Individual Differences In Anxiety In Relation To Inhibitory Processes

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Abstract

When an individual perceives a situation or stimulus as anxiety-provoking they may react behaviourally; often actions are carried out that make it possible for the individual to cope with the anxiety. Thus, the individual comes to associate the elicited behaviour with a decrease in anxiety. Potentially, when such behaviours are carried out, conditioned inhibitors, or safety signals, are generated. On theoretical grounds, these are expected to help maintain and secondarily reinforce the behaviour. The current thesis examined both conditioned inhibition and the learning of stimulus–response associations in both a healthy sample and a clinical sample of participants with anxiety disorder and/or problems with substance abuse.

Two novel tasks were developed and one previously used task was used to examine conditioned inhibition, Negative Images CI Task: Retardation Test, Negative Images CI Task: Summation Test and 'Mission to Mars' CI Task: Summation test respectively. Four response inhibition tasks were developed to examine any accuracy or reaction time differences to neutral and emotional stimuli: Emotional Stroop Task, Go/No-Go Words Task, Go/No-Go OCD Colour Images Task, Go/No-Go Black and White Images Task. Performance on all of the tasks was correlated with individual differences in anxiety as measured by questionnaires: HADS, MOCI, BIS/BAS and the EPQR-S. The results from the healthy sample tested showed clear evidence of discrimination learning, as well as conditioned inhibition as measured by both retardation and summation tests. There were also response inhibition differences on the Emotional Stroop, a classic Stroop effect, less accurate and slower for colour incongruent words compared to other word-types, and more accurate and quicker responses to negative and OCD related words. There were no response inhibition differences on any of the Go/No-Go tasks. Further to this, in general, individual differences in anxiety as measured by the HADS, MOCI, BIS/BAS and EPQR-S were related to performance on the tasks. The hypothesis was that individuals formally diagnosed with an anxiety disorder would show better

conditioned inhibition and response inhibition deficits. Recruitment for the clinical sample was unexpectedly difficult and therefore the sample size provides only preliminary data. The results from the clinical sample tested showed no difference in performance on any of the tasks; thus a formal clinical diagnosis of either an anxiety disorder or substance abuse disorder did not measurably impact on performance. However, overall the clinical group did not show discrimination learning or conditioned inhibition. On the Emotional Stroop Task the clinical sample showed a classic Stroop effect for accuracy and was also more accurate for negative words but there was no difference in latencies. There were no differences in performance on any of the Go/No-Go tasks. Across all of the tasks the clinical sample demonstrated a relationship between task stimuli and individual differences as measured by the HADS, MOCI, BIS/BAS and EPQR-S related to performance.

The results from the current tasks demonstrated that inhibitory processes are influenced or affected by individual differences in anxiety in a healthy sample; in particular certain measures either positively or negatively influence performance. In order for this to be fully conclusive all of the tasks carried out need to be tested in a larger clinical sample. The results have implications for psychological treatments, for example, cognitive behavioural therapy (CBT). CBT is based on associative learning principles, if safety signals were identified in the maintenance of the anxiety these could be incorporated into therapy and aid the breakdown of negative associations formed.

Dedicated to my husband Alex

‘we make a great team’

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Abbreviations

BDD	Body Dismorphic Disorder
BIS/BAS	Behavioural Inhibition System/Behavioural Activation System
CBT	Cognitive Behavioural Therapy
CER	Conditioned Emotional Response
CI	Conditioned Inhibitor
CS	Conditioned Stimulus
CSx	Conditioned Stimulus, x refers to a number assigned to that CS
DSM-IV	Diagnostic and Statistical Manual of Mental Disorders, 4th Ed.
EPQR-S	Eysenck's Personality Questionnaire Revised Short Version
ERP	Exposure Response Prevention
HADS	Hospital Anxiety and Depression Scale
IAPS	International Affective Picture System
IAPT	Increasing Access to Psychological Therapies
MOCI	Maudsley Obsessive Compulsive Inventory
NICE	National Institute of Clinical Excellence
OCD	Obsessive Compulsive Disorder
PTSD	Post Traumatic Stress Disorder
US	Unconditioned Stimulus

Chapter 1: Introduction

Anxiety disorders are debilitating and complex and although there are effective treatments the mechanisms that support such anxieties are poorly understood. It is widely recognised that many fears arise without any evidence that they have been learned. Nonetheless, cognitive behavioural therapy (CBT) which focuses on the un-learning of associations is a highly effective treatment for anxiety disorders. Watson & Rayner (1920) first demonstrated the role that classical conditioning can play and that fears and anxieties can be learned or acquired through this mechanism; a conditioned emotional response (CER). This occurred when a boy, little Albert, was shown white rat which was accompanied with a frightening noise. As a result of this pairing Little Albert cried and showed fear. It was also found that this response generalised to other white fluffy objects. CERs occur towards anxiety provoking or fearful situations. When faced with an aversive object or circumstance individuals often exhibit avoidance responses. These responses enable the individual to cope with the anxiety. One possibility is that the avoidance responses people make when fearful generate conditioned inhibitors (CIs), in this case safety signals (Gray, 1987), which prevent the excitatory response. Safety signals become negatively reinforced and secondarily rewarding. In the animal literature, CIs have been shown to be secondarily rewarding: rats 'sigh with relief' when given CI for shock (Soltysik & Jelen, 2005). This thesis will investigate whether individual differences in anxiety show particular sensitivity to CIs.

1.1 Anxiety, OCD and Panic Disorder

1.1.1 Description of Anxiety and Anxiety Disorders

Anxiety is an emotion that arises to perceived fearful situations or objects. This can be a response which is temporary, state anxiety; the individual feels fear,

tension and apprehension towards specific situations. Or, it can be a more general tendency, trait anxiety; the individual has a predisposition to perceive a wider range of situations as threatening. In response to the perceived anxiety our bodies produce adrenaline to prepare for the fight/flight/freeze response (DSM-IV, 2000). Adrenaline causes physiological changes; these include: increased heart rate, sweating, heavy breathing, shaking. The body is preparing to either fight, flight or flee the anxiety provoking and potentially harmful situation. Once in this situation typically these physiological changes decrease and so does the emotion/physical feeling of anxiety. However, for some individuals the anxiety and physical changes are overwhelming or are catastrophically misinterpreted that avoidance or safety behaviours develop. Avoidance or safety behaviours include actions or thoughts to ease anxiety such that the individual can remain in and cope with the situation. When avoidance or safety behaviours start to interrupt and impinge on daily routines anxiety disorders develop.

Anxiety disorders cover a number of disorders where the primary feature is abnormal or even inappropriate levels of anxiety. They are highly distressing and disabling for the individual suffering from them. The anxiety that is experienced is an unpleasant emotion and as a result of avoidance and safety behaviours people often experience social isolation and often have to give up their social leisure and work. There are six major disorders: Obsessive Compulsive Disorder (OCD), Panic Disorder (with or without agoraphobia), Generalized Anxiety Disorder (GAD), Post Traumatic Stress Disorder (PTSD), Phobias including social phobia and Acute Stress Disorder (DSM-IV, 2000). This thesis will concentrate on two main anxiety disorders: OCD and Panic Disorder.

1.1.2 Obsessive Compulsive Disorder

OCD is characterised by the presence of either obsessions, compulsions or both. Obsessions manifest as intrusive and distressing thoughts or images causing an increase in anxiety, compulsions are often strict repetitive rituals or

habits that are performed and are intended to reduce anxiety (American Psychiatric Association (DSM-IV), 2000). Many healthy people experience distressing thoughts and repetitive checking (e.g. checking the stove to see if it is switched off more than once) but for individuals with OCD the obsessions and compulsions interfere with their daily life. They cause distress when intrusive thoughts occur and if compulsions are not carried out; the individual often recognises that their behaviour is unreasonable and excessive in nature (DSM-IV, 2000; Riggs & Foa, 1993). This degree of insight is important to the maintenance of the disorder (Foa & Kozak, 1995) as this has implications for treatment outcomes. The individual needs to be able to recognise that these behaviours are excessive in order to address them in treatment. Onset typically begins in the early 20's, with some studies showing that age of onset is slightly earlier for males than for females (Lensi et al., 1996). The prevalence of OCD is approximately 2.5% in adults in an American sample (Reiger et al., 1988), although this varies due to geographical location (ranging from 2.5% in German and American samples, to 0.4% Taiwanese sample, Weissman et al., 1994). Prevalence rates have also increased over the past years from 0.05% in the 50's (Rudin, 1953) to 2.5% in the 80's (Reiger et al., 1988). These prevalence rates are from different samples and countries so the figures need to be considered with respect to geographical variation; however the increase does suggest a rise in incidence. This could be due to either an increase individuals suffering with OCD, an increase in public awareness, or a better understanding of how to detect OCD. Prevalence rates do not differ across gender, in other words the frequency with which OCD is diagnosed does not vary between males and females (Nestadt et al., 1994).

Individuals with OCD exhibit and can engage in a range of obsessions and compulsions to control their anxiety and it has been suggested that there are multiple symptom subtypes of OCD which vary by gender; men report more sexual and exactness obsessions whilst women report more aggressive and cleanliness obsessions (Lensi et al., 1996). Although no one standard taxonomy model has been identified many have been suggested with the number of subtypes ranging from four (Leckman et al., 1997; van Oppen et al., 1995) to seven (Calamari et al., 2004). The common subtypes are:

contamination/washing, harming/checking, hoarding, symmetry/ ordering. The category of symptom subtype that an individual with OCD presents with also has implications for treatment outcomes. Overt symptoms (more obvious explicit obsessions and behaviours like washing, hoarding) respond better to behavioural treatments. Covert symptoms (more concealed, hidden obsessions and behaviours like counting or checking in your head) respond better to medication, specifically with serotonin re-uptake inhibitors (Starcevic, 2008). The variation in symptom subtypes of OCD highlights the importance of identifying the specific obsessions and compulsions in order to optimise treatment potential.

As mentioned, individuals that suffer from OCD or Panic Disorder are often susceptible to other mental health difficulties: social isolation, employment and relationship issues to name a few. Further to this, due to the highly heterogeneous nature of OCD it is often co-morbid with other psychiatric disorders; co-morbidity can occur as a cause or an effect. OCD and Panic Disorder can be co-morbid with depression, schizotypy, borderline personality disorder, tic disorders and social phobia (Masellis et al., 2003; Swinson et al., 1998). Further to this it has been suggested that there is a spectrum of OCD related disorders. These include hypochondrias, body dismorphic disorder (BDD) and trichotillomania. These disorders share common themes such as cleanliness, lack of inhibition, obsessing and compulsions (Foa et al., 1996).

The central features of OCD are thoughts that are intrusive and unwanted and often accompanied by compulsive behaviours that are carried out to neutralise the thoughts. Many healthy individuals experience intrusive thoughts but the defining feature of OCD is the marked characteristics of OCD are that the thoughts are distressing, occur often and are strongly resisted by the individual experiencing them. Many theories have attempted to address why OCD develops and how it is maintained; these will be explained in detail below.

There is a lack of research suggesting that OCD develops as a result of a traumatic experience (Mineka & Zinbarg, 2006) however, it has been suggested that it may occur through verbal conditioning. The occurrence of

someone verbally transmitting negative or dangerous thoughts causes the development of OCD. Further to this it has been hypothesised that thought action fusion may occur (Shafran et al., 1996). An individual is taught or believes that their thoughts are equivalent to their actions and just as incorrect or that having particularly negative thoughts increases the chances of that occurring. As mentioned above, all of these types of thoughts are distressing and lead to increased attempts to resist these intrusions and in fact suppress them.

It has been argued that the content of the intrusive thoughts are actually evolutionarily beneficial. The cognitive theme of OCD is 'harm to one or others' and the distressing thoughts that occur are centred on this theme. Therefore, it could be argued that thoughts are not arbitrary but rather possess a non-random evolutionary advantage (De Silva et al., 1977). The behaviours, compulsions, that are carried out in accordance to these distressing thoughts are therefore by default not random but rather serve a purpose.

The ability to suppress thoughts has been investigated in individuals with OCD and is believed to be the key to the development and persistence of the disorder (Wegner et al., 1987). At a basic level, efforts to suppress a thought causes a later thought rebound effect, in essence the more you try to suppress a thought the more frequently you have that thought. Further to this, any stimuli used to distract from having that thought automatically become associated with that thought and act as a trigger for that thought. Although this theory suggests and provides a strong rationale behind the development and maintenance of OCD the literature is mixed with many studies reporting a rebound effect although equally as many fail to find any such effect (Purdon & Clark, 2001) and a meta-analysis finding a 'small to moderate' effect of thought suppression (Abramowitz et al., 2001). Overall, the evidence for the thought suppression theory is mixed but is relevant to OCD.

Learning theory of OCD has a strong foundation in both research and treatment of OCD. The two-factor theory of fear and avoidance states that fear is acquired through classical conditioning and maintained through operant

conditioning (Mowrer, 1947; 1960). Fear becomes conditioning to cues that precede an aversive event. These cues evoke anxiety and an instrumental response occurs to terminate the cue (Dollard & Miller, 1950). The behaviour is avoidance or escape from the feared stimulus and these become negatively reinforcing. Psychological therapies based on exposure to the feared outcome and preventing the behaviours have been very successful in the treatment of OCD (Franklin et al., 2000). This theory is central to the current thesis and will be discussed in more detail and how it applies to the current study later in the Chapter.

Biological theories of OCD suggest that basal ganglia and frontal lobe dysfunctions are largely involved in the neuroanatomy of OCD. Evidence shows that in post encephalitic patients who have sustained basal ganglia lesions OCD-like behaviour occurs (Wise & Rapoport, 1989). It has hypothesised that low levels of the neurotransmitter serotonin is involved in OCD with many patients responding positively to serotonergic anti-depressant drugs however evidence of actual serotonin levels in individuals with OCD remains equivocal (Pigott, 1996).

Although treatment can be symptom specific (see earlier) typically OCD is primarily treated with psychological therapies, more specifically exposure response therapy (ERP), which is based on cognitive behavioural principles (NICE, 2005). ERP involves exposing the individual to the object or thought that provokes the anxiety and then preventing the compulsion, the behavioural response to decrease anxiety. ERP also focuses on obsessions; by preventing the behavioural response the individual 'faces' their obsession and challenges that thought. The goal is to directly break the associations that have developed between the obsessions and compulsions. ERP is recognised as being the most effective psychological based therapy to treat OCD (NICE, 2005).

1.1.3 Panic Disorder with or without Agoraphobia

When considering anxiety and Panic the distinction between the two must be clear to aid in any interpretation as evidence shows distinctive functional differences between the two. Bouton et al. (2001) describes the distinction between the two as 'Anxiety is the apprehensive anticipation of future danger which is often accompanied by somatic symptoms' and 'Panic attacks are a subjective sense of extreme fear or impending doom accompanied by a strong autonomic surge and fight/flight behavioural tendencies' (Barlow et al., 1994 ; DSM-IV, 2000). Anxiety and panic share common characteristics, both involve physical sensations and both involve a sense of fear therefore it is useful to be able to clearly distinguish between the two.

Panic disorder was first defined by Klein & Fink (1962) as 'sudden attacks of anxiety with multiple somatic symptoms so severe that they would be appropriate to situations of mortal danger – occurring ''out of the blue'' without apparent cause'. Panic disorder is characterised by an individual experiencing at least one unexpected panic attack and consequently developing substantial anxiety over the possibility of having another attack. A panic attack is defined as 'a discrete period of intense fear that is accompanied by at least four out of thirteen somatic and cognitive symptoms', e.g. palpitations, increased heart rate, sweating, fear of losing control or dying (DSM-IV, 2000). They often occur on a regular but at the same time unexpected basis (Bouton et al., 2001). It is the interpretation and perception of the physical symptoms that sustains the anxiety and fear of a potential future attack. Often individuals catastrophically misinterpret their physical symptoms and believe they are suffering a heart attack or even death. As a result of this understanding of their physical symptoms, individuals engage in avoidance and safety behaviours to ensure no future attacks occur. Panic disorder can lead to agoraphobia. It typically develops as a result of having panic disorder but can also occur independently (DSM-IV, 2000). Agoraphobia is characterised by extreme anxiety if escape is difficult or avoidance of a situation in which having a panic attack could be dangerous or embarrassing for the person (DSM-IV, 2000).

Panic disorder has two peaks of onset; it can typically develop between the ages of 15 and 19 and again at 25 and 30 (Ballenger & Fyer, 1996). The prevalence is roughly 4% for panic disorder and 9% for panic disorder and agoraphobia (Wittchen et al., 1998) and this is generally consistent across the world (Weissman et al., 1997). More women are diagnosed with having the disorder than men (Weissman et al., 1997), and although the symptoms can come and go over a lifetime, the disorder is considered chronic.

Panic disorder is often co-morbid with other anxiety disorders. The most common disorders co-morbid with panic disorder are generalised anxiety disorder (15-30%), specific phobias (2-20%), OCD (10%) and post traumatic stress disorder (2-10%) (DSM-IV, 2000). Hypochondrias is also linked to panic disorder (Noyes, 2001) and often individuals develop depression (DSM-IV, 2000). It is believed that the reason why panic disorder is often co-morbid with other anxiety disorders is that they all share a common diathesis, excessive worrying about a potential situation or event occurring.

There are many competing biological and psychological theories about the etiology and maintenance of panic disorder. There are three main psychological theories: The cognitive theory, anxiety sensitivity and conditioning theory. The cognitive theory hypothesizes that an individual suffering from Panic Disorder develops their own anxieties through negative thought patterns; focus is on the physiological symptoms and the interpretation of them (Clark, 1986; 1988; 1996). The individual catastrophically misinterprets their own physical sensations therefore perpetuating and exacerbating their anxiety. A similar theory is called anxiety sensitivity (McNally, 1994; Reiss, 1991). The difference between cognitive theory and anxiety sensitivity is that the individual focuses on the long-term negative problems that they associate with the attacks. The individual believes that the panic attacks are ultimately damaging them physically. Some studies and the positive clinical outcomes of the use of cognitive therapy lend support for these theories (Clark et al., 1994; Schmidt et al., 1997; 1999). However, neither of these theories considers how the panic reaction nor how panic attacks can occur in the absence of negative cognitions, for example, nocturnal panic

attacks. The conditioning theory attempts to address the development and maintenance of Panic Disorder (Bouton et al., 2001). The theory suggests that the initial anxiety occurs when a neutral stimulus occurs with the physical symptoms of panic. The next occasion that stimulus is encountered the same physical symptoms will occur and in fact become strengthened (Bouton et al., 2001). It has been argued that the idea of an anxiety response conditioning to anxiety does not have strong face validity (Whalen & McKinney, 2007) and further to this that conditioning only occurs in individuals with certain genetic or temperamental vulnerabilities to panic in the first place (Mineka & Zinbarg, 2006).

Further to the psychological theories genetic and biological theories also exist about the etiology of Panic Disorder. It has been found that genetic factors contribute to 35 -39 % of Panic Disorder and Agoraphobia in a twin study (Kendler et al., 1992) and that 30% of first degree relatives have Panic Disorder (Zal, 1990). It has been suggested that a heightened sensitivity to certain substances that induce panic symptoms may make individuals vulnerable to their effects (McNally, 1994).

The first line of treatment for panic disorder is therapies based on CBT principles: exposure therapy and/or cognitive restructuring (NICE, 2011). Both exposure therapy and cognitive restructuring aim to change any unwanted behaviours or distorted thoughts. Exposure therapy generally speaking involves presenting the individual with an anxiety provoking stimulus or situation for a period of time long enough to demonstrate a decrease in their physical feelings of anxiety, e.g. heart palpitations, sweating, shaking. Over repeated exposures to the stimulus or situation the individual becomes habituated and is no longer fearful of it (Marks, 1987). Cognitive restructuring is the process of changing distorted thoughts. In therapy sessions anxiety related thoughts are identified and using techniques are explored and rationalised to help the individual change their irrational cognitions (Clark, 1986; Clark & Salkovskis, 1986). These two therapies are either carried out individually or simultaneously.

1.1.4 Anxiety and Substance Abuse

Substance abuse is characterised by a 'maladaptive pattern of substance use leading to clinically significant impairment or distress occurring within a 12 month period: role at work, school or home, dangerous driving, legal problems, social or interpersonal problems' (DSM-IV, 2000). Types of substances that are typically abused are: recreational drugs, alcohol or nicotine. It has been shown that anxiety and substance abuse disorders are frequently co-morbid (Cox et al., 1991; Kushner et al., 1990). Individuals that are diagnosed with an anxiety disorder (any classified in the DSM) are 50% more likely to be diagnosed with a substance abuse disorder (Reiger et al., 1988) specifically individuals with panic disorder having the greatest odds of being co-morbid with a substance abuse disorder compared to other mental health disorders.

There are three main causal explanations for co-morbidity, anxiety promotes substance abuse, substance abuse promotes anxiety and anxiety and substance abuse are caused by familial components. Firstly, it could be argued that anxiety promote substance abuse; people self-medicate (Quitkin et al., 1972) and aim to reduce their anxiety symptoms with alcohol and drugs. This promotes the behaviour via negative reinforcement. Secondly, it could equally be argued that substance abuse promotes anxiety; the pathological use of a substance leads directly to the development of an anxiety or an anxiety disorder. The physical symptoms of an anxiety disorder are a consequence of chronic substance abuse (George et al., 1990). Thirdly, anxiety and substance abuse could be caused by a familial component (Crowe et al., 1993; McGue, 1994; Noyes et al., 1978); family, biological, genetic, environmental factors could lead to the development of both anxiety and substance abuse disorders.

1.1.5 Subclinical Anxiety/ Individual Differences in Anxiety

Anxiety is an emotion that every individual experiences throughout stages of their life. It can be positive, e.g. new job, wedding, or negative, e.g. anxiety about situations or objects that disrupt daily routines, and even – within the

'normal range' – can include physiological and cognitive symptoms. Subclinical levels of anxiety are therefore quite common and could help to inform models for anxiety disorders. The anxiety levels can educate about what leads up to but not escalates into a diagnosed disorder. This can be measured by non-diagnostic questionnaires that give an indication of individual differences in subclinical anxiety.

Subclinical levels of OCD are quite common; people can experience cognitions or carry out compulsions without disruption to their daily life and it escalating into a disorder. Subclinical OCD can affect 2-25% of the population with people experiencing OCD symptoms greater than normal intrusive thoughts or ideas but that do not meet diagnostic criteria. More specifically, of the population that experience subclinical levels, 80% experience obsessions (Rachman & De Silva, 1978) and 55% engage in compulsions (Muris et al., 1997). As a result of engaging in OCD tendencies people have an increased chance of developing the disorder and it impacting on daily routines.

Panic attacks can also be experienced outside of the context of diagnosis (Norton et al., 1992). They can be infrequent and with limited symptoms therefore people do not seek treatment for them; this could be due to subclinical panickers using more avoidant behaviours and safety strategies (Katerndahl, 1999). Experiencing a single panic attack which does not develop into panic disorder can mean the individual is vulnerable to other co-morbid disorders, for example substance abuse (Bunaciu et al., 2010). As previously mentioned, panic disorder can lead to staying in more, and avoiding situations, which in turn can result in the development of depressive symptoms. Individuals may also develop safety behaviours, such rituals, habits and substance abuse, to maintain and cope with situations. These behaviours therefore impact on mental wellbeing and encourage development of other co-morbid disorders.

1.2 Inhibition

1.2.1 Description of Inhibition

Inhibition is the ability to control or stop either our behaviours or cognitions. It can be broadly divided up into motor/behavioural inhibition and cognitive inhibition (Harnishfeger, 1995). Behavioural inhibition is 'the control of overt behaviour, such as resisting temptation, motor inhibition and impulse control', cognitive inhibition is defined as 'the control of cognitive contents or processes, and can be intentional and conscious, or unintentional and unavailable for conscious introspection'.

Key to the maintenance of OCD and Panic Disorder, are negative thoughts about perceived threatening situations but also the behaviours that are produced in order to cope with or alleviate the anxiety being experienced. Individuals often recognise these behaviours are irrational but feel either that they cannot or do not want to stop them, because ultimately they do not want to experience the feeling of anxiety. They continue to execute behaviours which contribute to its alleviation (Calamari & Janeck, 1998). It could therefore be argued that there is an underlying deficit in inhibition in individuals who suffer from OCD or Panic Disorder; the thoughts that are experienced and the behaviours that are carried out are potentially maintaining the disorder. The inability to inhibit intrusive anxiety provoking thoughts and/or the inability to prevent behaviours that alleviate anxiety. An underlying deficit in response inhibition, particularly for thoughts and behaviours, could potentially be sustaining the symptoms and disorder. Whilst central to the current thesis, this view on how OCD and Panic Disorder may develop is not the only one alternative theoretical position, not necessarily mutually exclusive, that will be mentioned later in the Chapter.

1.2.2 Behavioural Inhibition, OCD and Panic Disorder

Motor inhibition is the ability to prevent physical movement to a response (Harnishfeger, 1995). People control their responses to stimuli on a daily basis,

for example, only checking something once, however for an individual with OCD or Panic Disorder there may be a disruption in the ability to do this. For example, an individual suffering from OCD may have a deficit in their ability to prevent the movement to an irrelevant situation or object, such as washing or checking. This movement, behaviour, also alleviates the anxiety that is experienced so becomes reinforced to the individual. Therefore, the individual becomes compelled to do it.

Individuals with OCD often carry out rituals or habits to cause a decrease in anxiety or try to prevent the thoughts they are having. It has been suggested that individuals suffering with OCD have impairment in their response/behavioural inhibition and many comparable studies have been done that have concluded that result. Bannon et al., (2002) showed response inhibition impairment in 20 OCD and 20 panic disorder patients on the Go/No-Go Task, OCD participants were slower to react to certain Go stimuli and made more errors. Further to this Penadés et al., (2007) also showed response impairment in three different inhibitory tasks, the Go/No-Go, Stroop and Stop task in 27 OCD and 25 healthy controls. OCD individuals were less likely to inhibit their responses and were slower on the Go/No-Go Task and Stop Task. Aycicegi et al., (2003) carried out a battery of neuropsychological tests (Object alternation test, Go/No-Go Task, Controlled Word Fluency Test, Design Fluency Test, Trail-Making Test, Porteus Maze Task and Divergent Thinking Task) and showed OCD patients had a response inhibition deficit. Watkins et al., (2004) showed response inhibition deficits in OCD patients on the Go/No-Go Task. Evidence suggests a behavioural inhibition (and potentially a cognitive inhibition deficit, discussed later in the Chapter) deficit in individuals suffering with OCD.

People with Panic Disorder carry out safety behaviours to be able to cope with anxiety provoking situations or they escape and avoid all together. Fewer studies have been carried out with Panic Disorder, Agoraphobia and motor inhibition than with other anxiety disorders. However initial results do suggest that there is a distinct motor inhibition effect in people predisposed or that have the disorder. Liu et al., (2008) examined 16 panic disorder individuals and 13

healthy controls in a Go/No-Go Task and the results showed a clear Go/No-Go effect suggesting that people with this disorder have an inhibitory control deficit. Furthermore, Rosenbaum et al., (2000) tested children of people with panic disorder (children are often predisposed to anxiety disorders if their parents have the condition) and found that they did show motor inhibition. However, Bannon et al., (2002) compared response times between an OCD group and the panic disorder group on the Go/No-Go Task and the panic disorder group were not slower therefore not showing as significant a deficit as compared with the other clinical group, OCD. The preliminary studies suggest that there may be a motor inhibition deficit in people with panic disorder (Liu et al., 2008; Rosenbaum et al., 2000).

1.2.3 Cognitive Inhibition, OCD and Panic Disorder

Cognitive inhibition is one mechanism to control thoughts and ideas (Harnishfeger, 1995). A deficit in cognitive inhibition occurs when an individual is not able to stop or override a mental process. A mental process could be controlling, stopping or selective attention. The process is not stopped entirely but is slowed or reduced (MacLeod, 2007). A disruption in cognitive inhibition (perhaps alongside a disruption in behavioural inhibition) and the ability to control thoughts is believed to be central to the maintenance of OCD and Panic Disorder.

People with OCD experience intrusive repugnant thoughts that they cannot stop until they perform an act to prevent it. Many experiments have been conducted to examine cognitive inhibition in OCD patients. Bohne et al., (2005) conducted a study that used neutral and negative words to assess thought suppression. OCD participants displayed a cognitive inhibition deficit; they were slower to suppress/inhibit OCD relevant words. Penadés et al., (2007) showed a Stroop interference effect in OCD patients on the Stroop task, OCD individuals had difficulties correctly categorising the stimuli on the classic Stroop task. Many more studies have shown a deficit in cognitive inhibition in people with OCD and anxiety states (Clayton et al., 1999; Enright

& Beech, 1993; Mathews & MacLeod, 1985; Okasha et al., 2000) reporting similar results.

