135-145.
- Spielberger, C. D., Gorsuch, R. C., Lushene, R. E., Vagg, P. R., & Jacobs, G. A. (1983). *Manual for the State-Trait Anxiety Inventory*. Palo Alto, CA.: Consulting Psychologists Press.
- Spielberger, C. D., Pollans, C. H., & Worden, T. J. (1984). Anxiety disorders. In S. M. Hersen (Eds.). *Adult psychopathology and diagnosis* (pp. 263-303). New York: Wiley.
- Språkbanken. (2003). *Concordances of the Bank of Swedish on the Net*, (online database). University of Gothenburg. Available: <http://spraakbanken.gu.se>.
- StatSoft (1994). *Statistica for the Macintosh*. Tulsa, OK: Author.
- Thayer, J. F., & Friedman, B. H. (2002). Stop that! Inhibition, sensitization, and their neurovisceral concomitants. *Scandinavian Journal of Psychology*, 43, 123-130.
- Tomarken, A. J., Sutton, S. K., & Mineka, S. (1995). Fear-relevant illusory correlations: What types of associations promote judgmental bias? *Journal of Abnormal Psychology*, 104, 312-326.
- Tooby, J., & Cosmides, L. (1990). The past explains the present: Emotional adaptations and the structure of ancestral environment. *Ethology and Sociobiology*, 11, 375-424.
- Tooby, J., & Cosmides, L. (1992). The psychological foundations of culture. In J. H. Barkow, L. Cosmides & J. Tooby (Eds.), *The adapted mind: Evolutionary psychology and the generation of culture* (pp. 19-136). New York: Oxford University Press.
- Turner, J., Kelly, B., Swanson, C., Allison, R., & Wetzig, N. (2005). Psychosocial impact of newly diagnosed advanced breast cancer. *Psycho-Oncology*, 14, 396-407.
- Turpin, G. (1991). The psychophysiological assessment of anxiety disorders: Three-systems measurement and beyond. *Psychological Assessment: A journal of Consulting and Clinical Psychology*, 3, 366-375.
- van den Hout, M., Tenney, N., Huygens, K., Merckelbach, H., & Kindt, M. (1995). Responding to subliminal threat cues is related to trait anxiety and emotional vulnerability: A successful replication of Macleod and Hagan (1992). *Behaviour Research and Therapy*, 33, 451-454.
- van den Hout, M., de Jong, P., & Kindt, M. (2000). Masked fear words produce increased SCRs: An anomaly for Öhman's theory of pre-attentive processing in anxiety. *Psychophysiology*, 37, 283-288.
- Verhaak, C. M., Smeenk, J. M. J., van Minnen, A., & Kraaimat, F. W. (2004). Neuroticism, preattentive and attentional biases towards threat, and anxiety

- before and after a severe stressor: A prospective study. *Personality and Individual Differences*, 36, 767-778.
- Vogeltanz, N. D., & Hecker, J. E. (1999). The roles of neuroticism and controllability/predictability in physiological response to aversive stimuli. *Personality and Individual Differences*, 27, 599-612.
- Wallin, B. G. (1981). Sympathetic nerve activity underlying electrodermal and cardiovascular reactions in man. *Psychophysiology*, 18, 470-476.
- Weinberger, D. A., Schwartz, G. E., & Davidson, J. R. (1979). Low-anxious, high-anxious, and repressive coping styles: psychometric patterns and behavioural and physiological responses to stress. *Journal of Abnormal Psychology*, 88, 369-380.
- Wells, A., & Matthews, G. (1994). *Attention and emotions: A clinical perspective*. Hove, UK: Erlbaum.
- Whalen, P. J., Rauch, S. L., Etcoff, N. L., McInerney, S. C., Lee, M. B., & Jenike, M. A. (1998). Masked presentations of emotional facial expression modulate amygdala activity without explicit knowledge. *Journal of Neuroscience*, 18, 411-418.
- Williams, J. M. G., Mathews, A., & MacLeod, C. (1996). The emotional Stroop task and psychopathology. *Psychological Bulletin*, 120, 3-24.
- Williams, J. M. G., Watts, F. N., MacLeod, C., & Mathews, A. (1997). *Cognitive psychology and emotional disorders*, 2nd Ed. New York: Wiley.
- Wilson, G. D., Kumari, V., Gray, J. A., & Corr, P. J. (2000). The role of neuroticism in startle reaction to fearful and disgusting stimuli. *Personality and Individual Differences*, 29, 1077-1082.
- Zinbarg, R. E., & Barlow, D. H. (1996). Structure of anxiety and the anxiety disorders: A hierarchical model. *Journal of Abnormal Psychology*, 105, 181-193.