A key feature of Panic Disorder is the catastrophic misinterpretation of bodily symptoms and the belief that if the individual does not escape or carry out safety behaviours to cope something terrible will happen e.g. death or a heart attack. It has been argued that individuals with Panic Disorder cannot rationalise or stop these misinterpreted thoughts that occur (Bandura, 1988; Clark, 1986; Rachman 1994). McNally et al., (1992) carried out a study using the emotional Stroop task and found that compared with healthy individuals, those with panic disorder took longer to recognise catastrophe words than positive, fear or bodily symptoms words. However, Kampman et al., (2002) showed no difference or interference on the Emotional Stroop Task with panic disorder, OCD and healthy individuals suggesting there is no cognitive inhibition deficit. The evidence for a cognitive inhibition deficit in panic disorder appears mixed.

1.3 Associative Learning

1.3.1 Classical Conditioning

Classical conditioning, stimulus-stimulus learning (Pavlov, 1927), has been implicated in the development of anxiety disorders (Watson & Rayner, 1920) whereby a neutral stimulus (conditioned stimulus, CS) is paired with an aversive or feared outcome (unconditioned stimulus, US) eliciting a fear response (CER). In humans a fear response can be increased heart rate, sweating, breathing, to name a few examples. This early conditioning model assumes that a traumatic event is necessary for the development of phobias and fears. Since the initial fear conditioning studies, learning theory models of anxiety disorders have grown. In OCD, for example, it has been argued that some stimuli become anxiety arousing via classical conditioning, and behaviours that provide relief from the anxiety become reinforced and strengthened thus helping to maintain the behaviours. Similarly, it has been

suggested that panic disorder occurs as a result of associating the initial panic attack with initially neutral internal and external cues. Anxiety becomes conditioned to these cues and therefore anxious apprehension develops but only for people with certain genetic or temperamental vulnerabilities to panic in the first place (Mineka & Zinbarg, 2006; Mowrer, 1956).

1.3.2 Conditioned Inhibition

Conditioned inhibition (Pavlov, 1927) occurs when a stimulus (conditioned inhibitor, CI) signals the absence of an outcome. Conditioned inhibition is established using a conditioned inhibition feature negative discrimination procedure. An excitatory stimulus is paired with an outcome; this excitatory stimulus (CS) is also paired with the CI and this signals the absence of that outcome. As a result of this pairing, the CI signals that the outcome (US) which would normally occur following the CS, will not now occur (Pavlov, 1927).

CS → US

[CS + CI] → 'No US'

There are other methods to produce conditioned inhibition. In an explicitly unpaired procedure, the CS and US are specifically unpaired in time; in effect the US is presented only on occasions which are temporally removed from the 'CS' which is therefore uninformative. Thus, the notional CS is in effect negatively correlated with the US and it develops inhibitory properties (CI).

CS ↛ US

Via an inhibition of delay procedure, the US is presented at the end of an extended CS. Due to the length of time the CS is presented, the early part of the CS effectively signals a period of no US, thus the delay-conditioned CS can be established as an inhibitor (Rescorla, 1967).

Extended CS → US

Or also by backward conditioning, the CS occurs after the US (Urcelay et al., 2008). Eventually the CS establishes as a signal for no US and becomes a CI.

Backward Excitatory
US → CS

Backward Inhibitory
No US → [CS + CI]

Fundamental to all of the methods to produce conditioned inhibition is that the CS signals the absence of an outcome, the US.

As illustrated above conditioned inhibition is conceptualized as a CS that signals that omission of a US when the US would otherwise be expected. Although inhibition can readily be shown the mechanisms and processes behind it are debated. The Rescorla-Wagner Model broadly speaking is defined as, $\Delta Vn = c(Vmax - Vn)$ where V = the strength of association, ΔV = the change in associative strength, Vmax = asymptote, Vn = strength of conditioning at the beginning of any trial, (Vmax - Vn) = surprise, ΔVn = the change in the strength of the association produced by trial 'n' and c = constant representing the speed of conditioning (Rescorla & Wagner, 1972). The model states inhibition occurs due to the extinction of unlearning rather than inhibitory learning. Inhibition is a negative form of learning that occurs when the sum of all the CSs 'overpredict' the US that occurs. After a trial the associative strength (V) of each stimulus (X) is adjusted, V_X (new) = V_X (old) + ΔV_X where ΔV_X (the change in associative strength because of the last trial) = $\alpha\beta(\lambda - V\Sigma$, α and β being the associabilities of CS and US, respectively. For conditioned inhibition to occur after feature negative discrimination training, CS → US and CS → No US trials, the above error correction calculation causes both CSs to bring their associative strength to signal no US, the CS will lose excitatory strength but the CI started at zero so it's associative strength becomes negative and therefore a conditioned inhibitor. Other theories actually

predict learning to both stimuli, the CS and CI. The Sometimes-Opponent-Processes theory (Brandon & Wagner, 1991; Brandon et al., 2002) states that learning and in particular to this thesis inhibition is dependent on what state the memory node is in. if a memory node is in A2 it can sometimes evoke an opposite response to that which is in A1. For example in relation to anxiety, the quick A1 response elicited could be increased heart rate, hyperactivity, sweating, this response diminishes quickly but the opposite response in A2, freezing or avoiding, are longer lasting (Blanchard & Blanchard, 1969). Another theory, such as the comparator theory regards performance and states that excitation or inhibition is determined by the relative strengths of the target CS as opposed to other comparator stimuli. For example, if the excitatory value of the CS is greater than that of the comparator stimuli then excitatory responding will occur, if it is lower than inhibitory responding will occur. Overall, competing theories demonstrate how inhibition can develop and relevant to this thesis how these can be applied to anxiety situations.

In order to demonstrate that conditioned inhibition has occurred and the stimulus is a true CI, learning about the CI must be different to that supported by the equivalent stimulus in the CS role. It is widely accepted that there are two tests to measure whether this has occurred, a summation test and a retardation test (Hearst, 1972; Rescorla, 1969), although there are other methods that have also been developed (Hearst, Bottjer, & Walker, 1980; Hearst & Franklin, 1977; Wasserman, Franklin, & Hearst, 1974). A summation test is where a new conditioned excitor is presented with an inhibitor. If it is a true inhibitor then this will inhibit the responding you would expect from the conditioned excitor it is paired with. A retardation test is where a previously trained inhibitor is converted into an excitor by pairing it with a US at the retardation test stage. A true inhibitor would take longer to convert to an excitor than a neutral CS, acquisition is said to be retarded. Ideally, a true conditioned inhibitor would be able to pass both tests as this would then rule out any other alternative explanations based on changes in attention to the stimuli. In a summation test, too much attention may be paid to the CI and in this case it would distract from the accompanying CS. Conversely, in a retardation test too little attention may be paid to the CI because of the prior

training history – non reinforced exposures - and in this case learning about it would be reduced. This relies on attention being a pivotal part of learning in the first instance to discount any other alternative explanation (Rescorla, 1969). Another method of testing for conditioned inhibition has been proposed. The approach-withdrawal methods (Hearst et al., 1980; Hearst & Franklin, 1977; Wasserman et al., 1974) suggests that a subject will approach a CS+ and withdrawal or avoid a CS- indicating conditioned inhibition like behaviour. Although not a widely used test of conditioned inhibition approach-withdrawal does provide a good behavioural measure.

The two test method of testing conditioned inhibition (by both summation and retardation tests) has readily been shown in animals, but harder to document in humans, with some studies reporting conditioned inhibition (typically with a summation test, Hasher et al., 1991; Migo et al., 2006; Neill & Westbury, 1987) and others not (Grings et al., 1974; McNally & Reiss, 1984; Neumann et al., 1997; Wilkinson et al., 1989). Papini & Bitterman (1993) have argued that passing a summation and retardation test is not sufficient to confirm a stimulus as a CI and that previous attempts at this have been methodologically flawed and not controlled for properly; studies have not used the same controls in both the retardation and summation test or not counterbalanced key stimuli correctly. Cole et al., (1997) have demonstrated conditioned inhibition addressing both of these limitations and found both tests were passed demonstrating conditioned inhibition. Ideally both, but minimally at least either retardation or summation, is still agreed on as the best method to show conditioned inhibition. To date, there is limited research that has demonstrated conditioned inhibition confirmed by a retardation test in a human population (one published study, Urcelay et al., 2008 demonstrated conditioned inhibition confirmed by both summation and retardation using backward conditioning).

1.3.3 Safety Signals

There are many existing theories as to how OCD and Panic Disorder develop (see previous OCD and Panic Disorder sections in the Chapter for some

mentioned in more detail): different levels of neurotransmitters, specifically noradrenaline and serotonin (McNally, 1994; Zohar & Insel, 1987); abnormalities in brain regions, the amygdala, limbic structures (Goddard & Charney, 1997; Gorman et al., 2000); psychodynamic theories, which posit that symptoms are an expression of underlying conflict (Kandel, 1999; Rush et al., 1998; Thorn et al., 1999); cognitive theories (Clark, 1986; 1988; 1996; De Silva et al., 1977; McNally, 1994; Reiss, 1991;Wegner et al., 1987) as well as learning-based theories (Bouton, 2001; Feather, 1963; Mowrer, 1947). Specific to this thesis, the two test theory (Mowrer, 1947, 1960) will be examined. The two test theory states that anxiety is a process of two processes. The initial process, where anxiety is learnt, occurs through Pavlovian conditioning experiences; anxiety conditions to a signal. The second process, instrumental responding, avoidance responses are carried out to the anxiety signal which are negatively reinforcing. Gray (1970) developed this theory further and stated that whilst carrying out the avoidance behaviours safety signals are generated which are secondarily rewarding and preserve the avoidance behaviour. The safety signals that are elicited could be argued to be CIs. Indeed it has been shown that anxious individuals demonstrate a greater responding in a CS+/CI- discrimination procedure compared with non-anxious individuals (increased fear to CS+ compared with CS- with an outcome that was aversive) (Orr et al., 2000). This was also demonstrated in a PTSD sample; PTSD individuals demonstrated greater discrimination responding during acquisition (Orr et al., 2000). Although this study did not examine OCD or Panic Disorder these results show that learning and, in particular, discrimination learning of the kind used to establish CI, and shows differences in relation to levels of anxiety.

Conditioned inhibition could be the type of learning phenomena that contributes to the maintenance of OCD and Panic Disorder. Individuals with OCD and Panic Disorder could be using CIs to control and sustain their behaviour. For example, in OCD dirt can become associated with illness or in panic disorder with agoraphobia going out can be associated with catastrophic physical implications: increased heart rate, sweating, and the feeling of dying. Associations have been learnt between these stimuli and it could be that these associations and the subsequent behaviours that occur in OCD and Panic

Disorder elicit safety signals and cause avoidance behaviour (Gray 1987). Safety signals are stimuli that are generated and accompany the behavioural response and provide a reinforcing effect. For example, the smells and sounds associated with the behaviour strengthen the avoidance response.

Avoidance is a behaviour that is carried out to provide relief from the anxiety causing situation, object or thought and as a result of avoidance behaviour safety signals are elicited. Examples of avoidance behaviour in OCD would be washing or checking, and in panic disorder drinking a bottle of water or breathing into a paper bag. Avoidance behaviour itself is persistent and becomes negatively reinforced through the decrease in anxiety and avoidance of perceived punishment. It could also become reinforced by the safety signals generated (secondarily reward, safety signals become negatively reinforced and sustain the avoidance response) (Cándido et al., 1991; Cook et al., 1987; Dinsmoor, 2001).

Safety signals are signals that accompany the avoidance or compulsive behaviour and are elicited as a result of it. For example, people with OCD have an automatic unwanted repugnant thought about e.g. dirt (CS) which causes them to become anxious and believe something bad will happen e.g. illness (US). As a result of this they carry out a compulsion to prevent the bad thing from happening and to decrease their anxiety, this could be washing. Not only has an association formed between the two stimuli and the behaviour, washing, becomes negatively reinforced by the decrease in anxiety but it also elicits safety signals when the behaviour is being carried out. These help to maintain the behaviour. They are signals such as the smell of the soap, touch of the towel, the sound of the water (CI). Safety signals are generated when the avoidance behaviour is carried out and also aid in the reinforcement of the behaviour and maintain the anxiety cycle.

Similarly, in panic disorder, the person would experience physiological anxiety symptoms, increased heart rate, breathing etc. (CS) which they then catastrophically misinterpret and experience thoughts such as having a heart attack or dying (US). In order to prevent this from happening they engage in

safety behaviours such as drinking a bottle of water (CI). At the same time, the behaviour itself generates safety signals, the sound of the water, the bottle's texture, the taste of the water which also helps to alleviate the anxiety and maintain the behaviour. It could be interpreted and argued that these safety signals are conditioned inhibitors and acquire their inhibitory properties via Pavlovian conditioning process (as detailed in the following diagram).

OCD example

CS	+	CI	→	No US (e.g., illness)
Thought		Smell of soap used		Avoidance

Panic Disorder example

CS	+	CI	→	No US (e.g., heart attack, death)
Bodily Symptoms		Water Bottle		Physical symptoms decrease, safety

Based on the evidence reviewed above, it could be hypothesised that individuals with OCD and Panic Disorder, should be better at learning about conditioned inhibitors. Previously in this thesis it was hypothesised that individuals with OCD and Panic Disorder would demonstrate a deficit in response inhibition however in relation to inhibitory learning they would display a facilitated effect[1]. It is not only the safety or avoidance behaviour but also the safety signals that are generated, CIs, that maintains their anxiety cycle. Thus, they should display enhanced levels of learning about these types of associations. This enhanced learning about CIs could be restricted to aversive conditioning with negative outcomes. In general negative stimuli are more readily conditioned, possibly because of evolutionary advantage in avoiding fearful or potentially threatening situations. OCD and Panic Disorder often develop because of high levels of anxiety towards a negative outcome: fear of others, places, objects. Therefore not only would people with OCD and

[1] The formal hypothesises are stated at the end of the experimental sequence section of this chapter.

Panic Disorder demonstrate facilitated inhibitory learning but explicitly for negative outcomes (Lavy et al., 1994).

1.4 Experimental Sequence

The aim of the experiments detailed in this thesis is to examine how a healthy and clinical (those with a recognised anxiety or substance abuse disorder) sample perform on conditioned inhibition tasks tested by (in separate tasks) retardation and summation tests. This performance will be compared with that seen in other inhibitory tasks: Emotional Stroop Task and Go/No-Go Task variants. Performance on the tasks will be correlated with individual differences which will be measured by the Hospital Anxiety and Depression questionnaire (HADS) (Zigmond & Snaith, 1983), Maudsley Obsessive Compulsive Inventory (MOCI) (Hodgson & Rachman, 1977), Behavioural Inhibition System and Behavioural Activation System questionnaire (BIS/BAS) (Carver & White 1994), and the Eysenck Personality Questionnaire Revised Short version (EPQR-S) (Eysenck et al., 1985).

To examine the role of inhibitory learning, specifically conditioned inhibition, two tasks were developed and a previously created task was used (Kantini et al., 2011a; Kantini et al., 2011b; Migo et al., 2006). The first task (Negative Images CI Task: Retardation Test, described in more detail in Chapter 2) tested for conditioned inhibition using a retardation test. IAPS (International Affective Picture System) pictures (Centre for the Study of Emotion and Attention, 1995) were stimuli; these were neutral, positive or negative valenced emotionally significant images and participants were asked to rate them accordingly. There were four distinct phases of each experiment: 1) pre-discrimination (what participants thought before learning); 2) discrimination training (acquisition); 3) retardation (what can be inferred from learning); 4) extinction (to assess the persistence of prior learning at the retardation stage). During each phase participants were asked to rate the stimuli, IAPS images, on a scale of 1-9, and this was be used as a measure of learning. This task was adapted to create the second task (Negative Images CI Task: Summation Test)

of conditioned inhibition which used the summation test method. The third stage of the task, retardation stage, was altered so that inhibition was tested through summation. The previously used task ('Mission to Mars' CI Task: Summation Test, Kantini et al., 2011a; Kantini et al., 2011b; Migo et al., 2006) was a summation test task using neutral stimuli. Participants were required to watch the computer screen for the first part of the task, to learn the discrimination. In the second part they were required to predict based on a sequence of planets and moons whether an intact or exploded rocket will appear. In all of the tasks performance and the relationship with individual differences, as measured by the questionnaires, was examined.

The Emotional Stroop Task (Foa et al., 1993; Lavy et al., 1994; Williams et al., 1996) involves categorising words as quickly as possible based on the colour they are presented in. The task that was used in this thesis included colour congruent words (word colour matches word font) and colour incongruent words (word colour does not match word font); the two categories of stimuli that make up the traditional colour Stroop task. This task also partially replicated (some but not all words were used) the Lavy et al., (1994) study and included negative and OCD words presented in different colours. Participants were being tested on their accuracy and speed to correctly categorise the word-types.

The Go/No-Go Task requires individuals to inhibit a pre-potent Go response to No-Go cues. Three versions of the Go/No-Go task were used. The first task (Go/No-Go Words Task) involved identifying words presented in italics or not. The second task (Go/No-Go Border Images Task) involved identifying images presented in colour with a black border around or not. Finally, the third task (Go/No-Go Colour Images Task) involved identifying images presented in black and white or colour. All tasks required the participants to respond as quickly and as accurately as possible. Participants were told which signal was the Go signal (italics, black border of the colour of the picture) and were asked to press the space bar/'g' key as quickly as possible when the Go signal was presented on the screen. The stimuli used for the word tasks included negative,

positive, OCD and neutral words (the same stimuli that is used in the Emotional Stroop Task). The stimuli used for the images tasks included neutral images and representations of OCD symptoms subtypes: hoarding, symmetry and cleanliness. Participants were being tested on their accuracy and speed to correctly identify the words/images.

The Negative Images CI Task: Retardation Test, 'Mission to Mars' CI task: Summation Test, Emotional Stroop Task, Go/No-Go Words Task and Go/No-Go Border Images task were tested in both the healthy and clinical samples. The Negative Images CI task: Summation Test and Go/No-Go Colour Images Task were tested in a healthy sample only (due to NHS ethical and time constraints). The individual differences questionnaires were administered to all participants, both the healthy and clinical sample.

The first hypothesis was that individuals who self report high levels of anxiety will show differences in inhibitory learning in comparison to a healthy population, especially in avoidance examples, as above. This would not be a learning deficit; in fact it would be enhanced learning of the discrimination. More specifically, participants would learn more readily about inhibitors and it would also be predicted that they would have an emotional reaction to the CS and CI stimuli and this would be reflected in their ratings. It could be argued that opponent processes may be generated (Dickinson & Dearing, 1979; Konorski, 1948, 1967; Solomon & Corbit, 1978). The opponent process theory states that a motivational stimulus activates two opposing processes (Solomon & Corbit, 1974). Initial exposure to a motivational stimulus causes an opposite after reaction however, with repeated exposure this response increases and ultimately causes a change in the motivation to seek the stimulus. An initially positive stimulus may be sought after to avoid the now strong aversive after response. These processes may depend on learning and facilitate habituation and tolerance (Siegel, 1977) and reflect classical conditioning. Opponent processes have been readily demonstrated in humans (namely addiction literature) and 2004; Robinson & Berridge, 2003; Vargas-Perez et al., 2007; Wise, 1996). An example specific to the current study, a CS that was paired

with an IAPS US positive would become positively toned, and the CI for the omission of this positive US would conversely become negatively toned. Similarly, a CI that signals the omission of something negative should become positively toned (how this was addressed and achieved in the design is detailed in the design section in Chapter 2). For the other inhibitory tasks (Emotional Stroop Task, Go/No-Go Words Task, Go/No-Go Border Images Task, Go/No-Go Colour Images Task), a second hypothesis would be that these individuals would show a deficit in response inhibition; individuals would be slower and less accurate to correctly categorise anxiety related words, a pattern of results similar to previously published studies (Foa et al., 1993; Lavy et al., 1994). These differences in inhibition – conditioned inhibition and response inhibition – would show a positive correlation with individual differences measures of anxiety as measured by the HADS, MOCI, BIS/BAS and EPQR-S.

Chapter 2: Developing Procedures to Demonstrate Conditioned Inhibition Using the Retardation Test

2.1 Introduction

It is widely accepted that there are two key tests for conditioned inhibition, the retardation test and the summation test (Hearst, 1972; Rescorla, 1969; Williams et al., 1992; see Papini & Bitterman, 1993; Wasserman et al., 1974, discussed in Chapter 1, for other methods of testing for conditioned inhibition). In a retardation test, a true conditioned inhibitor should take longer to be converted into a conditioned excitor. In a summation test (initially used by Pavlov to demonstrate conditioned inhibition, Pavlov, 1927) a true inhibitor should inhibit responding to a new conditioned excitor (with which it has not previously been paired). It can be argued that to conclusively demonstrate conditioned inhibition ideally both of these tests must be passed to rule out other alternative explanations of the apparent inhibition (Rescorla, 1969). For example, in a summation test too much attention may be paid to the 'CI' at the cost of the accompanying CS, therefore, the 'CI' may distract from the CS and reduce responding to it. In a retardation test the opposite case could be true, attention to the 'CI' may be reduced and therefore learning about the 'CI' is reduced and ultimately retarded. Both of these alternative explanations rely on attention being imperative to learning (some theories of conditioning say learning only occurs if we are paying proper attention to the stimuli, Mackintosh, 1975; Pearce & Hall, 1980) and hence it was proposed that both tests are required to discount attentional explanations (Rescorla, 1969) although others dispute attention being required (Papini & Bitterman, 1993; Williams et al., 1992).

Although the two test strategy for testing conditioned inhibition is widely accepted in animal research (Cole et al., 1997; Murray & Pearce, 2010; Pineno,

2010 (summation only); Rescorla & Holland, 1977; Rodrigo et al., 2009; Urcelay et al., 2008) many studies using human participants have only used a summation test (Grillon & Ameli, 2001; Karazinov & Boakes, 2004; Migo et al., 2006; Neumann et al., 1997) with, to date, only one successful demonstration of backward Pavlovian conditioned inhibition via both summation and retardation in humans (Urcelay et al., 2008).

An additional consideration arises in that previous conditioned inhibition studies have not used stimuli likely to elicit strong emotional responses in the participant. Migo et al., (2006) demonstrated conditioned inhibition via a summation test using a 'Mission to Mars' paradigm; participants were required to watch planets appear on the screen and predict whether an intact or exploded rocket would appear. Karazinov & Boakes (2004) created a food migraine task where participants were required to predict which foods prevented the incidence of a migraine. Participants in both of these studies were motivated to complete the task but the stimuli used by way of US outcomes would not necessarily directly elicit emotionally motivated responses. The IAPS images used in the present studies are an improvement in this regard in that those consistently rated as positive or negative are known to arouse participants, whereas the stimuli categorised as neutral generate no such responses. Thus, the positive and negative IAPS images elicit unconditioned responses and are therefore more suitable stimuli for conditioning.

The main aim of the experiments reported in the present Chapter is to develop a task that uses the retardation test method for demonstrating conditioned inhibition using stimuli that elicit emotional responses from the participant for use on a healthy and clinical sample. It is important to include such stimuli as they will be more sensitive for individuals that suffer from symptoms of anxiety, OCD and panic disorder because these stimuli are particularly salient to these individuals. Their anxieties and subsequent thoughts and behaviours are often triggered by such cues. These will include positive, negative and neutral images rated taken from a large normative sample for levels of pleasure and arousal, the IAPS database, will be used. Due to the nature of the IAPS categories, the positive and negative images will elicit an emotional response in

participants; the neutral ones will not and therefore will be used as filler images. The relationship between performance on the tasks and individual differences will be described in Chapter 5. To date summation tests have more frequently been used in human studies that have investigated conditioned inhibition (Grillon & Ameli, 2001; Grings et al., 1974; Karazinov & Boakes, 2004; Migo et al., 2006, Neumann et al., 1997) with only one study using both summation and retardation (Urcelay et al., 2008). The retardation test presents a particular challenge in that inhibitors are known to generate opponent processes (Dickinson & Dearing, 1979; Konorski, 1948; 1967; Solomon & Corbit, 1978): an emotionally significant stimulus evokes an initial reaction which is followed by an after effect of the opposite valence. Thus, stimuli used as inhibitors in experimental studies start neutral but over time an inhibitor for a negative outcome should acquire positive affect and be perceived as a positively valenced stimulus (Konorski, 1967). For example, conditioned inhibitors provide safety signals for avoidance behaviour. Safety signals stimuli that are generated by the animal's actions, provide feedback/information about the successful execution of the avoidance response and act as reinforcers of this behaviour (Cándido et al., 1991; Cicala & Owen, 1976; Dickinson, 1980; Dinsmoor, 2001; Galvany & Twitty, 1978; Morris 1975).

To investigate conditioned inhibition via a retardation test and with stimuli of different valences a computer task has been developed that is suitable for use on both a healthy and clinical adult population. Using a Pavlovian conditioned inhibition training paradigm (Pavlov, 1927; Rescorla, 1973) the task has four stages: pre-discrimination (CS → US trials), discrimination (CS → US and [CS + CI] → No US trials), transfer/retardation (CS/CI → US, a previously trained CS/CI either congruently or incongruently transferred) and extinction (CS/CI trials). Participants were firstly trained on the discrimination (CS → US and [CS + CI] → No US) and conditioned inhibition was tested by a retardation test method. A true inhibitor would be retarded (require more [CS → US] trials at the retardation test stage) to convert to a CS. Images that have been widely rated for their pleasure and arousal were selected from the IAPS database and at the retardation stage were either congruently or incongruently transferred. Stimuli that were congruently transferred were consistently paired with the

same affective outcome throughout each of the four stages of the task. For example, at the discrimination stage a CI which inhibits a positive outcome becomes negatively toned, therefore if at the 'retardation' stage this CI is paired with a negative outcome this should potentially facilitate subsequent learning; whereas retardation should be more readily demonstrated if the CI is paired with a positive outcome. Alternatively, at the discrimination stage a CI which inhibits a negative outcome becomes positively toned, therefore if at the 'retardation' stage this CI is paired with a positive outcome this should potentially facilitate subsequent learning; whereas retardation should be more readily demonstrated when the CI is paired with a negative outcome. Therefore, stimuli that were incongruently transferred were paired with the opposite affective outcome at the retardation stage. For example, at the discrimination stage a CI which inhibits a negative outcome becomes positively toned, therefore if at the retardation stage this CI is paired with a negative outcome this should more reliably retard subsequent learning. Alternatively, at the discrimination stage a CI which inhibits a positive outcome becomes negatively toned, therefore if at the retardation stage this CI is paired with a positive outcome this should more reliably retard subsequent learning (see Table 2.1).

Table 2.1

Congruent and incongruent transfer, at the transfer/retardation stage the previously trained CI was being presented as a CS

Discrimination	**Transfer/Retardation**	
	Positive	**Negative**
[CS + CI]1 → No US Positive	CI1 → Negative	CI1 → Positive
[CS + CI]2 →No US Negative	CI2 → Positive	CI2 → Negative

There have been procedural changes over the course of five separate experiments which are detailed in the Chapter, conditioned inhibition as measured by a retardation test and the use of affective images are discussed.

2.2 Experiment 1

2.2.1 Methods

2.2.1.1 Participants

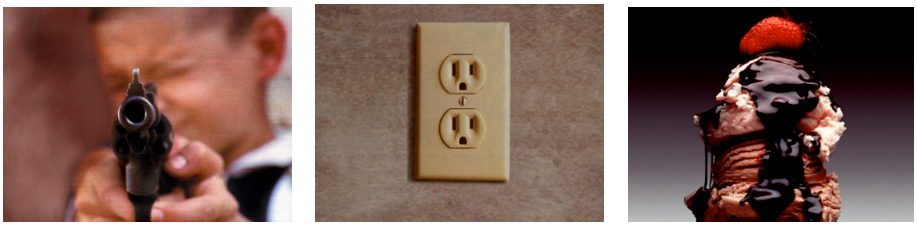
A total of 90 undergraduate participants volunteered to take part in this experiment. There were 43 males and 47 females with a mean age of 20 (range from 19-25). All participants had normal or corrected to normal vision and were naïve to the current task and hypothesis.

2.2.1.2 Apparatus

Thirty colour pictures, 10 neutral, 10 positive, and 10 negative were selected from the IAPS and used as the USs. The pictures were selected based on a sample of people rating these pictures as positive/negative/neutral. Pictures that had any sexual nature were excluded from use as there is a gender bias. Men tend to prefer the more sexually graphic picture whereas most women do not. Examples of the pictures that were used are: ice cream, plug socket, and guns (see Figure 2.1). A teal screen was used to signal the absence of a 'No US'. It could be argued that the 'No US' screen actually represents another salient outcome (teal coloured screen). What represents the absence of an outcome was investigated in a previous study (Migo et al., 2006). The 'No US' was represented by either a background screen or a rocket and participants were asked to rate the stimuli accordingly. There was no difference in the way participants were rating the stimuli and conditioned inhibition (via summation) was demonstrated in both task versions. Therefore, to make the script of the task and also the practicalities of running the task (many participants articulated they thought the programme was at fault when nothing appeared on the screen) plausible it was decided to use the stimuli that are reported in the thesis as representative of the absence of an outcome, 'No US'. Three black and white street scenes were used as the CS. The street scenes were selected as comparatively neutral pictures that were different from the IAPS neutral

pictures. The street scenes consisted of a street, buildings and pavement along the side. Three street furniture (post box, car, and tree) pictures were used as the CI. These were presented in colour, the post box was red, the car was yellow, and the tree was green. They were either photo-shopped into the CS picture or shown disembodied from the CS in the transfer stage. Each CI was consistently paired with the same CS as these pairings were deemed to be the most appropriate in that the CI did not look out of place in the CS. The stimuli used in the current task are qualitatively different from each other, the CS is complex compared to the simpler CI. It has been shown that when trained with complex stimuli although arguably (not specific to this thesis) more ecologically valid but demand more processing. It must also be noted that within-compound associations can potentially form in more complex stimuli (Rescorla & Cunningham, 1978; Rescorla & Durlach, 1981) and this has been demonstrated in [CS + CI] stimuli hence masking conditioned inhibition (Cunningham, 1981) but that cue competition may prevent this from happening (Mackintosh, 1975; Pearce & Hall, 1980; Rescorla & Wagner, 1972). When interpreting the findings from these tasks the type of stimuli used will be considered and reflected in the explanation.

All stimuli were presented on the screen of a personal computer using E-Prime (version 1.1) software. The computer was positioned approximately 0.5m at eye level away from the participant, the keyboard in front and mouse on their right hand side.



Negative US Neutral US Positive US

Street Scene CS Street Scene [CS + CI] Teal 'No US' Screen

Figure 2.1. Examples of the IAPS pictures (US), a street scene (CS) street scene with street furniture [CS + CI] and teal screen ('no US', an image used to signal the absence of a US outcome) used in the current task.

2.2.1.3 Procedure

Table 2.2 details the four stages of the conditioned inhibition task. Congruent and incongruent transfer of the positive and negative IAPS US pictures in the transfer stage will be described below. Both the previously trained CS and CI at the transfer stage were either congruently or incongruently transferred.

Table 2.2

The stages of task version one of the transfer test with conditioned inhibition task broken down by CS and US

Pre-Discrimination		**Discrimination Training**		**Transfer Stage**		**Extinction Test**
CS	**US**	**CS**	**US**	**CS**	**US**	**CS**
CS1	Neutral	CS1	Neutral	CS1	US Negative/Positive	CS1
CS2	Negative	CS2	Negative	CS2	US Negative/Positive	CS2
CS3	Positive	CS3	Positive	CS3	US Negative/Positive	CS3
		[CS1 + CI1]	No US	CI1	US Negative/Positive	CI1
		[CS2 + CI2]	No US	CI2	US Negative/Positive	CI2
		[CS3 + CI3]	No US	CI3	US Negative/Positive	CI3

All instructions were presented on a white background; black text, font Courier New, point size 17, bold positioned in the centre of the screen, and remained until the subject pressed the mouse. Each trial was separated by an inter-trial interval of 250 ms which was a grey screen. The rating scale was from 1-9: nine = positive, five = neutral, one = negative.

Pre-Discrimination

Instructions informed the participant that they would be presented with a series of pictures and that they needed to rate the pictures using the rating scale (1-9) that would appear at the bottom of the screen simultaneously with the pictures. All stimuli were presented on a white screen with the picture aligned in the centre of the screen. A CS would appear on the screen and remain on until the participant had rated it. A US would then appear on the screen and remain on until the participants had rated it. There were 30 CS → US trials, 10 of each US (neutral, positive and negative).

Discrimination Training

Instructions informed the participant that they would be presented with a series of pictures and that they needed to rate the pictures using the rating scale (1-9)

that would appear at the bottom of the screen simultaneously with the pictures. All stimuli were presented on a white screen with the picture aligned in the centre of the screen. A CS or [CS + CI] would appear on the screen and remain on until the participant had rated it. If a CS was presented the corresponding US IAPS picture would appear after, if an inhibited [CS + CI] trial the absence of a US, A 'No US' screen, was presented using a teal coloured screen. The teal coloured screen would remain on the screen until the participants had rated it. There were 15 CS → US trials, five of each CS, and 15 [CS + CI] → No US trials, five of each CI.

Transfer Stage

Instructions informed the participant that they would be presented with a series of pictures and that they needed to rate some of the pictures using the rating scale (1-9) that would appear at the bottom of the screen simultaneously with the pictures. All stimuli were presented on a white screen with the picture aligned in the centre of the screen. A CS or disembodied CI would appear on the grey screen and remain on the screen until the participant had rated it. Participants were required to use the CS or disembodied CI as a cue and predict using the rating scale what would come next. At this stage the CI is now being converted into a CS so therefore both the CS and CI were followed by a US. After participants predicted what would come next a US would appear on the screen for 1000 ms, this would either be congruent transfer or incongruent transfer (explained later in the Chapter). Participants were not required to rate this. There were 30 CS → US trials, five of each CS to congruent transfer, five of each CS to incongruent transfer, and there were 30 CI → US trials, five of each CI to congruent transfer, five of each CI to incongruent transfer.

Extinction Stage

Instructions informed the participant that they would be presented with a series of pictures and that they needed to rate the pictures using the rating scale (1-9) that would appear at the bottom of the screen simultaneously with the pictures.

All trials were on a white screen with the picture aligned in the centre of the screen. A CS or disembodied CI would appear on the screen and remain on the screen until the participant had rated it. Participants were required to use the CS or disembodied CI as a cue and predict using the rating scale what would come next. No US was presented at this stage. There were 30 CS presentations, five of each CS that was congruently transferred, five of each CS that was incongruently transferred, and there were 30 CI trials, five of each CI that was congruently transferred, five of each CI that was incongruently transferred.

2.2.1.4 Congruent/Incongruent Transfer

Congruent or incongruent transfer refers to which US (positive or negative) the CS or CI is paired with at the transfer stage. At the discrimination training stage (detailed in Table 2.3) the [CS + CI] is paired with 'No US' and the CS is paired with a positive or negative US. Participants could have an emotional response to the CI as it signals the absence of something. For example, CS1 → US Positive, [CS1 + CI] → 'No US', when the CI is presented alone at the transfer stage participants could rate it as negative as it previously signalled the absence of something positive. Therefore if the CI was congruently transferred, taking the emotional response that may occur into account, it would continue to be paired with the same outcome at both the discrimination stage and the transfer stage. If the CS was incongruently transferred it would, at the transfer stage, be paired with the other outcome. For the current design whichever type of transfer the CS received the CI received the opposite (see Table 2.3).

Table 2.3

Examples of congruent and incongruent transfer at the transfer stage

Discrimination	**Transfer Stage**	
	Congruent	**Incongruent**
[CS1 + CI1] → No US	CI1 → Negative	CI1 → Positive
CS1 → Positive	CS1 → Positive	CS1 → Negative
[CS2 + CI2] → No US	CI2 → Positive	CI2 → Negative
CS2 → Negative	CS2 → Negative	CS21 → Positive

The design of the task meant that participants either received congruent transfer or incongruent transfer, therefore, half received congruent and half received incongruent. Programmes were counterbalanced for valence and type of transfer between the CS and CI. Overall there were six different programmes that were delivered in a counterbalanced way to the participants. The whole computer task takes approximately 25 minutes to complete.

2.2.1.5 Design

All data were analysed using SPSS (version 15.0) and used an alpha of $p = .05$ and paired samples t-tests used a 95% confidence interval. Data were analysed for the pre-discrimination, transfer and extinction stages. Due to a technical error the data for the discrimination stage was not recorded. Both congruent and incongruent transfer was analysed. The neutral stimuli were not analysed as they were only filler trials to distract the participants from the learning task.

Pre-Discrimination

The data were entered into a 2 x 5 within subjects ANOVA with factors valence (positive and negative) and trials (1-5). Both the CS and US ratings were analysed.

Transfer and Extinction Stage

Data were analysed separately for congruent and incongruent transfer. The data (transfer ratings) were entered into a 2 x 2 x 5 within subjects ANOVA with factors inhibition (CS all and CI all), valence (positive and negative) and trials (transfer stage) or presentation (extinction stage) (1-5). Only the transfer ratings for the CS and CI were analysed.

2.2.2 Results

Due to the design of the experiment CS rating results are only meaningful if there is a significant main effect on valence at the pre-discrimination stage, and interaction between valence and inhibition at the transfer stage or extinction stage. Therefore results are only presented graphically if significant by these effects/interactions and thus meaningful. The US stimuli are designed to be unpleasant: US ratings were analysed by valence to confirm whether this was indeed the case for the participants of the study. Below is a summary table of the overall pattern of results for experiment 1 (see Table 2.4).

Table 2.4

Key main effects and interactions from the Negative Images CI Task: Retardation Test experiment 1

	Valence	**Valence x Inhibition**	**Valence x Inhibition x Trials**
Pre-Discrimination CS	Not significant	-	-
Pre-Discrimination US	Significant	-	-
Transfer Stage Congruent	-	Not significant	Not significant
Transfer Stage Incongruent	-	Not significant	Not significant
Extinction Stage Congruent	-	Not significant	Not significant
Extinction Stage Incongruent	-	Not significant	Not significant

2.2.2.1 Pre-Discrimination

CS ratings

There were no significant main effects or interactions, maximum $F(1,89) = 1.775$, $p = .238$, $\eta^2 = .016$ for the main effect of valence.

US ratings

There was a significant main effect of valence, $F(1,89) = 1054.618$, $p = .001$, $\eta^2 = .922$. The positive IAPS US pictures were rated higher than the negative IAPS US pictures (see Figure 2.2). This result demonstrates that the participants were rating the US IAPS stimuli as they were designed to be rated.

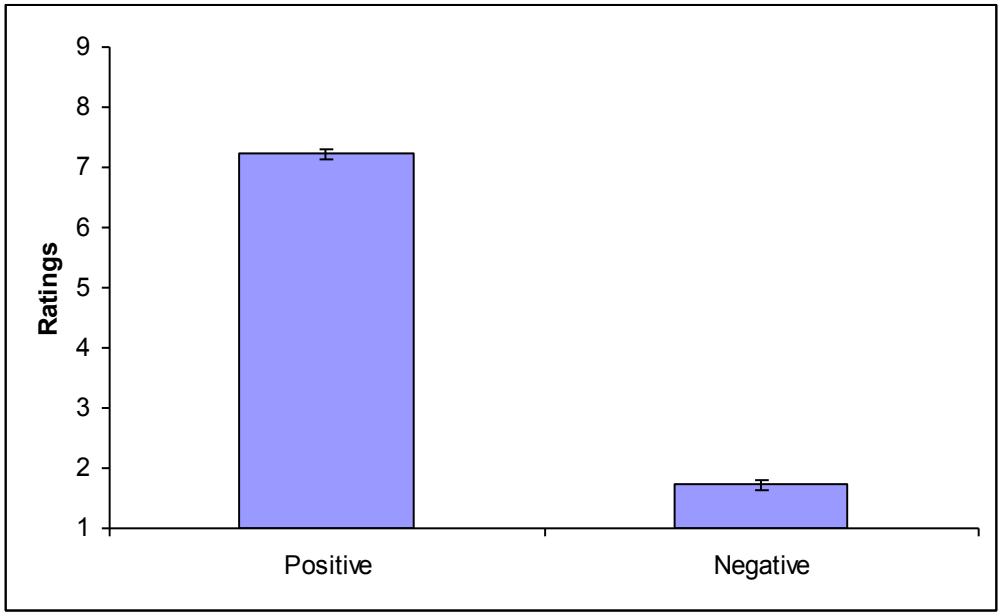


Figure 2.2. The main effect of valence for the IAPS US pictures at the pre-discrimination stage of the conditioned inhibition task. Error bars represent S.E.M.

There were no other significant main effects or interactions, maximum $F(4,356) = .392$, $p = .814$, $\eta^2 = .004$ for the main effect of trials.

2.2.2.2 Transfer Stage

Both the previously trained CS and CI were either congruently or incongruently transferred at this stage. Congruent transfer means that the stimuli were continuously trained with the same outcome; incongruent transfer means that they were trained with different outcomes. At this stage if participants received congruent transfer for the CI stimuli they received incongruent transfer for the CS stimuli. If participants received incongruent transfer for the CI stimuli they received congruent transfer for the CS stimuli. Therefore half of the participants received congruent transfer and half received incongruent transfer. Results are only meaningful at this stage if there is an interaction between valence and inhibition therefore they are only represented graphically if this is true.

Congruent transfer for the CI stimuli

CS and CI ratings

There was no significant interaction between inhibition and valence, $F(1,44) = 1.071$, $p = .306$, $\eta^2 = .024$. There was a significant main effect of inhibition, $F(1,44) = 20.294$, $p = .001$, $\eta^2 = .316$. The CS stimuli were being rated lower (*M* 4.258, *SD* .153) than the CI stimuli (*M* 5.062, *SD* .130). There was a significant main effect of valence, $F(1,44) = 42.308$, $p = .001$, $\eta^2 = .490$. The CS and CI stimuli associated with the positive IAPS US pictures were rated lower (*M* 3.904, *SD* .155) than the CS and CI stimuli associated with the negative IAPS US pictures (*M* 5.416, *SD* .165). There was a significant interaction between valence and trials, $F(4,176) = 13.648$, $p = .001$, $\eta^2 = .237$. Over the five trials the CS and CI stimuli associated with the positive IAPS US pictures were rated progressively lower (trial 1 = *M* 5.078, *SD* .176, trial 5 = *M* 3.022, *SD* .269) than the CS and CI stimuli associated with the negative IAPS US pictures (trial 1 = *M* 4.889, *SD* .183, trial 5 = *M* 5.878, *SD* .298). There were no other significant main effects or interactions, maximum $F(4,176) =$

2.023, p = .093, η^2 = .044 for the interaction between inhibition, valence and trials.

Incongruent transfer for the CI stimuli

CS and CI ratings

There was no significant interaction between inhibition and valence, $F(1,44)$ = .038, p = .845, η^2 = .001. There was a significant main effect of valence, $F(1,44)$ = 37.030, p = .001, η^2 = .457. The CS and CI stimuli associated with the positive IAPS US pictures were rated higher (*M* 5.749, *SD* .159) than the CS and CI stimuli associated with the negative IAPS US pictures (*M* 3.947, *SD* .182). There was a significant interaction between valence and trials, $F(4,176)$ = 13.778, p = .001, η^2 = .238. Over the five trials both the CS and CI stimuli associated with the positive and negative IAPS US pictures were being rated differently (Positive, trial 1 = *M* 4.922, *SD* .155, trial 5 = *M* 6.178, *SD* .272, Negative, trial 1 = *M* 4.844, *SD* .186, trial 5 = *M* 3.567, *SD* .343). There were no other significant main effects or interactions, maximum $F(4,176)$ = .902, p = .464, η^2 = .020 for the main effect of trials.

2.2.2.3 Extinction Stage

Congruent transfer for the CI stimuli

CS and CI ratings

There was no significant interaction between inhibition and valence, $F(1,44)$ = .556, p = .460, η^2 = .012. There was a significant main effect of inhibition, $F(1,44)$ = 5.636, p = .022, η^2 = .114. The CS stimuli were rated lower (*M* 4.320, *SD* .159) than the CI stimuli (*M* 4.980, *SD* .198). There was a significant main effect of valence, $F(1,44)$ = 31.850, p = .001, η^2 = .420. The CS and CI stimuli associated with the positive IAPS US pictures were rated lower (*M* 3.524, *SD* .215) than the CS and CI stimuli associated with the negative IAPS

US pictures (*M* 5.776, *SD* .243). There were no other significant main effects or interactions, maximum $F(4,176) = 1.750$, $p = .141$, $\eta^2 = .038$ for the main effect of presentations.

Incongruent transfer for the CI stimuli

CS and CI ratings

There was no significant interaction between inhibition and valence, $F(1,44) = 2.444$, $p = .125$, $\eta^2 = .053$. There was a significant main effect of valence, $F(1,44) = 35.028$, $p = .001$, $\eta^2 = .443$. The CS and CI stimuli associated with the positive IAPS US pictures were rated higher (*M* 5.877, *SD* .225) than the CS and CI stimuli associated with the negative IAPS US pictures (*M* 3.498, *SD* .215). There were no other significant main effects or interactions, maximum $F(1,44) = 3.450$, $p = .070$, $\eta^2 = .073$ for the main effect of inhibition.

2.2.3 Discussion

The results of Experiment 1 failed to demonstrate conditioned inhibition. At the transfer stage of the task, there was no significant interaction between valence and trials. This shows that the participants were not rating the CS (positive or negative, previously trained as a CS but now either congruently or incongruently transferred) or the CI (positive or negative, a previously trained CI now being presented as a CS, congruently or incongruently transferred) differently. This was the case for both congruent and incongruent transfer. Due to a technical error the data from the discrimination stage was not captured and therefore it cannot be determined whether the participants even learnt the discrimination between the CS only and the inhibited [CS + CI] trials. If this discrimination was not learned then no differences would be expected at the transfer stage. Participants must learn the discrimination between the CS and [CS + CI] in order for a transfer test to be passed and demonstrate conditioned inhibition.

One possible explanation for the lack of conditioned inhibition in Experiment 1 is that the pairings between the CS → US and [CS + CI] → 'No US' were not distinct and participants were not relating the two together. The task was quite long (it took 40 minutes to complete) and demanding for the participant requiring them to learn about many different stimuli (two stimuli, CS and [CS + CI] each with three valences, positive, negative and neutral). So the aim of the next task version is to reduce the load on the participant and make the stimuli pairings more distinct. Therefore, in the next task version the design has been modified to present more trials, but at a longer inter-trial interval (ITI). To reduce interference, a different colour screen was used during the inter-stimulus interval (ISI) (previously both the ITI and ISI screens were the same colour). These changes were intended to improve the likelihood of participants forming associations between the CS and US. In addition, the data from the discrimination stage will, in future, be recorded and analysed to identify whether participants are learning the discrimination between the CS → US and [CS + CI] → 'No US' trial types. Thus, the aim of the next experiment is to establish a successful discrimination stage and demonstrate conditioned inhibition, as tested using a transfer test method.

2.3 Experiment 2

2.3.1 Methods

2.3.1.1 Participants

A total of 24 undergraduate and general population participants volunteered to take part in this experiment. There were nine males and 15 females with a mean age of 28 (range from 19-54). All participants had normal or corrected to normal vision and were naïve to the current task and hypothesis.

2.3.1.2 Apparatus

The teal 'No US' screen was changed to an off white 'No US' screen with a black border (see Figure 2.3). Participants had reported that they liked the teal colour and had rated it as positive so the 'No US' was changed to off white 'No US' screen with a black border to encourage the participants to rate it as neutral and the absence of anything positive or negative. The other stimuli were the same as in the previous experiment.

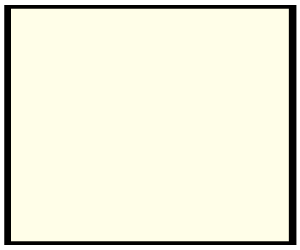


Figure 2.3. The off white 'No US' screen.

2.3.1.3 Procedure

The procedure was the same as the previous experiment with a few minor adjustments. The inter-trial interval was increased from 250 ms to 1000 ms and the inter-stimulus interval was changed to grey between each trial and white between each pairing.

Pre-Discrimination

The number of CS → US trials was increased from five to 10.

Discrimination

The ratio of CS → US and [CS + CI] → US was increased from 1:1 to 2:3. Instructions were changed at this stage so that the participant used the CS or [CS + CI] as a cue and to guess what would come next. The CS or [CS + CI]

would be followed by a US or 'No US' screen which the participants were required to rate.

Transfer/Extinction

Instructions were changed to say 'guess' and not 'predict' because participants reported that they were confused by what was meant by predict as they felt unable to predict with certainty anything at this stage so it was decided that the word guess would be more appropriate.

Overall there were two different programmes, one for congruent transfer and on for incongruent transfer. The programmes were counterbalanced for valence and type of transfer between the CS and CI. Overall there were six different programmes that were delivered in a counterbalanced way to the participants. The whole computer task took approximately 25 minutes to complete.

2.3.1.4 Design

All data were analysed using SPSS (version 15.0) and used an alpha of $p = .05$. Data were analysed for the pre-discrimination, discrimination, transfer and extinction stages. Both congruent and incongruent transfer were analysed. The neutral stimuli were not analysed as they were only filler trials to distract the participants from the learning task. The design was the same as the previous experiment with a few minor adjustments which are detailed below.

Pre-Discrimination

Due to the increase in the number of trials the data were entered into a 2 x 10 (previously a 2 x 5) within subjects ANOVA with factors valence (positive and negative) and trials (1-10). Both the CS and US ratings were analysed.

Discrimination

Data from this stage has previously not been recorded so, for the CS and [CS + CI] ratings the data were entered into a 2 x 2 x 8 within subjects ANOVA with factors inhibition (CS and [CS + CI]), valence (positive and negative) and trials (1-8). During this stage there was an uneven number of CS and [CS + CI] trials. There were eight CS trials and 12 [CS + CI] trials. Therefore for comparison by ANOVA the last 8 [CS + CI] trials would be used to compare against the CS trials.

For the US ratings the data was entered into a 3 x 8 within subjects ANOVA with factors valence (positive, negative and 'No US') and trials (1-8). As above, 12 trials of [CS + CI] → US were run but only the last eight trials of the 'No US' screen ratings were entered so a comparison by ANOVA could be made.

Transfer and Extinction Stage

Data were analysed separately for congruent and incongruent transfer. The data (transfer ratings) were entered into a 2 x 2 x 5 within subjects ANOVA with factors inhibition (CS and CI), valence (positive and negative) and trials (transfer stage) or presentation (extinction stage) (1-5). Only the CS and CI transfer ratings were analysed.

2.3.2 Results

Due to the design of the experiment ratings are only meaningful if they are significant by certain factors (see page 35). Therefore, results are only presented graphically if significant by these effects/interactions and thus meaningful. Below is a summary table of the overall pattern of results for Experiment 2 (see Table 2.5).

Table 2.5

Key main effects and interactions from the Negative Images CI Task: Retardation Test experiment 2

	Valence	**Valence x Inhibition**	**Valence x Inhibition x Trials**
Pre-Discrimination CS	Not significant	-	-
Pre-Discrimination US	Significant	-	-
Discrimination Training CS	-	Not significant	-
Discrimination Training US	Significant	-	-
Transfer Stage Congruent	-	Not significant	Not significant
Transfer Stage Incongruent	-	Not significant	Not significant
Extinction Stage Congruent	-	Not significant	Not significant
Extinction Stage Incongruent	-	Not significant	Not significant

2.3.2.1 Pre-Discrimination

CS ratings

There were no significant main effects or interactions, maximum $F(1,23) = 2.741$, $p = .111$, $\eta^2 = .106$ for the main effect of valence.

US ratings

There was a significant main effect of valence, $F(1,23) = 411.213$, $p = .001$, $\eta^2 = .947$. The US IAPS positive pictures were rated higher than the US IAPS negative pictures (see Figure 2.4).

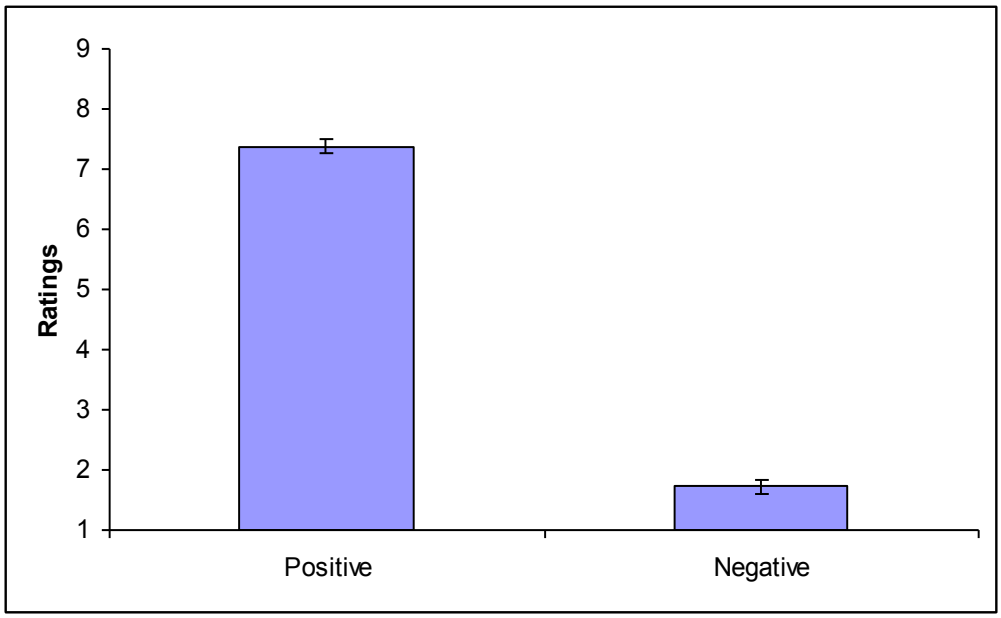


Figure 2.4. The main effect of valence of the US ratings at the pre-discrimination stage of the conditioned inhibition task. Error bars represent S.E.M.

There were no other significant main effects or interactions, maximum $F(9,207) = 1.374$, $p = .201$, $\eta^2 = .056$ for the interaction between valence and trials.

2.3.2.2 Discrimination Stage

CS and [CS + CI] ratings

There was no significant interaction between inhibition and valence, $F(1,23) = .398$, $p = .534$, $\eta^2 = .017$. As there was no significant interaction between inhibition and valence therefore the discrimination between the CS and [CS + CI] was not learnt. There was a significant main effect of inhibition, $F(1,23) = 5.284$, $p = .031$, $\eta^2 = .187$. The CS stimuli were rated higher (*M* 5.482, *SD* .142) than the [CS + CI] stimuli (*M* 5.219, *SD* .156). There were no other significant main effects or interactions, maximum $F(1,23) = 2.112$, $p = .160$, $\eta^2 = .084$ for the main effect of valence.

US ratings

There was a significant main effect of valence, $F(2,46) = 464.143$, $p = .001$, $\eta^2 = .953$. The positive IAPS US pictures were rated higher than the off white 'No US' screen and the negative IAPS US pictures (see Figure 2.5). There were no other significant main effects or interactions, maximum $F(7,161) = .758$, $p = .623$, $\eta^2 = .032$ for the main effect of trials.

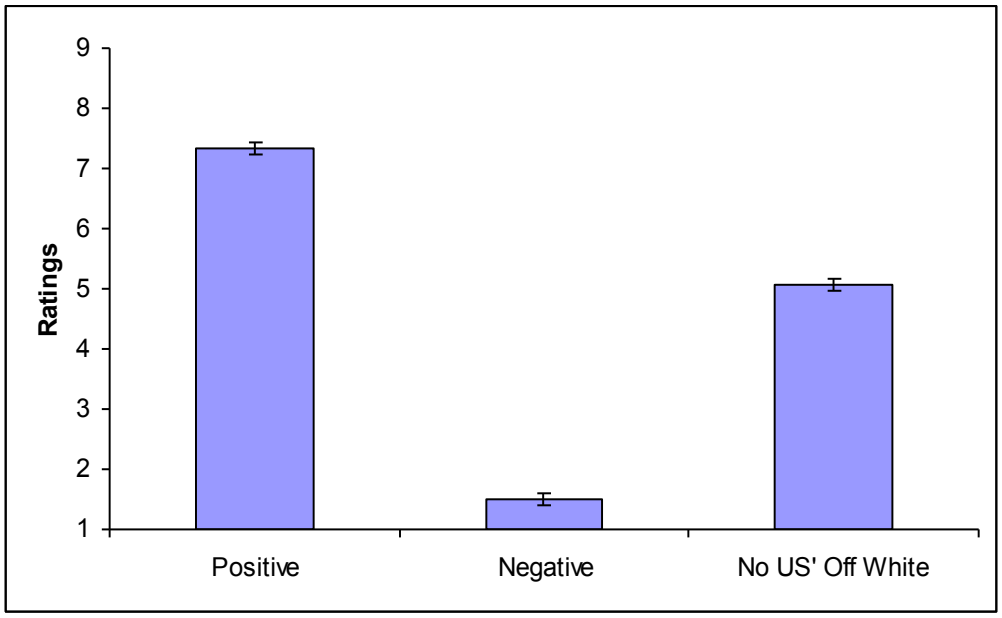


Figure 2.5. The main effect of valence of the US ratings at the discrimination stage of the conditioned inhibition task. Error bars represent S.E.M.

2.3.2.3 Transfer Stage

At this stage both the previously trained CS and CI were either congruently or incongruently transferred. Therefore, half of the participants received congruent transfer and half of the participants received incongruent transfer.

Congruent transfer for the CI

CS and CI ratings

There was no significant interaction between inhibition and valence, $F(1,11) = .840$, $p = .379$, $\eta^2 = .071$. There were no significant main effects or interactions, maximum $F(1,11) = 1.656$, $p = .225$, $\eta^2 = .131$ for the main effect of valence.

Incongruent transfer for the CI

CS and CI ratings

There was no significant interaction between inhibition and valence, $F(1,11) = .308$, $p = .590$, $\eta^2 = .027$. There was a significant main effect of valence, $F(1,11) = 6.857$, $p = .024$, $\eta^2 = .384$. The CS and CI stimuli associated with a positive IAPS US were rated higher (*M* 5.6, *SD* .287) than a CS and CI stimuli associated with a negative IAPS US (*M* 4.183, *SD* .362). There was a significant interaction between valence and trials, $F(4,44) = 3.890$, $p = .009$, $\eta^2 = .261$. The CS and CI stimuli associated with a positive IAPS US were progressively rated higher (trial 1 = *M* 5.167, *SD* .376, trial 5 = *M* 5.833, *SD* .391) than the CS and CI stimuli associated with a negative IAPS US (trial 1 = *M* 4.917, *SD* .443, trial 5 = *M* 3.417, *SD* .503). There were no other significant main effects or interactions, maximum $F(4,44) = 1.552$, $p = .204$, $\eta^2 = .124$ for the interaction between inhibition, valence and trials.

2.3.2.4 Extinction Stage

Congruent transfer for the CI

CS and CI ratings

There was no significant interaction between inhibition and valence, $F(1,11) = 1.449$, $p = .254$, $\eta^2 = .116$. There were no other significant main effects or interactions, maximum $F(1,11) = 3.303$, $p = .096$, $\eta^2 = .231$ for the main effect of valence.

Incongruent transfer for the CI

CS and CI ratings

There was no significant interaction between inhibition and valence, $F(1,11) = .171$, $p = .687$, $\eta^2 = .015$. There was a significant main effect of valence, $F(1,11) = 7.623$, $p = .019$, $\eta^2 = .409$. The CS and CI stimuli that were associated in previous training with a positive IAPS US were rated higher (*M* 5.65, *SD* .246) than a CS and CI stimuli that were associated in previous training with a negative IAPS US (*M* 3.975, *SD* .456). There were no other significant main effects or interactions, maximum $F(4,44) = 2.097$, $p = .097$, $\eta^2 = .160$ for the interaction between inhibition, valence and presentations.

2.3.3 Discussion

Counter to expectation, the results of Experiment 2 did not demonstrate conditioned inhibition. At the transfer stage of the task there was not a significant interaction between valence and trials. This despite the various improvements made to the task, demonstrating that participants were not rating the CS (previously trained as a CS but now either congruently or incongruently transferred) positive and negative stimuli and CI (previously trained CI now being presented as a CS) positive and negative stimuli differently. This was the

case for both congruent and incongruent transfer. A major improvement to the task was to ensure that the discrimination data was captured and analysed. This provided information as to whether participants initially learnt the discrimination between the CS and [CS + CI] trials. The results of Experiment 2 showed that this discrimination was not in fact significant. In other words, participants were not rating stimuli on the CS and [CS + CI] trials differently at the discrimination stage. On this basis, it is not surprising that participants did not demonstrate conditioned inhibition.

The task was still lengthy and demanding on participants with many stimuli and comparisons to learn about: in total, the experiment took 40 minutes to complete; a number of participants complained about the length of time and asked why they had to repeatedly rate the same image over and over. There were three valences to learn about over the four stages of the task pre-discrimination, discrimination (both CS and [CS + CI] for all valences, and congruent and incongruent transfer for both the CS and previously trained CI now presented as a CS at the transfer stage, and finally the extinction stage. As one of the key elements of the task is to establish whether the stimuli in use elicit an emotional response from participants, a future modification will be to eliminate the neutral stimuli from the task so that participants' learning will be focused on the emotionally salient IAPS US outcomes. This modification to the task makes the overall time to complete shorter and the discrimination learning more focused for the participant.

As mentioned previously, the retardation test involves taking a previously trained CI and converting it into a CS. The rate of learning is then compared to that supported by a novel CS. To date, the task versions used in the present thesis have not followed the conventional retardation test method, at the transfer stage the comparisons have been between a previously trained CI now presented as a CS (following a conventional retardation test method) and a previously trained CS still being presented at the transfer stage as a CS but either congruently or incongruently transferred – in separate task designs (not following conventional retardation test method). In the next task version the transfer stage will be modified into a traditional retardation test, at the transfer

stage the previously trained CSs will be replaced with two novel CSs to compare learning with the previously trained CIs now presented as CSs. This change, coupled with the removal of the neutral stimuli, will encourage discrimination learning and ultimately conditioned inhibition via the retardation test method.

In conclusion the next task version will not include any neutral valence stimuli (the valence is determined by the IAPS ratings), only positive and negative stimuli to investigate the emotional responses to stimuli and two novel CSs will be introduced to produce a conventional retardation test stage.

2.4 Experiment 3

2.4.1 Methods

2.4.1.1 Participants

A total of 24 undergraduate and general population participants volunteered to take part in this experiment. There were 10 males and 14 females with a mean age of 27 (range from 21 - 48). All participants had normal or corrected to normal vision and were naïve to the current task and hypothesis.

2.4.1.2 Apparatus

The stimuli were the same as in previous experiments. The neutral IAPS pictures were removed from the task. Two novel CSs were introduced at the retardation stage. They were two street scene pictures (see Figure 2.6).


Figure 2.6. Novel CS pictures introduced at the retardation stage.

2.4.1.3 Procedure

The procedure was the same as the previous experiment with a few minor adjustments. The design for this task is as below (positive and negative are used as examples in the Table below (see Table 2.6) all task programmes were counterbalanced for valence and congruent/incongruent transfer).

Table 2.6

The stages of the third task version of the retardation test with conditioned inhibition task broken down by CS and US

Pre-Discrimination		**Discrimination Training**		**Retardation Test**		**Extinction Test**
CS	**US**	**CS**	**US**	**CS**	**US**	**CS**
CS1	Negative	CS1	Negative	CS3	US Negative/Positive	CS3
CS2	Positive	CS2	Positive	CS4	US Negative/Positive	CS4
		[CS1 + CI1]	No US	CI1	US Negative/Positive	CI1
		[CS2 + CI2]	No US	CI2	US Negative/Positive	CI2

Pre-Discrimination

Neutral stimuli were removed. No other adjustments were made at this stage to the procedure.

Discrimination

Neutral stimuli were removed. No other adjustments were made at this stage to the procedure.

Retardation

Neutral stimuli were removed. Two novel CS pictures were introduced at this stage for a conventional retardation test. One CS was paired with US positive and one CS was paired with US negative. The CS pictures that were previously trained with were not tested at this stage. The disembodied CI pictures continued to be tested at this stage.

Extinction

Neutral stimuli were removed. Two novel CS pictures were introduced at this stage. The CS pictures that were previously trained with were not tested at this stage. The disembodied CI pictures continued to be tested at this stage.

Overall there were two different programmes, one for congruent transfer and on for incongruent transfer. The programmes were counterbalanced for valence and type of transfer between the CS and CI. Overall there were 8 different programmes that were delivered in a counterbalanced way to the participants. The whole computer task took approximately 20 minutes to complete.

2.4.1.4 Design

All data were analysed using SPSS (version 15.0) and used an alpha of $p = .05$ and paired samples t-tests used a 95% confidence interval. Data were analysed for the pre -discrimination, discrimination, transfer and extinction stages. Both congruent and incongruent transfer was analysed. The design was the same as the previous experiment with a few minor adjustments.

Pre-Discrimination

The data were entered into a 2 x 10 within subjects ANOVA with factors valence (positive and negative) and trials (1-10). Both the CS and US ratings were analysed.

Discrimination

The CS and US data were analysed in the same format as the previous task design.

Retardation and Extinction Stage

Data were analysed separately for congruent and incongruent transfer. The data were entered into a 2 x 2 x 5 within subjects ANOVA with factors inhibition (CS and CI), valence (positive and negative) and trials (retardation stage) or presentation (extinction stages) (1-5). Only the CS ratings were analysed.

2.4.2 Results

Due to the design of the experiment ratings are only meaningful if they are significant by certain factors (see page 35). In addition to this because the transfer stage was converted into a conventional retardation test results at the retardation test stage are meaningful if there is a significant interaction between inhibition, valence and trials/blocks. Therefore, results are only presented graphically if significant by these effects/interactions and thus meaningful. Over the page is a summary table of the overall pattern of results for Experiment 3 (see Table 2.7)

Table 2.7

Key main effects and interactions from the Negative Images CI Task: Retardation Test experiment 3

	Valence	Valence x Inhibition	Valence x Inhibition x Trials
Pre-Discrimination CS	Not significant	-	-
Pre-Discrimination US	Significant	-	-
Discrimination Training CS	-	Not significant	-
Discrimination Training US	Significant	-	-
Retardation Stage Congruent	-	Not significant	Not significant
Retardation Stage Incongruent	-	Not significant	Not significant
Extinction Stage Congruent	-	Not significant	Not significant
Extinction Stage Incongruent	-	Not significant	Not significant

2.4.2.1 Pre-Discrimination

CS ratings

There were no significant main effects or interactions, maximum $F(1,23) = 2.566$, $p = .123$, $\eta^2 = .100$ for the main effect of valence.

US ratings

There was a significant main effect of valence, $F(1,23) = 288.895$, $p = .001$, $\eta^2 = .926$. The positive IAPS US pictures were rated higher than the negative IAPS US pictures (see Figure 2.7).

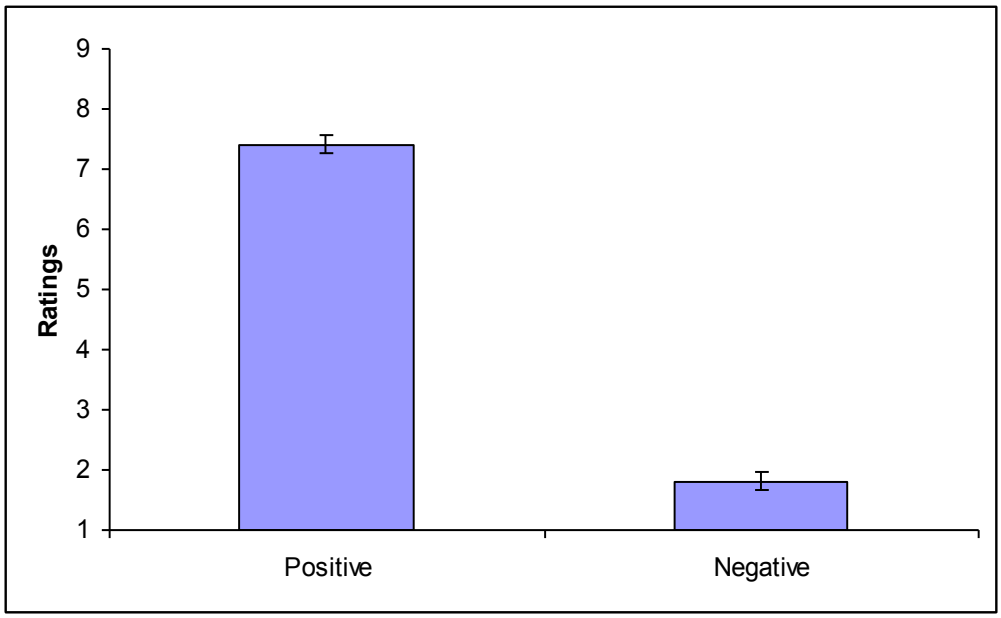


Figure 2.7. The main effect of valence of the US ratings at the pre-discrimination stage of the conditioned inhibition task. Error bars represent S.E.M.

There were no other significant main effects or interactions, maximum $F(9,207) = 1.492$, $p = .153$, $\eta^2 = .061$ for the interaction between valence and trials.

2.4.2.2 Discrimination Stage

CS and [CS + CI] ratings

There was a significant interaction between inhibition and valence, $F(1,23) = 8.265$, $p = .009$, $\eta^2 = .264$. The CS and [CS + CI] stimuli associated with both the positive and negative IAPS US were being rated differently (see Figure 2.8).

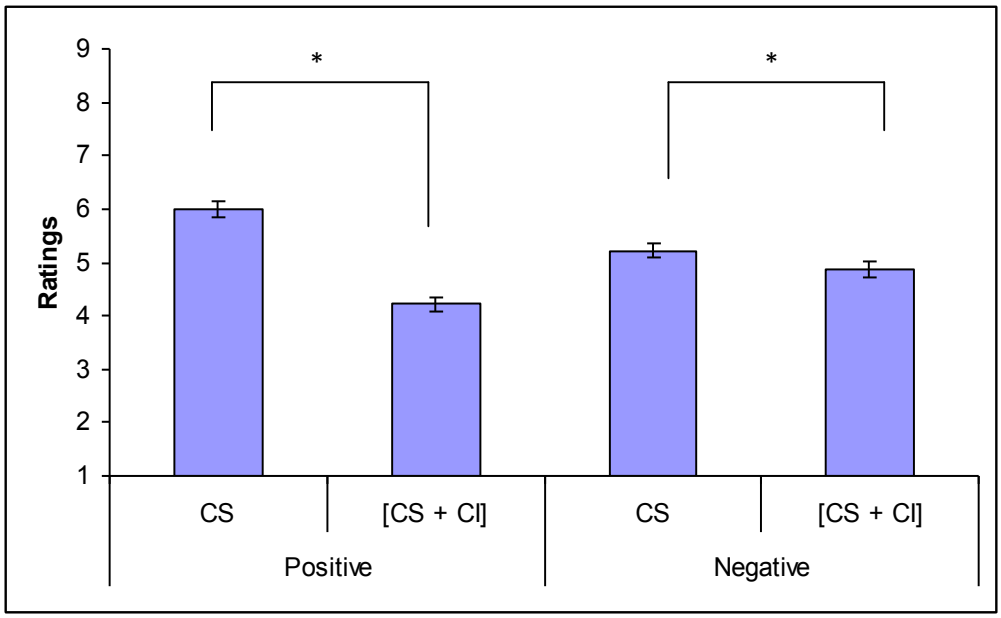


Figure 2.8. The interaction between inhibition and valence at the discrimination stage of the conditioned inhibition task. The CS was associated with either a positive or negative IAPS US. The [CS + CI] was associated with an off white 'No US' screen however has been classified as positive or negative according to what the CS is associated with. Error bars represent S.E.M. * = t-test significant at $p = .05$.

Paired samples t-tests were carried out to analyse the interaction. There was a significant difference between the means of the CS positive and [CS + CI] positive, $t(23) = 2.916$, $p = .016$. There was a significant difference between the means of the CS negative and [CS + CI] negative $t(23) = -2.336$, $p = .034$. There was a significant main effect of valence, $F(1,23) = 18.762$, $p = .001$, $\eta^2 = .449$. The data were collapsed across both types of stimuli: CS → Positive US and [CS + CI] → 'No US'. Although the [CS + CI] was associated with the absence of an outcome the CS used in the pairing was presented alone with a positive US and therefore when the data is collapsed it collapsed across these two different types of stimuli (CS and [CS + CI]). The CS stimuli associated with a positive IAPS US were rated higher (*M* 5.602, *SD* .163) than the CS stimuli associated with a negative IAPS US (*M* 4.542, *SD* .173). There was a significant interaction between inhibition, valence and trials, $F(7,161) = 3.455$, $p = .002$, $\eta^2 = .131$. Although there were non-systematic fluctuations generally the CS and [CS + CI] stimuli associated with the positive IAPS US pictures

were progressively rated as higher (nicer) than the CS and [CS + CI] stimuli associated with the negative IAPS US pictures (see Table 2.8).

Table 2.8

The interaction between inhibition, valence and trials at the discrimination stage of the conditioned inhibition task

Stimuli	Valence	Trial	Mean	S.E.M
CS	**Positive**	**1**	4.667	.453
		5	5.667	.428
	Negative	**1**	4.750	.435
		5	3.958	.487
[CS + CI]	**Positive**	**1**	5.750	.235
		5	5.333	.231
	Negative	**1**	4.750	.296
		5	4.458	.307

There were no other significant main effects or interactions, maximum $F(7,161) = 1.992$, $p = .059$, $\eta^2 = .080$ for the interaction between inhibition and trials.

US ratings

There was a significant main effect of valence, $F(2,46) = 158.647$, $p = .001$, $\eta^2 = .873$. The positive IAPS US pictures were rated higher than the off white 'No US' screen and the negative IAPS US pictures (see Figure 2.9).

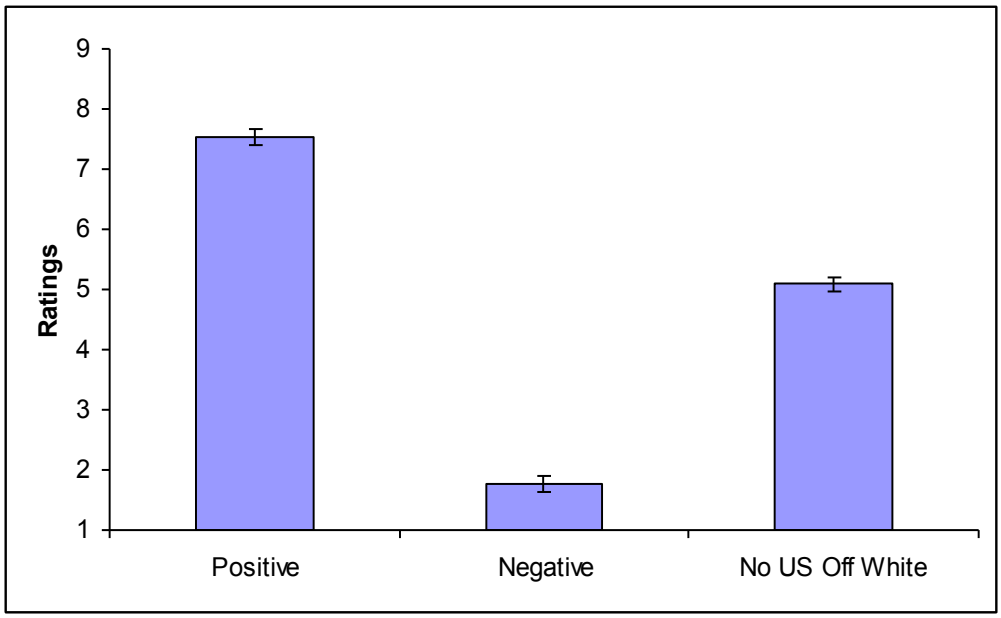


Figure 2.9. The main effect of valence of the US ratings at the discrimination stage of the conditioned inhibition task. Error bars represent S.E.M.

There were no other significant main effects or interactions, maximum $F(7,161) = 1.030$, $p = .677$, $\eta^2 = .029$ for the main effect of trials.

2.4.2.3 Retardation Stage

Congruent transfer for the CI

CS and CI ratings

There was no significant interaction between inhibition, valence and trials, $F(4,44) = 1.554$, $p = .203$, $\eta^2 = .124$. There was a significant main effect of valence, $F(1,11) = 24.619$, $p = .001$, $\eta^2 = .691$. The CSall and CIall associated with a positive IAPS US were rated higher (*M* 6.125, *SD* .282) than the CSall and CIall stimuli associated with a negative IAPS US (*M* 3.692, *SD* .293). There was a significant interaction between valence and trials, $F(4,44) = 7.421$, $p = .001$, $\eta^2 = .403$. The CS and CI stimuli associated with a positive IAPS US were progressively rated higher (trial 1 = *M* 4.750, *SD* .272, trial 5 = *M* 6.625, *SD* .568) than the CS and CI stimuli associated with a negative IAPS US (trial

1 = *M* 5.417, *SD* .452, trial 5 = *M* 3.500, *SD* .671). There were no other significant main effects or interactions, maximum $F(1,11) = 3.185$, $p = .102$, $\eta^2 = .225$ for the interaction between inhibition and valence.

Incongruent transfer for the CI

CS and CI ratings

There was no significant interaction between inhibition, valence and trials, $F(4,44) = 1.640$, $p = .181$, $\eta^2 = .130$. There was a significant main effect of valence, $F(1,11) = 26.735$, $p = .001$, $\eta^2 = .708$. The CS and CI stimuli associated with a positive IAPS US were rated higher (*M* 6.475, *SD* .313) than the CS and CI stimuli associated with a negative IAPS US (*M* 3.483, *SD* .350). There was a significant interaction between valence and trials, $F(4,44) = 10.025$, $p = .001$, $\eta^2 = .477$. The CS and CI stimuli associated with a positive IAPS US were progressively rated higher (trial 1 = *M* 5.083, *SD* .294, trial 5 = *M* 7.125, *SD* .533) than the CS and CI stimuli associated with a negative IAPS US (trial 1 = *M* 4.625, *SD* .332, trial 5 = *M* 3.208, *SD* .538). There were no other significant main effects or interactions, maximum $F(1,11) = 2.175$, $p = .168$, $\eta^2 = .165$ for the interaction between inhibition and valence.

2.4.2.4 Extinction Stage

Congruent transfer for the CI

CS and CI ratings

There was no significant interaction between inhibition, valence and trials, $F(4,44) = .174$, $p = .951$, $\eta^2 = .016$. There was a significant main effect of inhibition, $F(1,11) = 7.886$, $p = .017$, $\eta^2 = .418$. The CS and CI stimuli were rated lower (*M* 4.292, *SD* .251) than the CS and CI stimuli (*M* 5.217, *SD* .306). There was a significant main effect of valence, $F(1,11) = 15.271$, $p = .002$, $\eta^2 = .581$. The CS and CI stimuli that had previously been associated with a positive

IAPS US were rated higher (*M* 6.242, *SD* .495) than the CS and CI stimuli that had previously been associated with a negative IAPS US (*M* 3.267, *SD* .384). There were no other significant main effects or interactions, maximum $F(1,11) = 1.451$, $p = .254$, $\eta^2 = .117$ for the interaction between inhibition and valence.

Incongruent transfer for the CI

CS and CI ratings

There was no significant interaction between inhibition, valence and trials, $F(4,44) = 1.324$, $p = .276$, $\eta^2 = .107$. There was a significant main effect of valence, $F(1,11) = 22.194$, $p = .001$, $\eta^2 = .669$. The CS and CI stimuli that had previously been associated with a positive IAPS US were rated higher (*M* 7.108, *SD* .439) than the CS and CI stimuli that had previously been associated with a negative IAPS US (*M* 2.867, *SD* .485). There was a significant interaction between inhibition and valence, $F(1,11) = 7.370$, $p = .020$, $\eta^2 = .401$. The CS and CI stimuli that had previously been associated with both the positive and negative IAPS US were being rated differently (Positive CS, *M* 6.800, *SD* .516, Positive CI, *M* 7.417, *SD* .426, Negative CS, *M* 3.517, *SD* .635, Negative CI, *M* 2.217, *SD* .472). There were no other significant main effects or interactions, maximum $F(4,44) = 1.701$, $p = .167$, $\eta^2 = .134$ for the interaction between inhibition and trials.

2.4.3 Discussion

Statistical analysis confirmed that conditioned inhibition was not demonstrated in Experiment 3. As was the case in Experiments 1 and 2, there was no significant interaction between valence and trials at the retardation stage of the task and thus no evidence that participants were rating the CS positive and negative and CI positive and negative stimuli differently. This was the case for both congruent and incongruent transfer. Although the task was modified to be a conventional retardation test, with the addition of two novel CSs to compare

learning with the previously trained CIs, the key test comparisons did not reach significance.

However, in Experiment 3 there was evidence of learning at the discrimination stage. In other words, participants responded differentially on inhibited and non-inhibited trials during training. Thus, there was evidence that the modification of removing the neutral stimuli had indeed made the task less demanding on the participants. Although the number of trials remained the same (eight CS and 12 CI presentations) there were not as many comparisons to learn about, only two valences, whereas before there were three. This modification also meant the overall time taken to complete the task was less.

A true inhibitor should be slower to convert into a CS after being previously trained as a CI, thus learning should be retarded in comparison to learning about a novel CS. Given that the CI should take longer to learn about, an increased number of trials at the transfer stage might help to reveal any difference in the rate of acquisition. Therefore, in Experiment 4, participants were given 10 CS → US positive/negative pre-discrimination trials and eight CS → US positive/negative 12 [CS + CI] → 'No US' trials (no change from the previous experimental designs). In the retardation stage, the number of trials was increased from five trials to 20 trials of each novel CS and previously trained CI, 80 in total. In conclusion, having successfully established parameters to show that the discrimination was learned in Experiment 3, Experiment 4 tested whether increasing the number of the retardation stage trials would allow demonstration of conditioned inhibition via the retardation test method.

2.5 Experiment 4

2.5.1 Methods

2.5.1.1 Participants

A total of 24 undergraduate and general population participants volunteered to take part in this experiment. There were five males and 19 females with a mean age of 20 (range from 18-28). All participants had normal or corrected to normal vision and were naïve to the current task and hypothesis.

2.5.1.2 Apparatus

The stimuli were the same as in previous experiments.

2.5.1.3 Procedure

No adjustments were made to the pre-discrimination and discrimination stages. The number of trials/presentations was increased from five to 20 in both the retardation and extinction stages respectively. Overall there were two different programmes, one for congruent transfer and on for incongruent transfer. The programmes were counterbalanced for valence and type of transfer between the CS and CI. Overall there were eight different programmes that were delivered in a counterbalanced way to the participants. The whole computer task takes approximately 25 minutes to complete.

2.5.1.4 Design

All data were analysed using SPSS (version 15.0) and used an alpha of $p = .05$ and paired samples t-tests used a 95% confidence interval. Data were analysed for the pre -discrimination, discrimination, transfer and extinction stages. Both

congruent and incongruent transfers were analysed. The design was the same as the previous experiment except for a few minor adjustments.

Retardation and Extinction Stage

Data were analysed separately for congruent and incongruent transfer. The data were entered into a 2 x 2 x 5 within subjects ANOVA with factors inhibition (CS and CI), valence (positive and negative) and blocks (1-5). Only the CS ratings were analysed as before.

2.5.2 Results

Due to the design of the experiment ratings are only meaningful if they are significant by certain factors (see page 35). Therefore, results are only presented graphically if significant by these effects/interactions and thus meaningful. Below is a summary table of the overall pattern of results for experiment 4 (see Table 2.9)

Table 2.9

Key main effects and interactions from the Negative Images CI Task: Retardation Test experiment 4

	Valence	**Valence x Inhibition**	**Valence x Inhibition x Blocks**
Pre-Discrimination CS	Significant	-	-
Pre-Discrimination US	Significant	-	-
Discrimination Training CS	-	Significant	-
Discrimination Training US	Significant	-	-
Retardation Stage Congruent	-	Not significant	Not significant
Retardation Stage Incongruent	-	Not significant	Not significant
Extinction Stage Congruent	-	Not significant	Not significant
Extinction Stage Incongruent	-	Not significant	Not significant

2.5.2.1 Pre-Discrimination

CS ratings

There was a significant main effect of valence, $F(1,23) = 7.854$, $p = .010$, $\eta^2 = .255$. The CS stimuli associated with a positive IAPS US were rated higher (*M* 5.975, *SD* .210) than the CS stimuli associated with a negative IAPS US (*M* 4.985, *SD* .297). There were no other significant main effects or interactions, maximum $F(9,207) = 1.551$, $p = .132$, $\eta^2 = .063$ for the main effect of trials.

US ratings

There was a significant main effect of valence, $F(1,23) = 180.068$, $p = .001$, $\eta^2 = .887$. The positive IAPS US pictures were rated higher than the negative IAPS US pictures (see Figure 2.10).

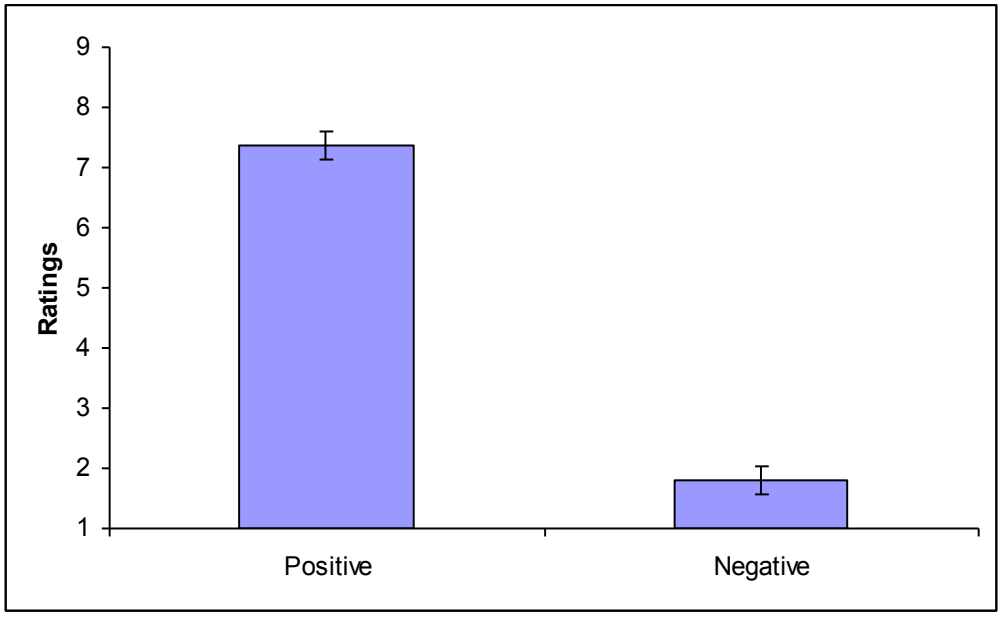


Figure 2.10. The main effect of valence of the US ratings at the pre-discrimination stage of the conditioned inhibition task. Error bars represent S.E.M.

There was a significant main effect of trials, $F(9,207) = 10.609$, $p = .001$, $\eta^2 = .316$ that arose due to non-systematic fluctuations over the ten trials. There was

a significant interaction between valence and trials, $F(9,207) = 13.268$, $p = .001$, $\eta^2 = .366$. There were non-systematic fluctuations over the ten trials but ratings remained overall higher for the positive IAPS US pictures (trial 1 = *M* 7.292, *SD* .244, trial 10 = *M* 7.750, *SD* .219) and lower for the negative IAPS US pictures (trial 1 = *M* 1.500, *SD*.209, trial 10 = *M* 2.208, *SD* .262).

2.5.2.2 Discrimination Stage

CS and [CS + CI] ratings

There was a significant interaction between valence and inhibition, $F(1,23) = 9.224$, $p = .006$, $\eta^2 = .286$ (see Figure 2.11). A paired samples t-test compared how participants were rating the CS → US positive compared to [CS + CI] → 'No US' positive and CS → US negative compared to [CS + CI] → 'No US' negative. Participants were rating the CS negative stimuli differently, more negative, to the [CS + CI] negative stimuli, $t(23) = -3.470$, $p = .002$. The difference in the ratings of the CS and [CS + CI] positive stimuli was not significant.

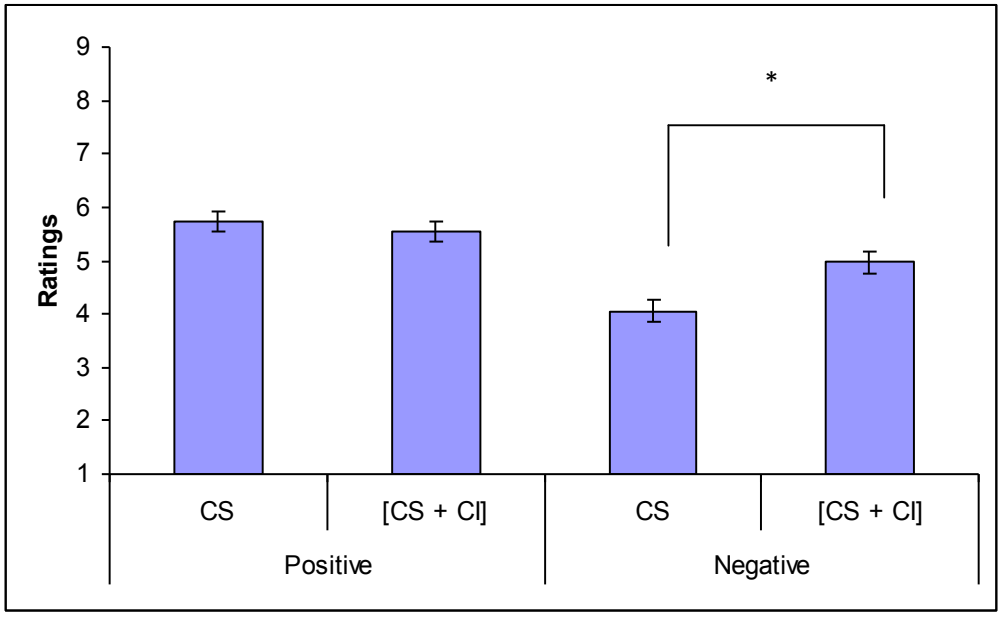


Figure 2.11. The interaction between valence and inhibition of the CS and [CS + CI] ratings at the discrimination stage of the conditioned inhibition task. Error bars represent S.E.M. * = t-test significant at $p = .05$.

There was a significant main effect of valence, $F(1,23) = 7.710$, $p = .011$, $\eta^2 = .251$. The CS and [CS + CI] stimuli associated with a positive IAPS US were rated higher (*M* 5.638, *SD* .234) than the CS and [CS + CI] stimuli associated with a negative IAPS US (*M* 4.513, *SD* .227). There was a significant main effect of inhibition, $F(1,23) = 4.829$, $p = .038$, $\eta^2 = .174$. The CS stimuli were rated lower (*M* 4.891, *SD* .160) than the [CS + CI] stimuli (*M* 5.260, *SD* .111). There were no other significant main effects or interactions, maximum $F(7,161) = 1.261$, $p = .273$, $\eta^2 = .052$ for the interaction between valence and trials.

US ratings

There was a significant main effect of valence, $F(2,46) = 35.307$, $p = .001$, $\eta^2 = .606$. The positive IAPS US pictures were rated higher than the off white 'No US' screen and the negative IAPS US pictures (see Figure 2.12).

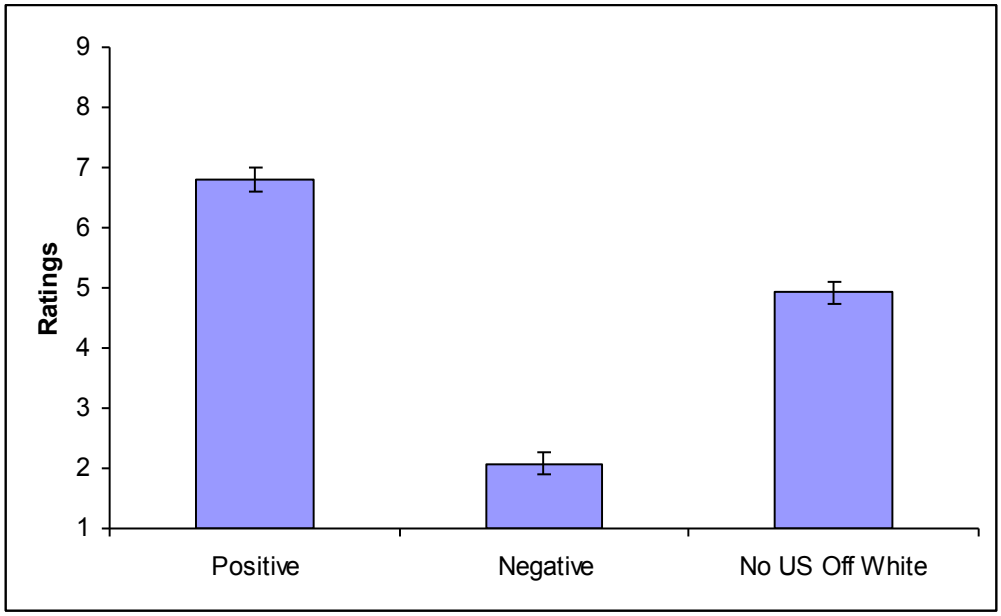


Figure 2.12. The main effect of valence of the US ratings at the discrimination stage of the conditioned inhibition task. Error bars represent S.E.M.

There were no other significant main effects or interactions, maximum $F(14,322) = 1.400$, $p = .151$, $\eta^2 = .057$ for the interaction between valence and trials.

2.5.2.3 Retardation Stage

Congruent transfer for the CI

CS and CI ratings

There was no significant interaction between inhibition, valence and blocks, $F(4,44) = 2.042$, $p = .056$, $\eta^2 = .157$. There was a significant main effect of valence, $F(1,11) = 24.025$, $p = .001$, $\eta^2 = .686$. The CS and CI stimuli associated with a positive IAPS US were rated higher (*M* 6.581, *SD* .381) than the CS and CI stimuli associated with a negative IAPS US (*M* 2.967, *SD* .370). There was a significant interaction between valence and blocks, $F(4,44) = 11.375$, $p = .001$, $\eta^2 = .508$. Over the five blocks of trials the CS and CI pictures paired with positive outcomes continued to be rated higher and the CS and CI pictures paired with negative outcomes continued to be rated lower. There were no other significant main effects or interactions, maximum $F(1,11) = 4.57$, $p = .056$, $\eta^2 = .294$ for the interaction between inhibition and valence.

Incongruent transfer for the CI

CS and CI ratings

There was no significant interaction between inhibition, valence and blocks, $F(4,44) = .750$, $p = .563$, $\eta^2 = .064$. There was a significant main effect of valence, $F(1,11) = 26.046$, $p = .001$, $\eta^2 = .703$. The CS and CI stimuli associated with a positive IAPS US were rated higher (*M* 6.865, *SD* .451) than the CS and CI stimuli associated with a negative IAPS US (*M* 2.646, *SD* .423). There was a significant interaction between valence and blocks, $F(4,44) = 9.348$, $p = .001$, $\eta^2 = .459$. Over the five blocks of trials the CS and CI pictures

paired with positive outcomes continued to be rated higher and the CS and CI pictures paired with negative outcomes continued to be rated lower. There were no other significant main effects or interactions, maximum $F(1,11) = 1.381$, $p = .265$, $\eta^2 = .112$ for the main effect of inhibition.

2.5.2.4 Extinction Stage

Congruent transfer for the CI

CS and CI ratings

There was no significant interaction between inhibition, valence and blocks, $F(4,44) = 1.640$, $p = .181$, $\eta^2 = .130$. There was a significant main effect of valence, $F(1,11) = 42.093$, $p = .001$, $\eta^2 = .793$. The CS and CI stimuli that had previously been associated with a positive IAPS US were rated higher (*M* 7.202, *SD* .413) than the CS and CI stimuli that had previously been associated with a negative IAPS US (*M* 2.338, *SD* .359). There were no other significant main effects or interactions, maximum $F(1,11) = 4.668$, $p = .054$, $\eta^2 = .298$ for the interaction between inhibition and valence.

Incongruent transfer for the CI

CS and CI ratings

There was no significant interaction between inhibition, valence and blocks, $F(4,44) = 1.231$, $p = .312$, $\eta^2 = .101$. There was a significant main effect of valence, $F(1,11) = 34.767$, $p = .001$, $\eta^2 = .760$. The CS and CI stimuli that had previously been associated with a positive IAPS US were rated higher (*M* 7.512, *SD* .471) than the CS and CI stimuli that had previously been associated with a negative IAPS US (*M* 2.065, *SD* .481). There were no other significant main effects or interactions, maximum $F(1,11) = 2.435$, $p = .147$, $\eta^2 = .181$ for the main effect of inhibition.

2.5.3 Discussion

Despite the increased number of trials at the retardation test, conditioned inhibition was not demonstrated in Experiment 4. There was no interaction between inhibition and valence at the retardation stage of the task, thus participants were still not rating the previously trained CI now presented as a CS differently to a novel CS and there was no evidence for any difference in the rate of acquisition. This was the case for both congruent and incongruent transfer.

As in Experiment 3, analysis of the earlier discrimination learning trials provided evidence that participants learned the discrimination between the CS and [CS + CI] presentations. However, when the interaction between inhibition and valence at the discrimination stage was further analysed via post hoc tests it became clear that the discrimination was significant only with the negative stimuli. In other words, participants reliably rated the CS → negative and [CS + CI] → 'No US' negative differently but their ratings were not different for the CS → positive and [CS + CI] → 'No US' positive presentations (the only difference being that CS alone was associated with a positive US).

Although the IAPS stimuli have been categorised by valence on the basis of a very large sample of ratings, and those selected as USs in the present study are generally rated as positive and negative (Centre for the Study of Emotion and Attention, 1995), the positive images are generally viewed as more subjective and less arousing. In the present series of experiments, a relatively high proportion of participants (approximately 15) commented that they found some of the 'positive' IAPS US images less salient than the 'negative' IAPS US stimuli; for example, an ice cream cone may not be rated as positive by someone who is dieting or who does not like ice cream. In addition to removing the positive IAPS stimuli the novel CS stimuli at the retardation stage will be changed. Instead of using the complex street scenes the novel CS stimuli will be street furniture and more representative of the same category of images as the previously trained CIs now being presented as CSs. This will

help to minimise any processing demands or within-compound associations. Overall, the procedural changes for the next experiment included that the positive stimuli were removed in Experiment 5, to simplify the design and further strengthen the discrimination with the negative stimuli and that the two novel CSs at the retardation stage were changed to be selected from the street furniture category.

Previously the task variants examined in Experiments 1-4 used a sample size of 24 (in line with the likely maximum sample size of participants able to be recruited with OCD or Panic Disorder, a formal power analysis is reported in Chapter 6). Although the discrimination learning component of the task is now robust, conditioned inhibition by the retardation test has yet to be demonstrated. For the next task version to be used in Experiment 5 a much bigger sample size will be recruited. This will help to pull out any difference in a small effect size and should help to demonstrate both discrimination learning and conditioned inhibition via the retardation test method.

In conclusion, the positive stimuli will be removed from all stages of the task and more participants will be recruited to increase the statistical power.

2.6 Experiment 5

2.6.1 Methods

2.6.1.1 Participants

A total of 72 undergraduate and general population participants volunteered to take part in this experiment. There were 20 males and 52 females with a mean age of 24 (range from 18-55). Sixty participants completed the incongruent transfer version and 12 participants completed the congruent transfer version. Power was calculated using G*Power (Erdfelder et al., 1996) to determine the sample size for the meaningful main effects/interactions at the discrimination training and retardation stage for a medium effect of .25 (Cohen, 1977). At the

discrimination stage for the main effect of inhibition the required sample size is 32, the critical is F = 2.092 and the actual power would be .991. At the retardation stage for the interaction between inhibition and blocks the required sample size is 20 and the critical F = 1.64 and the actual power would be .997. All participants had normal or corrected to normal vision and were naïve to the current task and hypothesis.

2.6.1.2 Apparatus

The stimuli were the same as in previous experiments. All congruent stimuli were removed from the task so only negative stimuli were used at each stage of the task.

2.6.1.3 Procedure

Pre-Discrimination

No adjustments were made at this stage to the procedure.

Discrimination

No adjustments were made at this stage to the procedure.

Retardation

Two novel CSs were introduced which were the same style of stimuli as the CIs, street furniture (see Figure 2.13). This was so the CS stimuli at the retardation stage were representative of being selected from the same category of stimuli as the CI stimuli. At this stage participants were shown 20 trials of each of these stimuli, a previously trained CI congruently or incongruently transferred, three novel CSs paired with either a positive or negative picture.

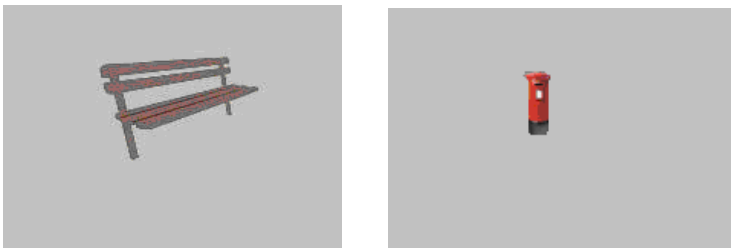


Figure 2.13. Examples of the novel CS stimuli used (not to scale) at the retardation stage.

Extinction

Two novel CSs were introduced which were the same style of stimuli as the CIs, street furniture. So, at this stage, participants were shown 20 trials of each of these stimuli, a previously trained CI congruently or incongruently transferred, three novel CSs followed by either a positive or negative picture. Overall there were two different programmes, one for congruent transfer and one for incongruent transfer. The whole computer task took approximately 25 minutes to complete.

2.6.1.4 Design

All data for the pre-discrimination, discrimination, transfer and extinction stages, both congruent and incongruent transfer were analysed using SPSS (version 15.0) and used an alpha of $p = .05$ and paired samples t-tests used a 95% confidence interval. The design was the same as the previous experiment with a few minor adjustments.

Pre-Discrimination

The data were entered into a within subjects ANOVA with one factor, trials (1-10). Both the CS and US data were analysed using this format.

Discrimination Training

The CS data were entered into a 2 x 8 within subjects ANOVA with factors, inhibition (CS and [CS + CI]) and trials (1-8). The US data were entered into a 2 x 8 within subjects ANOVA with factors, valence (negative US and off-white 'No US') and trials (1-8).

Retardation and Extinction Stage

Data were analysed separately for congruent and incongruent transfer. The data were blocked into five blocks of four trials. The data was entered into a 2 x 5 within subjects ANOVA with factors, inhibition (CI and CS) and blocks (1-5). Only the CS data was analysed. Incongruent transfer retardation data was further analysed using a 2 x 5 within subjects ANOVA with factors, inhibition (CI and CS) and trials (1-8) and using paired samples t-tests on the first 8 trials for both the CI and CS.

2.6.2 Results

The positive stimuli have been removed for this task version, therefore, the results are meaningful if they are significant by either a main effect of trials or inhibition at the pre-discrimination or discrimination stage respectively or an interaction between inhibition and blocks/trials at the retardation stage. Therefore, results are only presented graphically if significant by these effects/interactions and thus meaningful. As before the US ratings were analysed to confirm that participants' perceived the IAPS valences as intended. Below is a summary table of the overall pattern of results for experiment 5 (see Table 2.10).

Table 2.10

Key main effects and interactions from the Negative Images CI Task: Retardation Test experiment 5

	Trials	**Inhibition**	**Inhibition x Blocks**
Pre-Discrimination CS	Significant	-	-
Pre-Discrimination US	Not significant*	-	-
Discrimination Training CS	-	Significant	-
Discrimination Training US	-	Significant *	-
Retardation Stage Congruent	-	Not significant	Not significant
Retardation Stage Incongruent	-	Significant	Significant
Extinction Stage Congruent	-	Not significant	Not significant
Extinction Stage Incongruent	-	Significant	Significant

* Significant main effect of valence

2.6.2.1 Pre-Discrimination

CS ratings

There was a significant main effect of trials, $F(9,639) = 3.517$, $p = .001$, $\eta^2 = .052$.

Over the ten trials there were non-systematic fluctuations but generally the participants were rating the CS as positive (trial 1 = *M* 6.111, *SD* .192, trial 10 = *M* 6.306, *SD* .177).

US ratings

There were no significant main effect, maximum $F(9,639) = .957$, $p = .210$, $\eta^2 = .019$ for the main effect of trials.

2.6.2.2 Discrimination Training

CS and [CS + CI] ratings

There was a significant main effect of inhibition, $F(1,71) = 127.076$, $p = .001$, $\eta^2 = .650$. The CS stimuli associated with the negative US pictures were rated lower (*M* 2.906, *SD* .194) than the [CS + CI] compound which was not reinforced (*M* 4.946, *SD* .128) (see Figure 2.14).

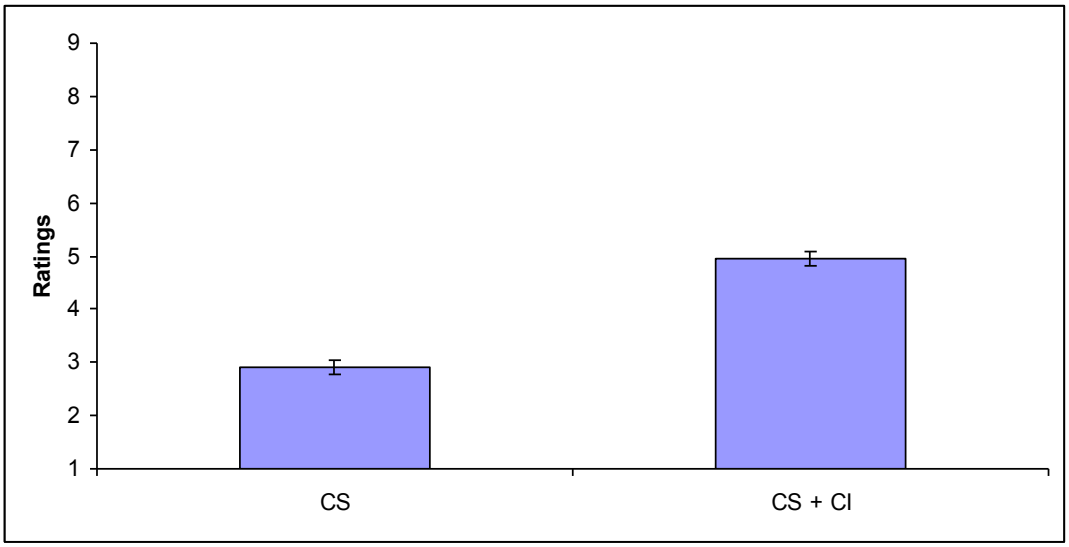


Figure 2.14. The main effect of inhibition of the CS ratings at the discrimination training stage of the conditioned inhibition task. Error bars represent S.E.M.

There was a significant interaction between inhibition and trials, $F(7,497) = 2.615$, $p = .018$, $\eta^2 = .033$. There were non-systematic fluctuations over the 10 trials but generally the CS remained rated as negative (trial 1 = *M* 3.306, *SD* .282, trial 10 = *M* 2.736, *SD* .237) and the [CS + CI] remained rated as neutral (trial 1 = *M* 4.722, *SD* .177, trial 10 = *M* 5.056, *SD* .149). There were no other significant effects maximum $F(7,497) = .963$, $p = .419$, $\eta^2 = .014$ for the main effect of trials.

US ratings

There was a significant main effect of valence, $F(1,71) = 364.886$, $p = .001$, $\eta^2 = .835$. The negative IAPS US pictures were rated lower than the off white 'No US' screen (see Figure 2.15).

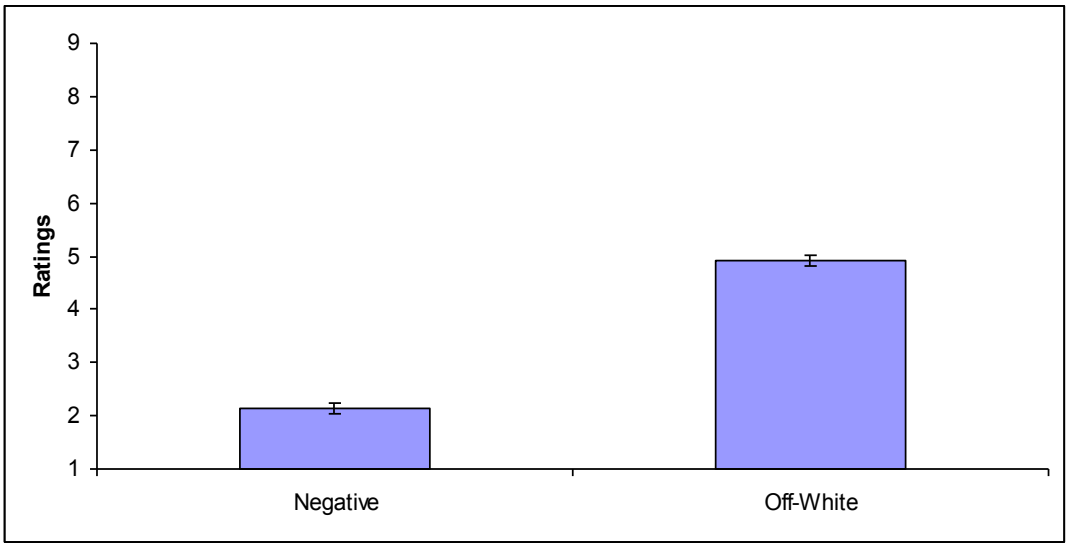


Figure 2.15. The main effect of valence of the US ratings at the discrimination stage of the conditioned inhibition task. Error bars represent S.E.M.

There was a significant main effect of trials, $F(7.497) = 18.506$, $p = .001$, $\eta^2 = .189$. There were non-systematic fluctuations over the 8 trials, (trial 1 = *M* 3.264, *SD* .114, trial 8 = *M* 3.910, *SD* .128). There was a significant interaction between valence and trials, $F(7.497) = 22.379$, $p = .001$, $\eta^2 = .223$. Over the 8 trials the negative IAPS US pictures were rated progressively more positive but still overall were rated as negative (trial 1 = *M* 1.639, *SD* .177, trial 8 = *M* 2.819, *SD* .173) and the off white 'No US' screen ratings remained around neutral (trial 1 = *M* 4.889, *SD* .102, trial 8 = *M* 5.000, *SD*.125).

2.6.2.3 Retardation Stage

Congruent transfer for the CI

Only 12 participants completed the congruent transfer Negative Images Negative Images CI Task: Retardation Test.

CS and CI ratings

There was no significant main effect of inhibition, $F(1,11) = 1.988$, $p = .185$, $\eta^2 = .154$. There was no significant interaction between inhibition and blocks $F(4,44) = .134$, $p = .969$, $\eta^2 = .012$. There was a significant main effect of blocks, $F(4,44) = 28.298$, $p = .001$, $\eta^2 = .502$. The previously trained CI and the novel CS were both progressively rated as more positive over the 5 blocks of trials (block 1 = *M* 6.833, *SD* .217, block 5 = *M* 8.198, *SD* .312). There were no other significant main effects or interactions, maximum $F(1,11) = 1.988$, $p = .185$, $\eta^2 = .154$ for the main effect of inhibition.

Incongruent transfer for the CI

CS and CI ratings

There was a significant interaction between inhibition and blocks, $F(4,236) = 16.741$, $p = .001$, $\eta^2 = .226$. Over the 5 blocks of trials both the previously trained CI and the novel CS were being rated as progressively nastier (see Figure 2.16).

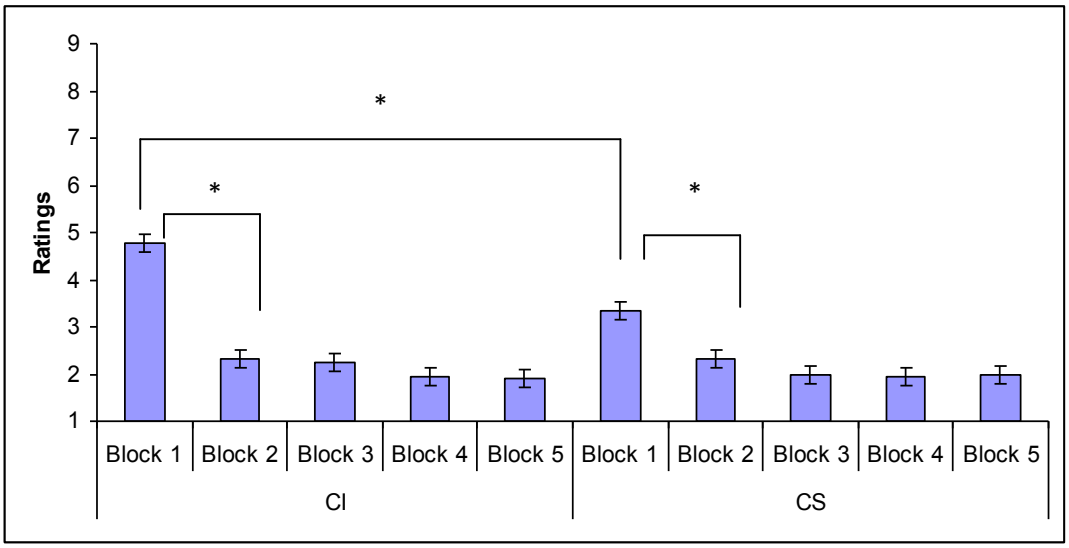


Figure 2.16. The interaction between inhibition and blocks for incongruent transfer of the CI stimuli at the retardation stage of the conditioned inhibition task. Error bars represent S.E.M. * = t-test significant at $p = .05$.

Inspection of Figure 2.16 suggests that the interaction arose because the overall decrease in the ratings of the CS and the previously trained CI occurred at different rates. Furthermore, consistent with the view that inhibitors acquire emotional properties, the initial ratings were different. This observation was confirmed statistically in that the initial block 1 ratings for the previously trained CI and the novel CS were significantly different, $t(59) = 5.927$, $p = .001$. For both the CS and the previously trained CI, the drop in the ratings reached significance only between blocks 1 and 2, $t(59) = 3.603$, $p = .001$, and $t(59) = 6.742$, $p = .001$, respectively. However, as might be expected given the difference in baseline, Figure 2.16 shows that the drop from block 1 to 2 was greater for the previously trained CI. Therefore, a more focused analysis was carried out on the first eight trials (first two blocks) of the retardation stage.

On the trial-by-trial analysis, there was a significant main effect of inhibition, $F(1,59) = 17.926$, $p = .001$, $\eta^2 = .233$. The previously trained CI stimuli were rated more neutral (M 3.506, SD .114) compared to the novel CS stimuli (M 2.773, SD .175). There was a significant main effect of trials, $F(7,413) = 57.025$, $p = .001$, $\eta^2 = .491$. Overall the previously trained CI and the novel CS were progressively rated as nastier over the first eight trials (trial 1 = M 6.275,

SD .231, trial 8 = *M* 2.142, *SD* .185). There was a significant interaction between inhibition and trials, $F(7,413) = 9.325$, $p < .05$. $p = .001$, $\eta^2 = .136$. Over the first eight trials the CS and the previously trained CI were being rated differently (see Figure 2.17). For the previously trained CI now being presented as a CS, there was a significant difference in the ratings between trial 1 and 2 ($t59 = 6.29$, $p = .001$), trial 2 and 3, ($t59 = 5.31$, $p = .001$) and trial 5 and 6 ($t59 = 2.12$, $p = .038$). For the novel CS there was a significant difference in the ratings between trial 1 and 2 ($t59 = 5.226$, $p = .001$) and trial 2 and 3, ($t59 = 2.839$, $p = .006$). There were no other significant differences by t-test. Participants were still rating the previously trained CI - now presented as a CS - differently, specifically more negatively, by trials 5 and 6. This demonstrates that they were still learning about the stimuli whereas the ratings of the novel CS were showing no further change (this had stopped by trial 3) suggesting that the rate of acquisition was different for the two stimuli. Thus, participants were slower to learn about a previously trained CI now presented as a CS compared with a novel CS.

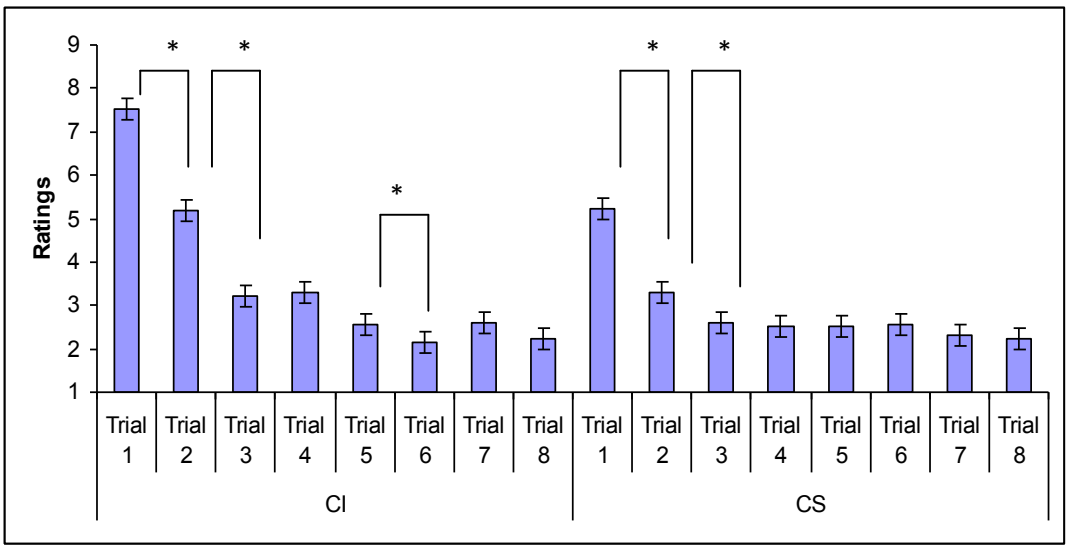


Figure 2.17. The first eight trials ratings of the CI and CS stimuli for incongruent transfer of the CI stimuli at the retardation stage of the conditioned inhibition task. Error bars represent S.E.M. * = t-test significant at $p = .05$.

2.6.2.4 Extinction Stage

Congruent transfer for the CI

CS and CI ratings

There was no significant interaction between inhibition and blocks, $F(4,44) = 1.187$, $p = .271$, $\eta^2 = .097$. There were no significant main effects or interactions, maximum $F(4,44) = 1.842$, $p = .433$, $\eta^2 = .085$ for the main effect of blocks.

Incongruent transfer for the CI

CS and CI ratings

There was a significant interaction between inhibition and blocks, $F(4,236) = 15.751$, $p = .001$, $\eta^2 = .524$. There were non-systematic fluctuations but overall the previously trained CI (block 1 = *M* 3.412, *SD* .130, block 5 = *M* 2.042, *SD* .194) and the novel CS (block 1 = *M* 1.775, *SD* .132, block 5 = *M* 2.004, *SD* .187) were progressively being rated as negative over the blocks. There was a significant main effect of inhibition, $F(1,59) = 13.789$, $p = .001$, $\eta^2 = .194$. The previously trained CI stimuli were rated slightly higher (*M* 2.245, *SD* .156) than the novel CS stimuli (*M* 1.895, *SD* .157). There was a significant main effect of blocks, $F(4,236) = 29.592$, $p = .001$, $\eta^2 = .383$. There were non-systematic fluctuations but overall the previously trained CI and the novel CS were progressively rated as negative over the blocks (block 1 = *M* 2.594, *SD* .110, block 5 = *M* 2.023, *SD* .177).

2.6.2.5 Awareness Check

Participants were asked at the end of the task if they could explain to the experimenter what it was that meant a negative or positive stimuli appeared on the screen. Out of the 72 participants tested, 63 reported that they were aware

of the contingencies. These participants correctly articulated what piece of street furniture was associated with a negative or positive US at the third stage of the task (retardation stage). Out of the other nine participants, four reported that they either had no awareness at all, two reported they were not aware of the contingencies but thought the task was about the stimuli getting progressively nastier, one thought there was a 50/50 chance of a negative or positive image appearing on the screen and that it was completely random, and two participants thought there was a pattern to the sequence of images (two negative then one positive).

2.6.3 Discussion

The results of the final task version show that conditioned inhibition was demonstrated using the retardation test method. Other studies have previously demonstrated conditioned inhibition using the summation test method (Grillon & Ameli, 2001; Karazinov & Boakes, 2004; Migo et al., 2006). In the final task version of this study, at the retardation test stage participants were rating the novel CS and previously trained CI differently for stimuli that were incongruently transferred and this reached significance. When the result was further analysed it was shown that by the fifth trial participants were still learning about the previously trained CI, this was significant, and they were not learning any more about the novel CS; learning about the novel CS had actually reached asymptote by trial 3. This result shows that learning was slower for the previously trained CI compared to a novel CS demonstrating that the inhibitor was a true inhibitor and in the previous stage had acquired inhibitory properties that were carried over into the retardation test stage (a retardation test is one of the two key tests to show conditioned inhibition, Rescorla, 1969).

The results from the retardation test stage suggest that conditioned inhibition was demonstrated but it was also important to check that participants had learnt the discrimination. Analysis of the results showed that they had, there was a significant difference in the way participants were rating the CS and [CS + CI]

at the discrimination stage. Power analyses also revealed that the ideal sample sizes to recruit in order to show a medium effect were 32 and 20 for a key main effect at the discrimination and key interaction at the retardation stage respectively. The sample size recruited overall was 12 for congruent transfer and 48 for incongruent transfer. The incongruent transfer task design statistically clearly demonstrated that individuals had learnt the discrimination and the inhibitory properties were causing retardation to learning about a novel stimulus. Moreover, the sample size supports these results and the task had strong statistical power. Overall, these two results, the significant difference in ratings at the discrimination stage and the slower learning for the previously trained CI compared with the novel CS successfully demonstrate conditioned inhibition using the retardation test method.

The ratings from the final task version also provide insight as to why retardation may have occurred. Participants were slower to learn about the previously trained CI when the stimulus was incongruently transferred. In this condition, participants were trained with different US stimuli at the discrimination stage and retardation stage. For example, CS → US Negative, [CS + CI] → 'No US', participants may rate the CI as positive as it signals the absence of a negative outcome. Indeed, in the present study, the results for the first rating of the retardation stage indicated that this was the case; participants were rating the previously trained CI for a negative outcome as positive. This suggests that participants had attached an emotional significance to the CI and that this may have contributed to the retardation of learning. Thus findings were consistent with the hypothesis that participants should treat the previously trained CI as a safety signal; over time previously neutral stimuli acquired positive properties because they signalled the absence of a negative outcome (Cándido et al., 1991; Cicala & Owen, 1976; Dickinson, 1980; Konorski, 1967; Morris 1975). Participants demonstrated their emotional responses to the stimuli via the ratings scale and the results of these ratings were consistent with the mechanisms proposed to underlie retardation theoretically. The results confirmed that participants had attached emotional relevance to the previously trained CI, this contributed to the way they rated stimuli and in consequence how they learnt about the stimuli subsequently in comparison to novel stimuli

(Dickinson & Pearce, 1977; Konorski, 1948; 1967; Konorski & Szwejkowska, 1956).

Chapter 3: Developing Task Variants to Demonstrate Conditioned Inhibition Using the Summation Test

3.1 Introduction

As outlined in Chapter 2 it is generally agreed upon that in order to show true conditioned inhibition at least one (ideally both) of two key tests must be passed: a retardation test and a summation test (Hearst, 1972; Rescorla, 1969). The previous Chapter detailed the development of a conditioned inhibition task that successfully used a retardation test to measure inhibition; the CI was slower to turn into a CS, learning about it was retarded compared with the novel CS introduced at the retardation stage. However, it could be argued that attention to the CI was reduced and therefore if participants are not paying attention to the stimuli they are not able to learn about it. As a result this was the cause of the retarded learning at the retardation stage. This argument obviously depends on attention being involved in learning (Mackintosh, 1975; Pearce & Hall, 1980). Mackintosh (1975) proposed that learning is dependant on attention and the associability of a stimulus and how accurately it predicts reinforcement. If the CS is a good predictor associability will be high conversely if the CS is a poor predictor associability will be low. Further to this, participants/subjects will pay little attention to poor predictors of the CS and therefore learn less about it. Pearce & Hall (1980) have also suggested that learning is contingent on the amount of attention that is paid to the stimulus during training. They suggest that whilst training attention must be paid to the stimulus but once learning has been established attention is no longer required. However, there are other learning theories that stipulate that attention is not a requisite of learning but rather learning is based on the surprise (Rescorla & Wagner, 1972) as detailed previously. As mentioned above, it can be argued and theorised that learning is dependant on attention to the stimulus so in order

to rule out attentional explanations another test must be carried out in order to show true conditioned inhibition.

The other test that can be carried out that complements a retardation test is called a summation test. A summation test was originally conducted by Pavlov (1927) to demonstrate conditioned inhibition. To show a true conditioned inhibition in a summation test the inhibitor is paired with a transfer (CS_t) or novel generalised (S_g) excitatory stimulus (not previously paired with the inhibitor). If it is a true inhibitor it will reduce summation test responding to an excitor - which has been previously trained (CS_t) or which is similar to trained excitors (S_g) – but which has not previously been presented together with the inhibitor (and in the absence of the otherwise expected outcome). Compared with a CS_t or S_g presented alone the CI plus CS_t or S_g and will produce less responding. It could be argued that in a summation test too much attention is paid to the CI and therefore distracts from the CS and reduces responding. This is why the two tests are ideally both needed to display true conditioned inhibition although there have been successful demonstrations of conditioned inhibition in procedures which control for external inhibition (Kantini et al., 2011a; Kantini et al., 2011b).

As previously discussed, examples of conditioned inhibition tested by a summation test have been successfully shown in both animal (Cole et al., 1997; Murray & Pearce, 2010; Pineno, 2010; Rescorla & Holland, 1977; Rodrigo et al., 2009; Urcelay et al., 2008) and human studies (Grillon & Ameli, 2001; Karazinov & Boakes, 2004; McNally & Reiss, 1984; Migo et al., 2006; Neumann et al., 1997; Wilkinson, 1989). Typically, human studies have used neutral stimuli that do not evoke any strong emotional responses in the participants; participants were able to complete the task but the stimuli did not elicit an emotional response. As described in Chapter 2 inhibitors can generate opponent process (a stimulus evokes an initial response which is followed by an opposite after response, Dickinson & Dearing, 1979; Konorski, 1948; 1967; Solomon & Corbit, 1978). Conditioned inhibitors start with a neutral valence but when paired with a negative outcome over trials they could acquire

positivity for the participant. An inhibitor for something negative is positive in the sense that it reliably signals the absence of something aversive (Konorski, 1967). In essence these conditioned inhibitors are safety signals, they signal the absence of a negative outcome.

The aim of the experiments detailed in the current Chapter is to develop a task that uses the summation test for conditioned inhibition, and which will be suitable for use on a healthy and clinical sample. The relationship between performance on the tasks and individual differences will be described in Chapter 5. The first task described, Negative Images CI Task: Summation Test, uses stimuli that elicit strong emotional responses in the participants and the second task, 'Mission to Mars' CI Task: Summation Test, that has been previously tested was used, this one uses more neutrally valenced stimuli. The first task, the Negative Images CI Task: Summation Test, was developed from the protocol of the task tested by the retardation method, detailed in Chapter 2. The only difference to the task design was to add another CS stimulus to the discrimination stage and convert the retardation stage to a summation test stage. At the discrimination stage another CS was introduced, the transfer CS, CS_t, at this stage this CS was never paired with the CI. The retardation stage was altered to a summation test. The CS_t was presented alone and also with the CI, [CS_t + CI]. Two more stimuli were introduced, a generalised CS, S_g, which was also paired with the CI, [S_g + CI]. If it is a true inhibitor responding to CS_t/S_g plus CI will be lower compared with the same CS_t/S_g presented on its own. Images were taken from the IAPS database to provide experimental outcomes which would elicit emotional responses from participants. IAPS images are widely rated as being negative. There are two versions of the Negative Images Task: Summation Test. The second task was a protocol used in a previous study, the 'Mission to Mars' CI Task: Summation Test (Kantini et al., 2011a; Kantini et al., 2011b; Migo et al., 2006). Participants were required to watch the screen and were presented with images of planets as the CSA, CSB, CS_t, a grey frame as the CI (only presented with CSA and CSB at training), and an intact (non-inhibited trial) or exploded rocket (inhibited trial) as the US. At the test stage another stimulus, stimulus S_g was introduced, this

was a generalised stimulus that had not been previously trained, an image of a moon was used. Both the CS_t and the S_g were presented on their own and with the CI. The summation test required them to predict, based on a sequence of images, including either a particular planet (CS_t) or the moon (S_g), whether they would see an intact or exploded rocket. If the stimulus was a true inhibitor than responding to the CS_t and S_g would be lower than when presented on their own; the inhibitory properties of the CI would have transferred over. The method and results of each task are detailed and discussed.

3.2 Experiment 1

3.2.1 Methods

3.2.1.1 Participants

A total of 12 undergraduate and general population participants volunteered to take part in this experiment. There were three males and nine females with a mean age of 35 (range from 21-60). All participants had normal or corrected to normal vision and were naïve to the current task and hypothesis.

3.2.1.2 Apparatus

The stimuli were the same as in the previous experiments in Chapter 2.

3.2.1.3 Procedure

Retardation and summation are two methods to test for conditioned inhibition. The previous CI tasks have used a retardation method to test for conditioned inhibition. For this experiment the test stage was changed from a retardation test to a summation test. Both the retardation test (see Chapter 2) and the summation test ran independently rather than together in one design. The pre-discrimination stage stayed the same as the previous experiments. The

discrimination stage stayed mostly the same as the previous experiment. The only change was the addition of another stimulus, a transfer stimulus, CS_t; this was paired with negative IAPS images as the US. At the summation stage the participants were shown the CS_t, [CS_t + CI], a generalised stimulus was introduced (a stimulus that was not presented in the training phase), S_g, and [S_g + CI]. If the CI is a true inhibitor it will inhibit the response elicited from the trained or generalised excitors. It is the comparison between CS_t and [CS_t + CI] and S_g and [S_g + CI] which provides the basis of the summation test. At the extinction stage the S_g, [S_g + CI], CS_t, and [CS_t + CI] stimuli were presented without the US. Below is a Table of the four stages of the conditioned inhibition summation task (see Table 3.1).

Table 3.1

The stages of task version one of the Negative Images CI Task: Summation Test broken down by CS and US

Pre-Discrimination		**Discrimination Training**		**Summation Test**		**Extinction Test**
CS	**US**	**CS**	**US**	**CS**	**US**	**CS**
CS	Negative	CS	Negative	CS_t	US Negative	CS_t
		CS_t	Negative	S_g	US Negative	S_g
		[CS + CI]	No US, off white screen	[CS_t + CI]	No US, off white screen	[CS_t + CI]
				[S_g + CI]	No US, off white screen	[S_g + CI]

All instructions and formatting remained the same as the previous experiments in Chapter 2. At the pre-discrimination and discrimination stages there were 10 trials of each CS and US, at the summation test and extinction stage there were 10 trials of each CS and US. The whole computer task takes approximately 15 minutes to complete.

3.2.1.4 Design

All data were analysed using SPSS (version 15.0) and used an alpha of $p = .05$ and paired samples t-tests used a 95% confidence interval. Data were analysed for the pre-discrimination, discrimination, summation and extinction stages.

Pre-Discrimination

The data were entered into a within subjects ANOVA with one factor, trials (1-10). Both the CS and US data were analysed using this format.

Discrimination Training

The CS data were entered into a 2 x 10 within subjects ANOVA with factors, inhibition (CS, [CS+ CI]) and trials (1-10). The US data were entered into a 2 x 10 within subjects ANOVA with factors, valence (negative and off white) and trials (1-10).

Summation and Extinction Stage

The CS data were entered into a 2 x 2 x 10 within subjects ANOVA with factors, inhibition (presence or absence of CI), stimulus type (CS_t, transfer, S_g, generalised) and trials (1-10).

3.2.2 Results

Due to the design of the experiment CS rating results are only meaningful if there is a significant main effect of trials at the pre-discrimination stage, main effect of inhibition at the discrimination training stage, transfer stage or extinction stage. Therefore results are only presented graphically if significant by these effects/interactions and thus meaningful. The US stimuli are designed

to be unpleasant: US ratings were analysed by valence to confirm whether this was indeed the case for the participants of the study. Over the page is a summary table of the overall pattern of results for experiment 1 (see Table 3.2).

Table 3.2

The key main effects and interactions from the Negative Images CI Task: Summation Test experiment 1

	Inhibition
Pre-Discrimination CS	Not significant*
Pre-Discrimination US	Not significant**
Discrimination Training CS	Significant
Discrimination Training US	Significant**
Summation Stage	Significant
Extinction Stage	Significant

* Significant main effect of trials

** Significant main effect of valence

3.2.2.1 Pre-Discrimination

CS ratings

There was no significant main effect, maximum $F(9,99) = .956$, $p = .481$, $\eta^2 = .080$ for the main effect of trials.

US ratings

There was no significant main effect, maximum $F(9,99) = .880$, $p = .546$, $\eta^2 = .074$ for the main effect of trials.

3.2.2.2 Discrimination Training

CS and [CS + CI] ratings

There was a significant main effect of inhibition, $F(1,11) = 28.346$, $p = .001$, $\eta^2 = .720$. The CS stimulus was being rated differently, more negatively, to the [CS + CI] stimulus (see Figure 3.1).

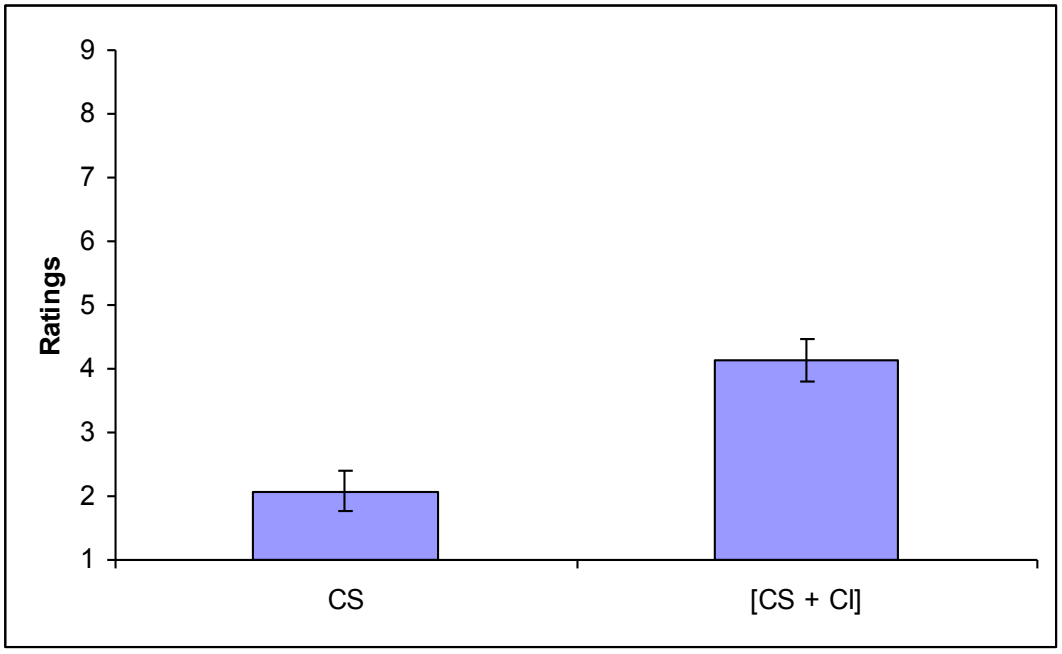


Figure 3.1. The main effect of inhibition at the discrimination stage of the Negative Images CI Task: Summation Test. Error bars represent S.E.M.

There was an overall main effect of trials, $F(9,99) = 2.386$, $p = .017$, $\eta^2 = .178$. There were non-systematic fluctuations over the ten trials (see Table 3.3).

Table 3.3

The main effect of trials at the discrimination stage with non-systematic fluctuations over the 10 trials

Trial	Mean ± S.E.M
1	2.292 ± .401
2	2.958 ± .351
3	2.917 ± .347
4	2.958 ± .345
5	2.917 ± .325
6	3.583 ± .374
7	3.375 ± .205
8	3.292 ± .278
9	3.417 ± .253
10	3.375 ± .332

More importantly, there was a significant interaction between inhibition and trials, $F(9,99) = 4.815$, $p = .001$, $\eta^2 = .304$. Over the course of the ten trials CS and CI were being rated differently; the CS ratings remained consistently negative whereas the [CS + CI] ratings became more neutral over the ten trials suggesting that participants had successfully learnt that the stimuli signalled different outcomes and therefore demonstrated the discrimination (see Table 3.4). Paired t-tests showed that while there was no significant difference between trial 1 and trial 10 ratings of the CS, $t(11) = 2.043$, $p = .071$ there was a significant increase in the ratings of the compound [CS + CI] presentations, $t(11) = -4.758$, $p = .001$

Table 3.4

Interaction between inhibition and trials at the discrimination stage of the Negative Images CI Task: Summation Test

Trials	**CS**		**[CS + CI]**	
	Mean	**S.E.M**	**Mean**	**S.E.M**
1	2.333	.369	2.250	.429
2	2.750	.484	3.167	.548
3	1.583	.336	4.250	.592
4	1.833	.386	4.083	.484
5	2.000	.426	3.833	.562
6	2.667	.482	4.500	.417
7	2.000	.426	4.750	.392
8	1.750	.329	4.833	.386
9	2.000	.477	4.833	.386
10	1.917	.417	4.833	.386

US ratings

There was a significant main effect of valence, $F(1,11) = 30.741$, $p = .001$, $\eta^2 = .775$. The negative US and off white 'No US' stimuli were being rated differently (see Figure 3.2).

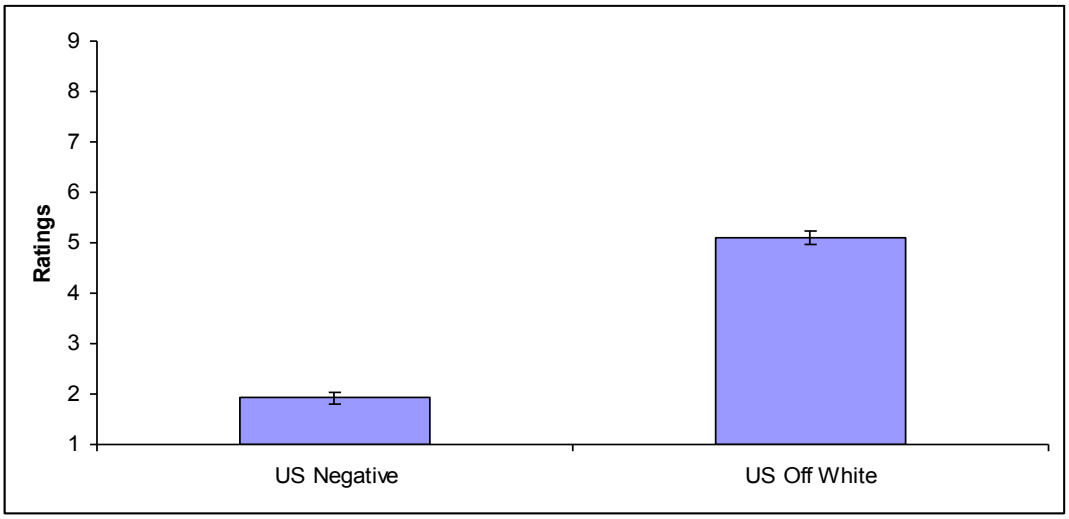


Figure 3.2. The main effect of US valence at the discrimination stage. The negative and off white 'No US' stimuli were being rated differently. Error bars represent S.E.M.

There were no other significant main effects or interactions, maximum $F(9,99) = 1.867$, $p = .068$, $\eta^2 = .144$ for the main effect of trials.

3.2.2.3 Summation Test

CS_t, S_g, $[CS_t + CI]$, $[S_g + CI]$ ratings

There was a significant main effect of inhibition, $F(1,11) = 401.478$, $p = .001$, $\eta^2 = .973$. The CS stimuli (CS_t and S_g) and CI stimuli ($[CS_t + CI]$ and $[S_g + CI]$) were being rated differently (see Figure 3.3).

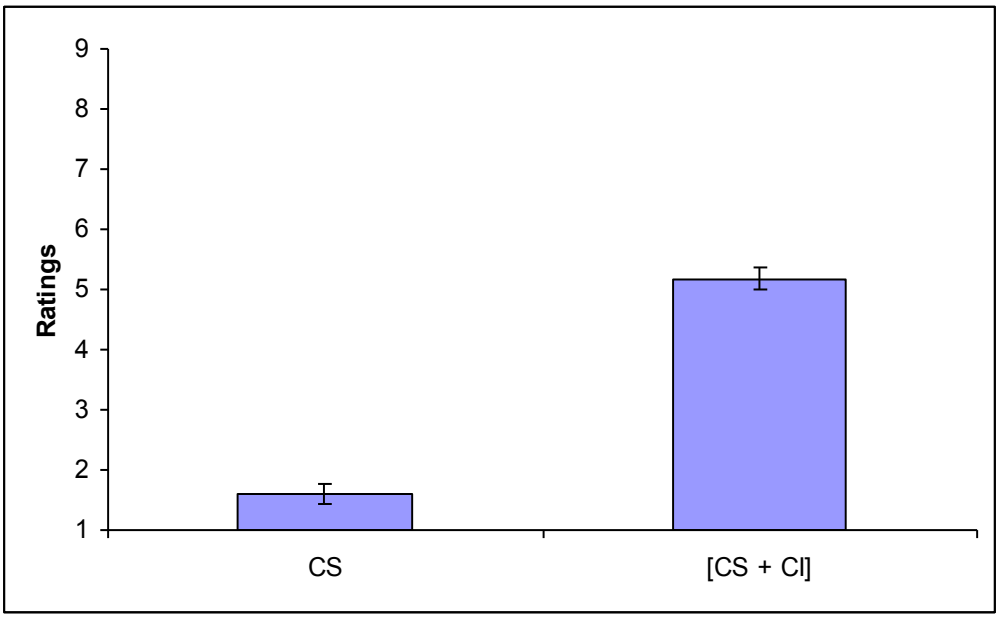


Figure 3.3. The main effect of inhibition at the summation test stage. The CS stimuli, both CS_t and S_g and previously the CI stimuli, both [CS_t + CI] and [S_g + CI] were being rated differently suggesting that the inhibitory properties of the CI had transferred over. Error bars represent S.E.M.

There was a significant interaction between inhibition and stimulus type $F(1,11) = 5.051$, $p = .046$, $\eta^2 = .315$ (see Figure 3.4). However, the summation test was passed for both stimulus types; planned t-test comparisons showed there was a significant difference between CS_t and [CS_t + CI] ratings, $t(11) = -15.520$, $p = .001$, and between S_g and [S_g + CI] ratings, $t(11) = 21.252$, $p = .001$.

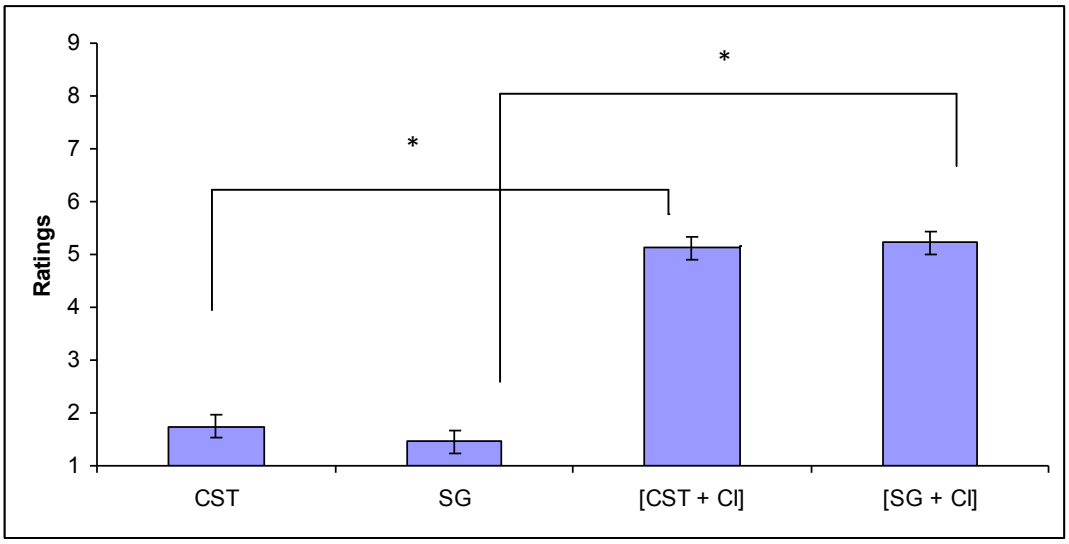


Figure 3.4. The interaction between inhibition and stimulus type at the summation stage. Error bars represent S.E.M. * represents significant t-tests.

There was a significant interaction between inhibition and trials, $F(9,99) = 2.823$, $p = .005$, $\eta^2 = .204$. There were non-systematic fluctuations over the ten trials (see Table 3.5) but generally the CS stimuli were rated as negative and the [CS + CI] stimuli were rated as neutral.

Table 3.5

Interaction between inhibition and trials at the summation test stage of the Negative Images CI Task: Summation Test

Trials	CS Means ± S.E.M.	[CS + CI] Means ± S.E.M.
1	2.208 ± .298	4.792 ± .366
2	1.750 ± .292	5.208 ± .168
3	1.458 ± .179	5.125 ± .125
4	1.500 ± .195	5.125 ± .090
5	1.500 ± .246	5.083 ± .056
6	1.333 ± .178	5.292 ± .179
7	1.542 ± .217	5.208 ± .323
8	1.583 ± .267	5.292 ± .351
9	1.583 ± .253	5.333 ± .198
10	1.542 ± .250	5.250 ± .209

There were no other significant main effects or interactions, maximum $F(1,11) = 1.553$, $p = .239$, $\eta^2 = .124$ for the main effect of stimulus type.

3.2.2.4 Extinction

CS_t, S_g, [CS_t + CI], [S_g + CI] ratings

There was a significant main effect of inhibition, $F(1,11) = 112.867$, $p = .001$, $\eta^2 = .911$. The CS stimuli (CS_t and S_g) and CI stimuli ([CS_t + CI] and [S_g + CI]) were being rated differently (see Figure 3.5).

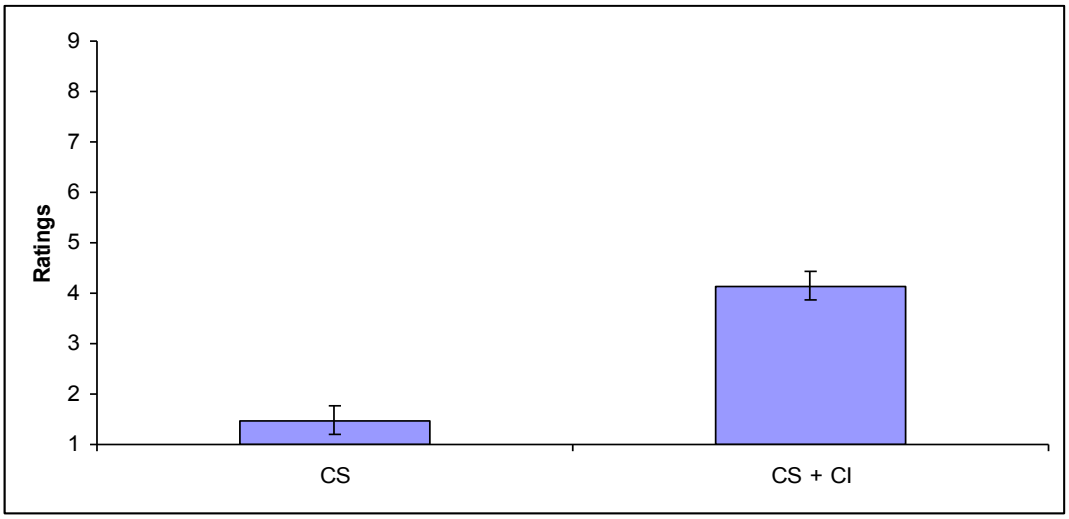


Figure 3.5. The main effect of inhibition at the extinction stage. The CS stimuli, both CS_t and S_g and previously the CI stimuli, both [CS_t + CI] and [S_g + CI] were being rated differently suggesting that the inhibitory properties of the CI had transferred over. Error bars represent S.E.M.

There was a significant main effect of stimulus type, $F(1,11) = 11.602$, $p = .006$, $\eta^2 = .513$. The S_g stimuli were being rated differently (*M* 3.358, *SD*.156) to the CS_t stimuli (*M* 2.271, *SD* .328).

There was a significant interaction between inhibition and stimulus type, $F(1,11) = 15.432$, $p = .002$, $\eta^2 = .584$ (see Figure 3.6). However, on the extinction measure, the summation test was again passed for both stimulus types, for CS_t versus [CS_t + CI] presentations, $t(11) = -2.604$, $p = .025$, and for S_g versus [S_g + CI] presentations, $t(11) = 13.568$, $p = .001$.

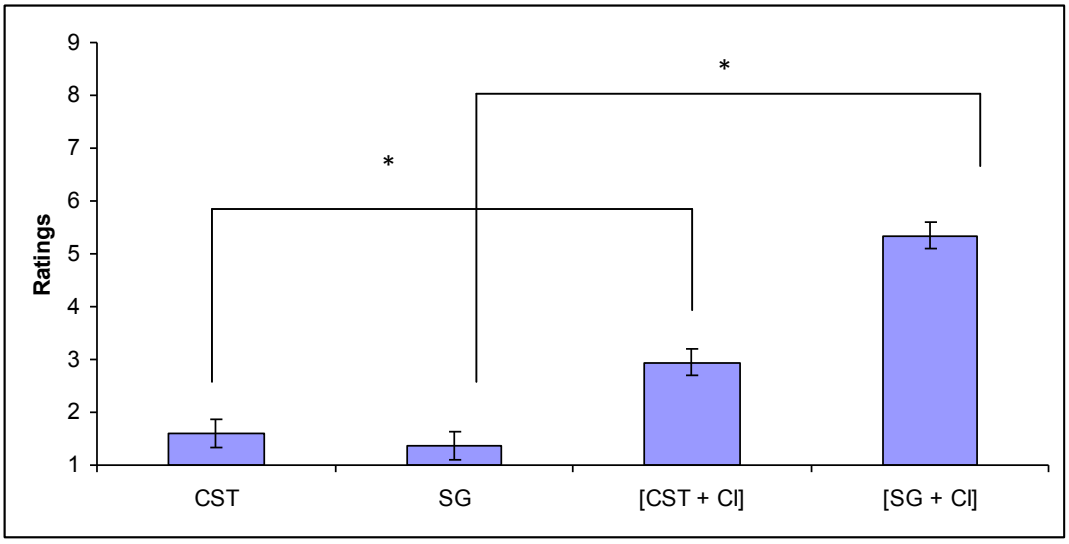


Figure 3.6. The interaction between inhibition and stimulus type at the extinction stage. Error bars represent S.E.M. * represents significant t-tests.

There were no other significant main effects or interactions, maximum $F(9,99) = 1.297$, $p = .248$, $\eta^2 = .105$ for the main effect of trials.

3.2.3 Discussion

The results of Experiment 1 demonstrated discrimination learning and conditioned inhibition was confirmed by the summation tests. At the discrimination stage of the experiment, participants were rating the CS differently depending on whether it was presented concurrently with the CI (or not). This suggests that participants had learnt that the stimuli signalled different things, the CS a negative outcome and the [CS + CI] the absence of such an outcome, represented as an off white screen. Thus participants 'passed' the initial stage of the procedure that is necessary to demonstrate conditioned inhibition. At the summation stage, participants were rating the non-inhibited trials differently from the inhibited trials. The summation test performance was somewhat dependent on stimulus type (either transfer or generalised) but importantly the key stimuli that form the summation test were significantly

different from each other, CS_t presentations were rated significantly more negatively than [CS_t + CI] and S_g presentations were rated significantly more negatively than [S_g + CI]. This significant summation test discrimination demonstrates that the CI was a true inhibitor in that it transferred its inhibitory properties over to the CS_t and S_g as reflected in the participants' ratings.

This experiment supports previous research that has demonstrated conditioned inhibition via a summation test (Grillon & Ameli, 2001; Karazinov & Boakes, 2004; McNally & Reiss, 1984; Migo et al., 2006; Neumann et al., 1997). This task version used stimuli that would elicit an emotional response in the participants. The IAPS stimuli that are widely rated as arousing and negative were used to accomplish this.

Although the results of this first task version were positive and discrimination learning and conditioned inhibition was successfully shown another task version where a new stimulus will be introduced will be tested in the next experiment. As mentioned previously (see page 27) although the 'No US' screen can arguably be interpreted as a salient outcome rather than the absence of an outcome however, what participants interpreted as representative of the absence of an outcome has been examine (Migo et al., 2006). The results showed that there was no significant difference between a background computer screen and a rocket as representative of the absence of an outcome, a 'No US' (Migo et al., 2006). It was therefore decided that to make script of the task and practicalities of running the task smooth an off white screen was to be used as the 'No US'. However, a new stimulus will be introduced into the next experiment. This will be a 'minus trial' condition. A 'minus trial' is a trial where the 'No US' screen is presented without a preceding [CS + CI]; the 'No US' is presented alone in this trial. By introducing this stimulus any direct association, e.g. any association the participant develops directly between the CI and the absence of an outcome, 'No US', will be weakened. In order to demonstrate conditioned inhibition two key tests are ideally used: retardation and summation to counter any evidence that less or more attention is being paid to the CI respectively. The addition of a 'minus trial' weakens any direct

association between the CI and the absence of an outcome ‘No US’ and therefore any ‘more’ attention paid to it. The next task will procedurally stay similar with the exception of the addition of the ‘minus trial’, a ‘No US’ off white screen presented without a preceding [CS + CI].

3.3 Experiment 2

3.3.1 Methods

3.3.1.1 Participants

A total of 12 undergraduate and general population participants volunteered to take part in this experiment. There were five males and seven females with a mean age of 35 (range from 25 - 58). All participants had normal or corrected to normal vision and were naïve to the current task and hypothesis.

3.3.1.2 Apparatus

The stimuli were the same as in the previous experiments in Chapter 2.

3.3.1.3 Procedure

The procedure remained the same except for one minor change; minus trials were introduced at the discrimination stage, this is where the ‘No US’ was presented in the absence of CS or [CS + CI] (see Table 3.6).

Table 3.6

The stages of task version two of the Negative Images CI Task: Summation Test broken down by CS and US. A minus trial was introduced at the discrimination training stage

Pre-Discrimination		**Discrimination Training**		**Summation Test**		**Extinction Test**
CS	**US**	**CS**	**US**	**CS**	**US**	**CS**
CS	Negative	CS	Negative	CS_t	US Negative	CS_t
		CS_t	Negative	S_g	US Negative	S_g
		[CS + CI]	No US, off white screen	[CS_t + CI]	No US, off white screen	[CS_t + CI]
			Minus trial, No US, off white screen	[S_g + CI]	No US, off white screen	[S_g + CI]

Participants were told to use the CS or [CS + CI] as cue to guess on the rating scale what would come next. They were then told that this would be followed by the US but that also sometimes the 'No US' would just appear on the screen and that whenever it did to rate what they thought of that picture. The 'minus trials' ('No US' screen presented randomly throughout the discrimination stage) were introduced to weaken any direct association between the CI and the representation of the absence of the US (the off white screen, which was presented on its own during this task variant).

3.3.1.4 Design

All data were analysed using SPSS (version 15.0) and used an alpha of $p = .05$. The data were analysed using the same format as the previous experiment.

3.3.2 Results

Due to the design of the experiment CS rating results are only by certain factors (see page 90). Therefore results are only presented graphically if significant by these effects and thus meaningful. Below is a summary table of the overall pattern of results for experiment 2 (see Table 3.7).

Table 3.7

The key main effects and interactions from the Negative Images CI Task: Summation Test experiment 2

	Inhibition
Pre-Discrimination CS	Not significant*
Pre-Discrimination US	Not significant**
Discrimination Training CS	Significant
Discrimination Training US	Significant **
Summation Stage	Significant
Extinction Stage	Significant

* Significant main effect of trials

** Significant main effect of valence

3.3.2.1 Pre-Discrimination

CS ratings

There was no significant main effect, maximum $F(9,99) = .841$ $p = .643$, $\eta^2 = .079$, for the main effect of trials. Participants were not rating the CS differently over the ten trials; they rated it consistently as neutral.

US ratings

There was no significant main effect, maximum $F(9,99) = .925$, $p = .411$, $\eta^2 = .104$ for the main effect of trials. Participants were not rating the US differently over the ten trials; they rated it consistently as negative.

3.3.2.2 Discrimination Training

CS and [CS + CI] ratings

There was a significant main effect of inhibition, $F(1,11) = 11.877$, $p = .007$, $\eta^2 = .569$. The CS and [CS + CI] stimuli were being rated differently (see Figure 3.7).

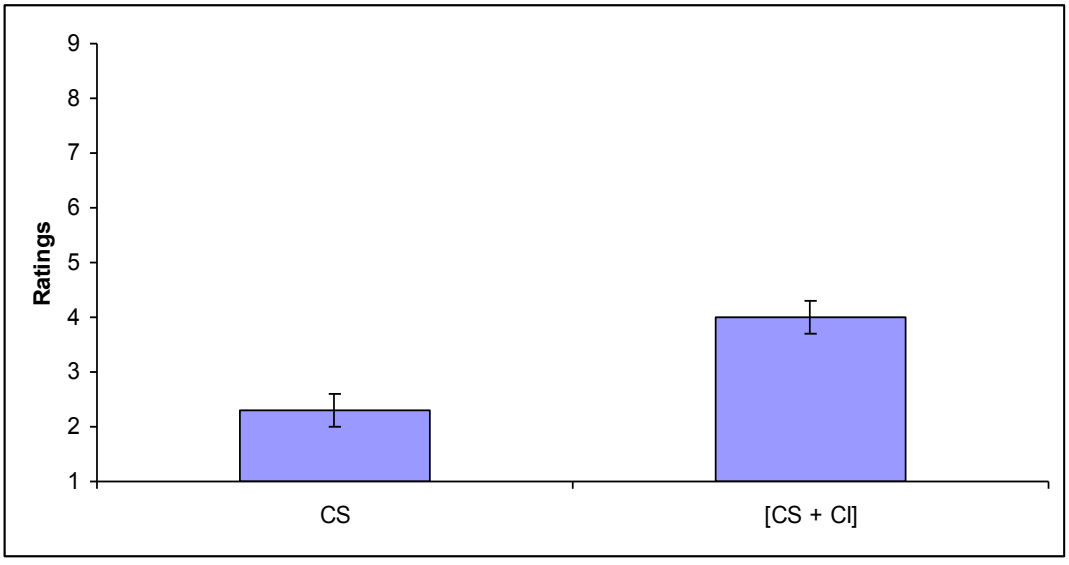


Figure 3.7. The main effect of inhibition at the discrimination stage of the Negative Images CI Task: Summation Test. Error bars represent S.E.M.

There were no other significant main effects or interactions, maximum $F(9,99) = 1.915$, $p = .061$, $\eta^2 = .175$ for the interaction between inhibition and trials.

US ratings

There was a significant main effect of valence, $F(1,11) = 7.609$, $p = .022$, $\eta^2 = .458$. The negative US and off white 'No US' stimuli were being rated differently (see Figure 3.8).

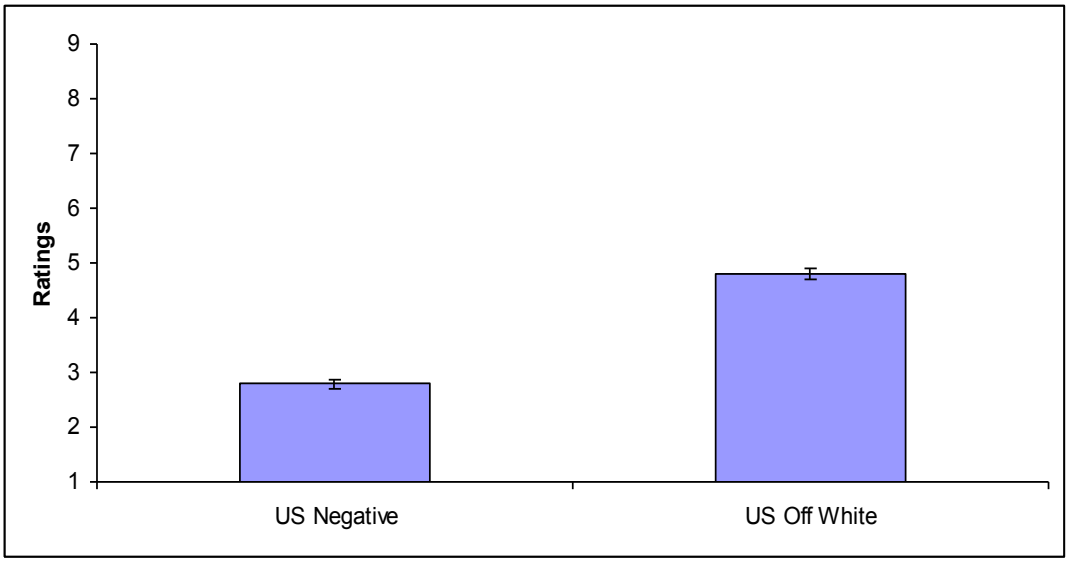


Figure 3.8. The main effect of US valence at the discrimination stage. The negative and off white 'No US' stimuli were being rated differently. Error bars represent S.E.M.

There were no other significant main effects or interactions, maximum $F(9,99) = 1.501$, $p = .162$, $\eta^2 = .143$ for the main effect of trials.

3.3.2.3 Summation Test

CS_t /S_g and [CS_t + CI]/[S_g + CI] ratings

There was a significant main effect of inhibition, $F(1,11) = 24.834$, $p = .001$, $\eta^2 = .734$. The CS_t / S_g and [CS_t + CI]/[S_g + CI] were being rated differently (see Figure 3.9).

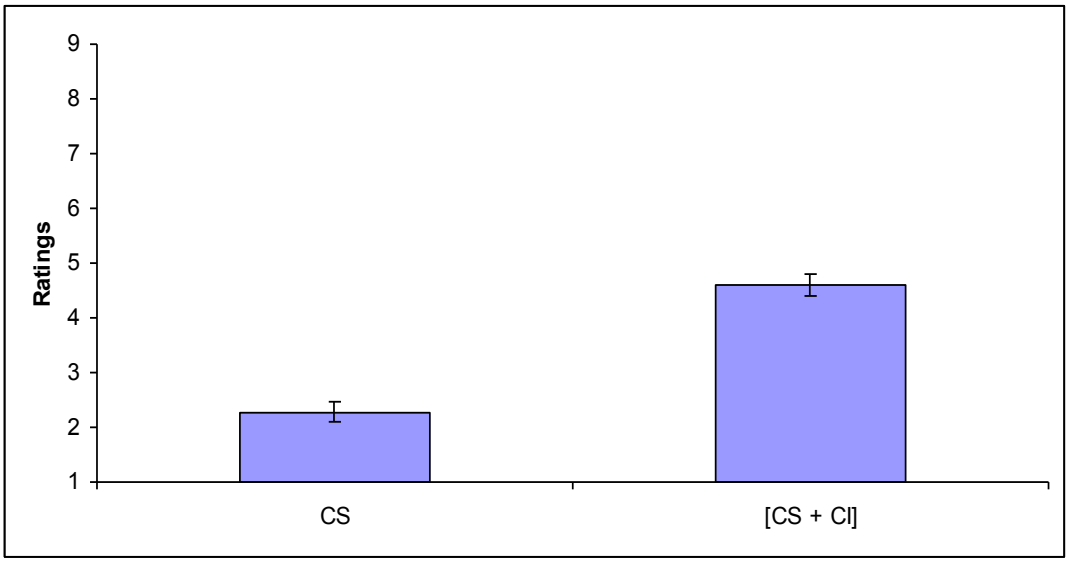


Figure 3.9. The main effect of inhibition at the summation test stage. The CS_t /S_g and [CS_t + CI]/[S_g + CI] were being rated differently suggesting that the inhibitory properties of the CI had transferred over. Error bars represent S.E.M.

There were no other significant main effects or interactions, maximum $F(1,11) = 1.923$, $p = .199$, $\eta^2 = .176$ for the interaction between inhibition and stimulus type.

3.3.2.4 Extinction Stage

CS_t /S_g and [CS_t + CI/[S_g + CI]] ratings

There was a significant main effect of inhibition, $F(1,11) = 20.137$, $p = .002$, $\eta^2 = .691$. The S_g and [CS_t + CI] were being rated differently (see Figure 3.10).

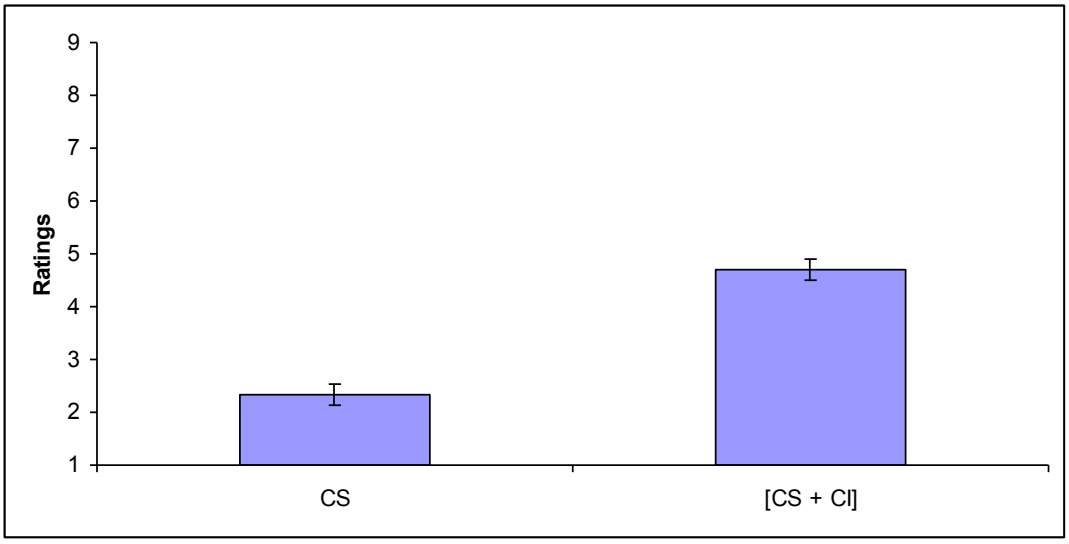


Figure 3.10. The main effect of inhibition at the extinction stage. The CS_t /S_g and [CS_t + CI]/[S_g + CI] were being rated differently suggesting that the inhibitory properties of the CI had transferred over. Error bars represent S.E.M.

There were no other significant main effects or interactions, maximum $F(1,11) = .1.763$, $p = .217$, $\eta^2 = .164$ for the interaction between inhibition and stimulus type.

3.3.3 Discussion

The results from the second task version show that conditioned inhibition was successfully demonstrated via a summation test. At the discrimination stage, as required, participants were rating the CS and the [CS + CI] significantly different from each other. Participants had learnt that the CS signalled a negative outcome and that the [CS + CI] signalled the absence of any such outcome. At the summation stage, participants continued to rate key CS and [CS + CI] stimuli significantly different from each other. Specifically, they rated both CS_t and S_g as negative, which reflects the expectation of a negative outcome, whereas they rated the [CS_t + CI] and [S_g + CI] presentations as neutral, indicating an expectation of the absence of any such outcome. Importantly, in Experiment 2, the stimulus type (CS_t vs. S_g) had no significant effect on summation test performance. This result confirms that the inhibitory

properties of the CI had transferred over to CS_t and S_g and the CI was a true inhibitor.

Moreover in this specific task version, the introduction of the 'minus trial', a trial where the off white 'No US' screen was presented alone, did not effect the demonstration of conditioned inhibition as tested by the summation test. In fact, it could be argued that the introduction of the 'minus trial' actually weakened any direct association between the CI and the absence of an outcome, the 'No US'. From the results, in the first experiment summation was passed but interacted with stimulus-type (CS_t and S_g) however, in the current task design this was not the case. The inhibitory properties of the CI transferred over to the CS at the summation stage demonstrating conditioned inhibition. Therefore, the 'minus trial' diluted any direct link between the CI and absence of an outcome (some theories of learning suggest that attention is a pre-requisite and in this case participants could be paying too much attention to the CI and directly associated that with the absence of an outcome) but yet summation was still demonstrated with both test stimuli: CS_t and S_g.

The next conditioned inhibition summation task version has been used previously (Kantini et al., 2011a, Kantini et al., 2011b; Migo et al., 2006) and is being introduced as a comparison. For my factors which are detailed in this section the next experiment provides a good basis to compare with the previously reported experiments. All the stimuli in the versions detailed so far have been presented in a simultaneous manner; they all appear on the screen at once. In the next task version stimuli will be presented in a serial sequence. Further to this, the stimuli in all the previous tasks have been arousing for the participants; they were selected from the IAPS database for this purpose. In the next task neutral stimuli will be used. Learning in the next task version is implicit and with distractors, providing a comparison for the two versions described before. Another distinction between the two tasks is the next task will control for external inhibition. External inhibition occurs when a neutral stimulus occurs slightly prior or simultaneously with a learned response impacting on responding and causing a decrease. It is a natural response to divert attention to the other stimulus but ultimately causing responding to it to

weaken. It is ideal to be able to control for external inhibition and demonstrate that learning can occur in different contexts. In the next task this will be examined and additional stimuli will be introduced to control the effects of external inhibition. Stimuli of various colors, shapes and sizes will be introduced so that participants are required to learn about the CS and CI under different contexts therefore controlling for external inhibition. Overall, the next task will still examine conditioned inhibition as measured by the summation task but many components that make up the task will be altered to be able to provide a comparison.

3.4 Experiment 3

3.4.1 Methods

3.4.1.1 Participants

A total of 46 undergraduate and general population participants volunteered to take part in this experiment. There were 14 males and 32 females with a mean age of 25 (range from 19 - 37). All participants had normal or corrected to normal vision and were naïve to the current task and hypothesis.

3.4.1.2 Apparatus

Nine coloured pictures of planets were used as the CS stimuli; these were CSA and CSB, plus CS_t (transfer stimulus) and S_g (a generalised stimulus). Additionally to control for the effects of external inhibition, there were seven distractor planets (see Figure 3.11). A picture of an intact rocket was used as the US and a picture of an exploded rocket was used as the absence of a US (see Figure 3.12). An earlier study examined whether participants rated a blank screen or an exploded rocket to represent the absence of a US differently (Migo et al., 2006). The results showed that the method used to represent the absence of the otherwise expected outcome made no difference to the demonstration of

the conditioned inhibition effect. In the present study, it was therefore decided to use an exploded rocket to denote US absence. A grey frame that surrounded the perimeter of the screen was used as the CI (see Figure 3.13). All stimuli were presented against a navy background on the screen of a personal computer using E-Prime (version 1.1) software. The computer screen was positioned approximately .5m at eye level away from the participant, the keyboard in front and mouse on their right hand side.

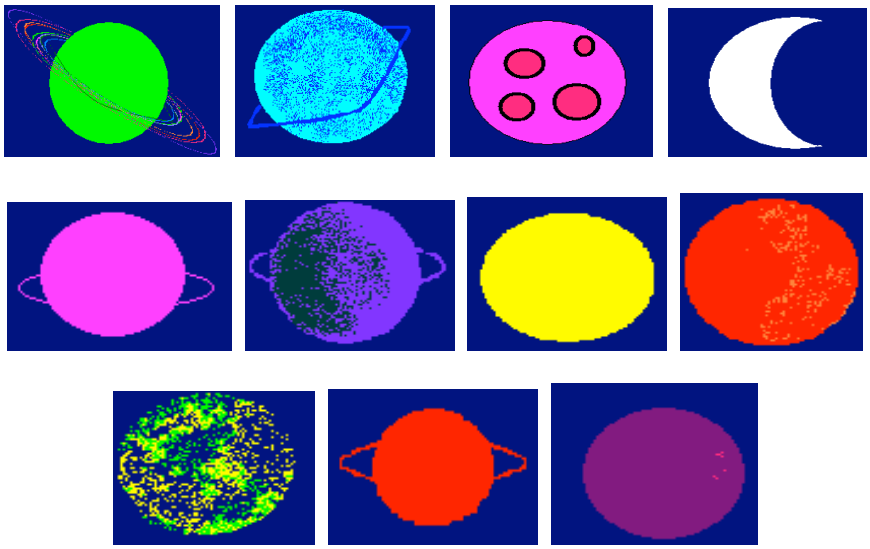


Figure 3.11. The stimuli used in the task, top row from left to right CSA, CSB, CS_t, S_g on the bottom two rows the seven distractor planets (Kantini et al., 2011a; Kantini et al., 2011b; Migo et al., 2006). These images are not to scale and were shown in various sizes in the task version.

Figure 3.12. The US stimuli, an intact rocket and an exploded rocket.

Figure 3.13. The CI grey frame screen, the blue screen presented on non-inhibited trials and the question mark.

3.4.1.3 Procedure

Below is a Table of the 2 stages of the 'Mission to Mars' CI Task: Summation Test (see Table 3.8).

Table 3.8

The design of the 'Mission to Mars' CI Task: Summation Test

Discrimination Training		**Summation test**
CS	**US**	**CS**
CSA	Intact Rocket	CS_t
[CI, CSA]	Exploded Rocket	[CI, CS_t]
CSB	Intact Rocket	S_g
[CI, CSB]	Exploded Rocket	[CI, S_g]
CS_t	Intact Rocket	-

All instructions were presented on a navy background, white font Courier New, point size 16, bold, positioned in the centre of the screen, and remained until the subject pressed the mouse. The rating scale was from 1-9: nine = intact rocket, five = unsure, one = exploded rocket.

Discrimination Stage

Instructions informed the participant that their fleet of spaceships was on a mission to Mars and that some of the fleet's rockets were exploding. The participant in the first stage was instructed to keep watch on their fleet by counting the number of intact rockets and that whenever they saw either an intact or exploded rocket to press the mouse button, this was simply so that the computer task would keep running. For each trial, if it was a CI trial, the grey frame would appear on the screen for 1000 ms, four planets would then appear serially, one CS and three distracter planets, on the screen for 2000 ms and

1000 ms respectively. Depending on whether it was a CS or CI trial an intact or exploded rocket would appear on the screen until the participant had pressed the mouse button then three more distracter planets would appear on the screen for 1000 ms each. All stages of the trial were presented on a navy screen; the planets appeared randomly on the screen at different locations: top, bottom, left, right, and the four corners. The rocket always appeared in the centre of the screen. There were 27 presentations of the CS trials and 18 presentations of the CI trials, 45 trials in total. Instructions informed the participant to report the number of intact rockets that they had counted; this was actually a distracter task.

Summation Stage

Instructions then informed the participant that when a question mark appeared on the screen they needed to indicate on a scale of 1 – 9 the likelihood of an intact rocket appearing; nine was the greatest likelihood of an intact rocket appearing, five was unsure, and one was the greatest likelihood of an exploded rocket appearing. For each trial, if it were a CI trial, the grey frame would appear on the screen for 1000 ms, four planets would then appear serially, one CS and three distracter planets, on the screen for 2000 ms and 1000 ms respectively. A question mark would then appear on the screen with the 1 – 9 scale underneath. Participants had to click on a number and the answer would then appear on the screen. All stages of the trial were presented on a navy screen, the planets appeared randomly in either cardinal or ordinal positions, the rocket always appeared in the centre of the screen. There were 10 CS trials and 10 CI trials, 20 in total. The whole computer task takes approximately 20 minutes to complete.

3.4.1.4 Design

All data were analysed using SPSS (version 15.0) and used an alpha of $p = .05$. Learning at the discrimination stage was implicit and with distractors, no data were collected at this stage. Data were analysed at the summation stage only. The data were entered into a 2 x 2 x 5 within subjects ANOVA with factors inhibition (presence or absence of CI) stimulus type (CS_t or S_g) and trials (1-5).

3.4.2 Results

Below is a summary table of the key significant result for Experiment 3 (see Table 3.9).

Table 3.9

The key main effects and interactions from the 'Mission to Mars' CI Task: Summation Test

	Inhibition
Summation Stage	Significant

3.4.2.1 Summation Test

There was a significant main effect of inhibition, $F(1,45) = 11.769$, $p = .001$, $\eta^2 = .207$. Stimuli presented in the absence of an inhibitor (*M* 5.717, *SD* .193) were being rated differently to stimuli that were presented immediately after an inhibitor (*M* 4.533, *SD* .188) (see Figure 3.14).

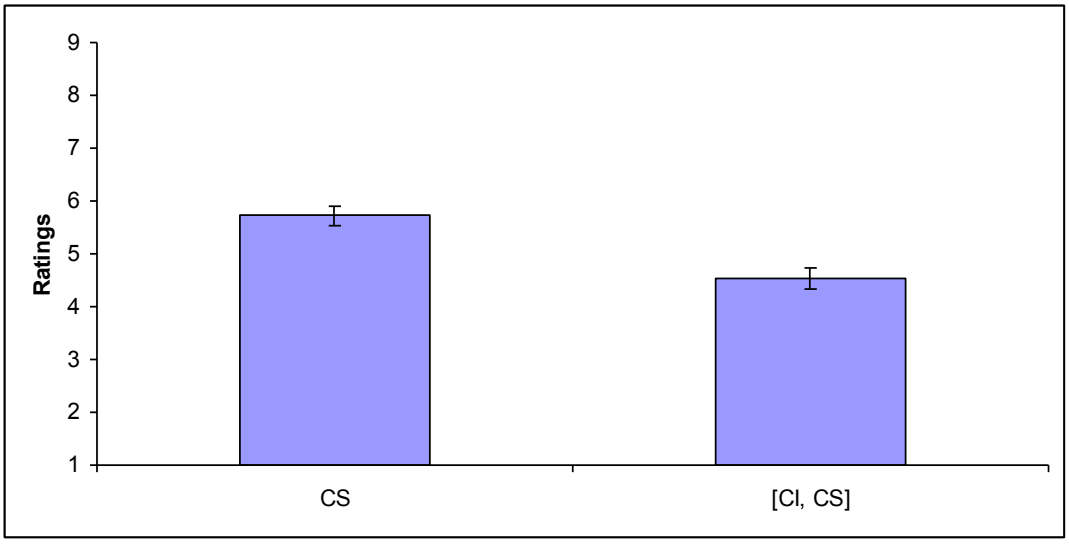


Figure 3.14. The main effect of inhibition for the 'Mission to Mars' CI Test: Summation Task. Participants were rating the CS and [CI, CS] stimuli differently over the five trials. Error bars represent S.E.M.

There were no other significant main effects or interactions, maximum $F(4,168) = 1.532$ $p = .195$, $\eta^2 = .033$, for the interaction between inhibition and trials.

3.4.2.2 Awareness Check

Participants were asked at the end of the task if they knew what predicted an intact or an exploded rocket. Out of 46 participants three said that they thought the link was between the grey frame and whether an intact or exploded rocket would appear, the other 43 participants thought the size of planets or their colour predicted the outcome (or its absence). Overall the majority of the participants tested were not explicitly aware of the contingencies.

3.4.3 Discussion

Conditioned inhibition as tested by a summation test was successfully demonstrated in the third task version. At the summation test stage there was a significant difference in the way participants were rating the CS_t and S_g and the alternative [CI, CS_t] and [CI, S_g] presentations. They were rating the CS_t and S_g stimuli higher on the rating scale which suggests they learnt that these preceding stimuli predicted that an intact rocket would be displayed. They were rating the [CI, CS_t] and [CI, S_g] lower on the rating scale suggesting that they learnt that these preceding stimuli predicted the absence of an outcome (represented by the display of an exploded rocket). The representation of the absence of an outcome, the rocket, is arguably a salient outcome and does not conform to traditional demonstrations of non-reinforced trials. However, as mentioned previously (see page 99) and also previously demonstrated (Migo et al., 2006) this task version with these stimuli have successfully demonstrated conditioned inhibition and that the rocket is a reliable representation of the absence of an outcome. Participants were rating the key stimuli significantly differently from each other. This difference in ratings suggests that the inhibitory properties of the CI had transferred over and that stimulus type (CS_t vs. S_g) did not affect the expression of conditioned inhibition. The participants were rating the non-inhibited stimuli (CS_t and S_g) differently from the inhibited stimuli ([CI, CS_t] and [CI, S_g]). Thus, the results suggest that the CI in this task is a true inhibitor in that conditioned inhibition was demonstrated on both variants of the summation test.

Instructions at the discrimination stage distracted participants about the task; they had to count the number of rockets whilst watching the screen. It was not until the end of the task, they were asked whether they understood what predicted an intact or an exploded rocket. The feedback obtained from participants (the 'awareness check') was consistent with the possibility that the learning at the discrimination stage was implicit: the majority of participants did not articulate any awareness of the true experimental contingencies.

This supports previous research that has demonstrated conditioned inhibition via a summation test not only in human studies (Grillon & Ameli, 2001; Karazinov & Boakes, 2004; McNally & Reiss, 1984; Migo et al., 2006; Neumann et al., 1997) but also in animal studies (Cole et al., 1997; Murray & Pearce, 2010; Pineno, 2010; Rescorla & Holland, 1977; Rodrigo et al., 2009; Urcelay et al., 2008). The results of the experiments detailed in this Chapter demonstrate that conditioned inhibition via a summation test was relatively (in comparison with the previous Chapter and the retardation test method) simpler to show. In must be noted though that the tasks that were used in this Chapter were developed from an already established protocol (the same design was used across all three summation test tasks) from a conditioned inhibition summation task (Migo et al., 2006) and using stimuli where conditioned inhibition via a retardation task had been successfully demonstrated. Therefore any judgement that conditioned inhibition as tested by a summation test is easier to show is confounded by these factors and cannot be fully concluded by the evidence and tasks used in the current thesis. Had the tasks been developed in the opposite order this would perhaps not be the case. Nonetheless it is an interesting methodological point that must be acknowledged that there are potentially differences between the summation and retardation tests and the ease with which they are able to demonstrate conditioned inhibition in humans.

Thus, to conclude, the results from all three task versions used in the present Chapter have successfully demonstrated conditioned inhibition, as confirmed by the summation test. In all three task versions, the inhibitory properties showed the transfer which is held to be typical of a true inhibitor (Grillon & Ameli, 2001; Hearst, 1972; Kantini et al., 2011a; Kantini et al., 2011b; Karazinov & Boakes, 2004; McNally & Reiss, 1984; Migo et al., 2006; Neumann et al., 1997; Rescorla, 1969).

Chapter 4: Response Inhibition Tasks

4.1 Introduction

As previously mentioned, inhibitors potentially play a key role in the maintenance of anxiety, OCD and Panic Disorder. The previous Chapters have detailed the development of computer tasks to examine conditioned inhibition as measured by retardation in one task variant (Negative Images CI Task: Retardation Test) or by a summation test in two task variants (original task described in this thesis Negative Images CI Task: Summation Test and already established task, Migo et al., 2006; Kantini et al., 2011a; Kantini et al., 2011b, 'Mission to Mars' CI Task: Summation Test). All task variants successfully demonstrated conditioned inhibition; the stimuli were true inhibitors as this was reflected in the way the participants rated the stimuli at the retardation or summation stages of the tasks. However, other inhibitory processes may also potentially play a key role in the maintenance of anxiety, OCD and Panic Disorder.

Inhibition has been defined as the ability to control a response to stimuli (Harnishfeger, 1995). This could either be a behavioural response (the physical reaction to stimuli) or a cognitive response (the thoughts or emotional reactions generated by stimuli) (Harnishfeger, 1995). A taxonomy of three different classes of inhibition based on eight underlying inhibitory processes has been proposed (Nigg, 2000). The first class is executive inhibition effects and includes interference control, cognitive inhibition, behavioural inhibition and oculomotor processes. The second class is motivational inhibition effects and includes response to punishment cues and response to novelty process. Finally, the third class is automatic inhibition of attention and includes suppression of recently inspected stimuli and suppression of information at unattended locations. People who experience anxiety or suffer from OCD or Panic Disorder often have distressing worrying thoughts and can adapt behaviours to cope with those thoughts or anxiety provoking situations (DSM-IV, 2000). If

we cannot manage or control these thoughts or behaviours this may potentially contribute to the continuation and maintenance of the anxiety feelings and symptoms; cognitive theories of OCD and Panic Disorder suggest that attention is selectively biased towards threatening stimuli (Barlow, 1988; Beck et al., 1985; Eysenck, 1992). A variety of tasks have been developed, some of which are discussed in more detail in the Chapter, to measure a persons ability to control their thoughts and behaviours: Stroop task (Stroop, 1935), Wisconsin Card Sorting Task (Berg, 1948), Stop-Signal Task, Negative Priming (Tipper & Cranston, 1985), Go/No-Go Task (Donders, 1868; 1969; Luce, 1986).

The Stroop Task is commonly used to investigate response inhibition (MacLeod, 1991; Stroop, 1935). Participants are required to categorise stimuli based on what colour ink the word is presented in. Colour words are presented either congruently (the same colour as the word, e.g. the word red in red ink) or incongruently (a different colour to the word, e.g. the word red presented in blue ink). A cognitive interference occurs between the word and the colour it is presented in, causing participants response to be less accurate and slower to stimuli that are colour incongruent. Although in the original task participants' answers (the colour words) were reported verbally (Stroop, 1935), the Stroop effect has been successfully shown using computer keyboard, when participants are required to press the designated key to indicate their responses (Keele, 1972; Pritchatt, 1968). Many studies have shown this classic Stroop effect (see MacLeod, 1991 for a comprehensive review). The Stroop task has also been further developed to include an emotional component by using stimuli that are associated with mood or mood disorders, the Emotional Stroop Task. Individuals who are sensitive to such stimuli would be expected to have less accurate and slower response latencies for emotional words (Williams et al., 1996). Studies that have looked specifically at anxiety, OCD and Panic disorder to date have had mixed results, with some studies reporting no difference in colour naming latencies (Kyrios & Iob, 1998; McNally et al., 1992; 1994; McNeil et al., 1999) whereas some do report differences (Foa et al., 1993; Lavy et al., 1994; Thorpe & Salkovskis, 1997a; Thorpe & Salkovskis 1997b).

The Go/No-Go Task is another widely used task to investigate response inhibition (Donders, 1868; 1969; Luce, 1986). Participants are required to respond to the more frequently presented Go stimuli as quickly as possible and inhibit their responses to the less frequently presented No-Go signal. The bias towards Go signals creates a pre-potent response that the participants are then required to inhibit to the No-Go stimuli. Like the Stroop Task, the Go/No-Go Task can incorporate emotional stimuli; participants that are sensitive to these stimuli may display differences in their ability to inhibit their responses towards them. This has been investigated in OCD and Panic Disorder with neutral stimuli (Aycicegi et al., 2003; Watkins et al., 2005) and results have shown that participants that suffer from OCD or Panic Disorder show response impairment (they are slower to respond to emotional stimuli) in comparison to healthy or clinical controls (Bannon et al., 2002; Penadés et al., 2007).

The aim of the experiments detailed in the current Chapter is to develop a variety of tasks which are suitable for use in healthy and clinical populations, to examine different aspects of inhibition. This Chapter will describe the methods and results of the various inhibitory tasks and the relationship to individual differences (specifically measures of anxiety differences within a normal range) will be described in Chapter 5. The first task described in this Chapter is the Emotional Stroop Task. Four categories of words were used: neutral, OCD-related, negative and colour words; the colour words were presented in both the congruent and incongruent format and it is these two conditions which provide the basis to the classic Stroop Task. The neutral, OCD-related and negative words were taken from a previous study (Lavy et al., 1994). The study showed an emotional Stroop effect with a diagnosed OCD sample, specifically with negative OCD related words, participants were most delayed for OCD negative words compared to OCD positive, general negative and general positive words. In the current task participants were required to categorise all four types of stimuli depending on what colour ink they were presented in by pressing the corresponding key on the keyboard.

The second task explained in this Chapter is the Go/No-Go Words Task. Previous studies have used neutral shapes or words (Aycicegi et al., 2003; Watkins et al., 2004). The task used in the current Chapter incorporates emotional stimuli related to OCD and anxiety; again these words were taken from the Lavy et al., (1994) study. Participants were required to respond to the Go signal (words presented in italics format) by pressing the space bar/'g' key as quickly and as accurately as possible and let the computer program time out on the No-Go trials. This task went through three design versions. Further to this people are often aroused more so by images than words, therefore the third task that is described in this study are the Go/No-Go Images Tasks (two versions) using emotional images related to OCD and anxiety. Participants were required to respond to the Go signal as quickly and as accurately as possible and let the computer program time out for the No-Go Task. There are two versions of the Go/No-Go Images Tasks. In the first version, Go/No-Go Border Images Task, the Go signal was whether the images have a black border around them or not. In the second version, Go/No-Go Colour Images Task, the Go signal was whether the images were presented in colour and not in black and white. All tasks were administered in a counterbalanced way across all participants. The method and results of each task are detailed and discussed.

4.2 Stroop

4.2.1 Methods

4.2.1.1 Participants

A total of 144 undergraduate and general population participants volunteered to take part in this experiment (individual difference measures in relation to performance on the Stroop Task are discussed in Chapter 5). There were 47 males and 97 females with a mean age of 24 (range from 18 – 57 years). All participants had normal or corrected to normal vision and were naïve to the current task and hypothesis.

4.2.1.2 Apparatus

Six neutral words (practice trials), six OCD words, six negative words and three colour words were used as the stimuli in the Emotional Stroop Task. The words were selected from a task that demonstrated an emotional Stroop bias (Lavy et al., 1994). The words were, neutral: square, fork, potato, percent, month and blanket, OCD: mess, doubt, filthy, uncertain, guilty and fail, negative: hate, abuse, deceit, murder, treachery and war, colour in/congruent: blue, red green. The words were presented on a black background, green, red or blue text, font Arial, point size 48, and positioned in the centre of the screen. Neutral words were only presented at the practice stage. OCD and negative words were randomly but equally allocated to be presented in the three colours green, red and blue. The colour words were presented in their congruent and incongruent forms. The stimuli were presented in a random order. All stimuli were presented on a 15-inch screen of a personal computer using E-Prime (version 1.1) software. The screen was positioned approximately .5m at eye level away from the participant, the keyboard in front and mouse on their right hand side.

4.2.1.3 Procedure

All instructions were presented on a white background, black text, font Courier New, point size 16, bold and positioned in the centre of the screen and remained until the subject pressed the mouse button.

Practice trials – The instructions informed the participant that they would be presented with a series of words and that they needed to categorise them by pressing the corresponding colour coded number key as quickly as possible. The words were categorised into either presented in red, blue or green colours. Participants were given feedback as to whether they had correctly categorised the word and displayed the time taken in milliseconds to correctly categorise the word. Either, ‘Correct’ ‘Incorrect’ or ‘No response detected’ would appear

on the screen for 1000 ms. Trials came up in a random order. All trials were presented on a white screen with the word presented in coloured text aligned in the centre of the screen. A word would then appear on the screen and remained on the screen until the participant had categorised it. The trial did not time out. In the practice trials there were 12 trials using neutral words that would not be presented again in the real testing stage.

Test trials – The protocol for the test trials was the same as the practice trials except that there was no feedback at this stage. There were 168 trials, with an equal number of each colour and word-type.

4.2.1.4 Design

All data were analysed using SPSS (version 15.0) and used an alpha of $p = .05$ and paired samples t-tests used a 95% confidence interval. Before analysis data were blocked to make a more condensed version of the data suitable for ANOVA analysis. There were 42 trials of each category and both accuracy and reaction time were recorded. All practice trials were excluded.

Only data where the participants had responded correctly were included in the analyses of the reaction time data. Data were blocked into six blocks of seven trials. The blocks were averaged and the data was entered into a 4 x 6 within subjects ANOVA with factors word-type (OCD, negative, colour congruent and colour incongruent) and blocks (1-6).

For accuracy all data were used and was blocked into six blocks of seven trials. In this case, the scores obtained on each trial were added together and averaged. The data were entered into a 4 x 6 within subjects ANOVA with factors word-type (OCD, negative, colour congruent and colour incongruent) and blocks (1-6).

4.2.2 Results

4.2.2.1 Reaction Time

There was a significant main effect of word-type, $F(3,429) = 96.532$, $p = .001$, $\eta^2 = .417$. Paired samples t-tests revealed that the reaction times for these word-types were significantly different from each other (congruent and incongruent words, $t(143) = -7.565$, $p = .001$, congruent and OCD words, $t(143) = -3.346$, $p = .032$, incongruent and negative words, $t(143) = 6.130$, $p = .001$, incongruent and OCD words, $t(143) = 4.687$, $p = .001$, negative and OCD words, $t(143) = -3.071$, $p = .041$) (see Figure 4.1).

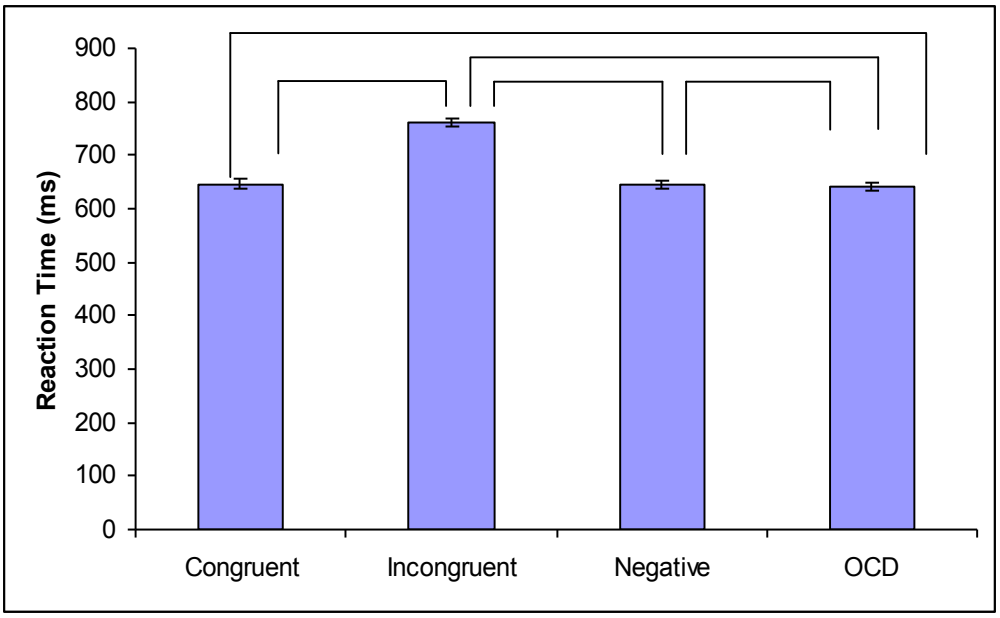


Figure 4.1. The main effect of word-type for reaction times to correctly categorise words in the Stroop task. Error bars represent S.E.M. Comparison lines represent significant differences by paired samples t-tests.

There was a significant main effect of blocks, $F(5,715) = 2.540$, $p = .027$, $\eta^2 = .018$. This arose because there were non-systematic fluctuations in overall reaction times over the six blocks of seven trials (see Table 4.1).

Table 4.1

The main effect of blocks for reaction time data on the Stroop task. There were non-systematic fluctuations over the 6 blocks

Blocks	Mean ± S.E.M
1	655.308 ± 12.724
2	680.972 ± 10.279
3	676.080 ± 11.700
4	679.081 ± 11.180
5	672.847 ± 10.299
6	691.444 ± 12.284

More importantly, there was a significant interaction between word-type and blocks, $F(15,2145) = 6.291$, $p = .001$, $\eta^2 = .045$. There were non-systematic fluctuations for each word-type over the 6 blocks of 7 trials but participants were significantly quicker, on block one, to correctly categorise OCD words compared to negative words, $t(136) = 5.868$, $p = .001$, colour congruent words, $t(136) = 4.983$, $p = .001$, and colour incongruent words, $t(136) = 8.365$, $p = .001$. Further to this participants were progressively slower to correctly categorise OCD words over the blocks, block 1 compared with block 6, $t(136) = -4.820$, $p = .001$ (see Table 4.2).

Table 4.2

Word-type interacted with blocks for reaction time data on the Emotional Stroop Task. Generally, for each word-type there were non-systematic fluctuations over the 6 blocks

Blocks	Congruent Mean ± S.E.M	Incongruent Mean ± S.E.M	Negative Mean ± S.E.M	OCD Mean ± S.E.M
1	676.367 ± 20.133	753.509 ± 15.403	669.694 ± 11.385	521.665 ± 26.758
2	654.114 ± 12.211	737.884 ± 15.620	660.918 ± 12.059	670.972 ± 15.407
3	645.067 ± 12.840	776.204 ± 27.588	644.276 ± 13.948	638.771 ± 10.209
4	638.141 ± 11.278	781.989 ± 23.010	642.038 ± 11.709	654.157 ± 14.191
5	649.992 ± 12.560	767.745 ± 20.716	641.995 ± 11.799	631.654 ± 10.399
6	670.534 ± 13.726	793.290 ± 21.403	654.852 ± 13.172	647.101 ± 13.146

4.2.2.2 Accuracy

There was a significant main effect of word-type, $F(3,429) = 85.040$, $p = .001$, $\eta^2 = .385$. Paired samples t-tests revealed the accuracy these word-types were significantly different from each other (congruent and incongruent words, $t(143) = 9.969$, $p = .001$, congruent and negative words, $t(143) = -2.875$, $p = .005$, incongruent and negative words, $t(143) = -11.981$, $p = .001$, incongruent words and OCD words $t(143) = -10.632$, $p = .001$) (see Figure 4.2).

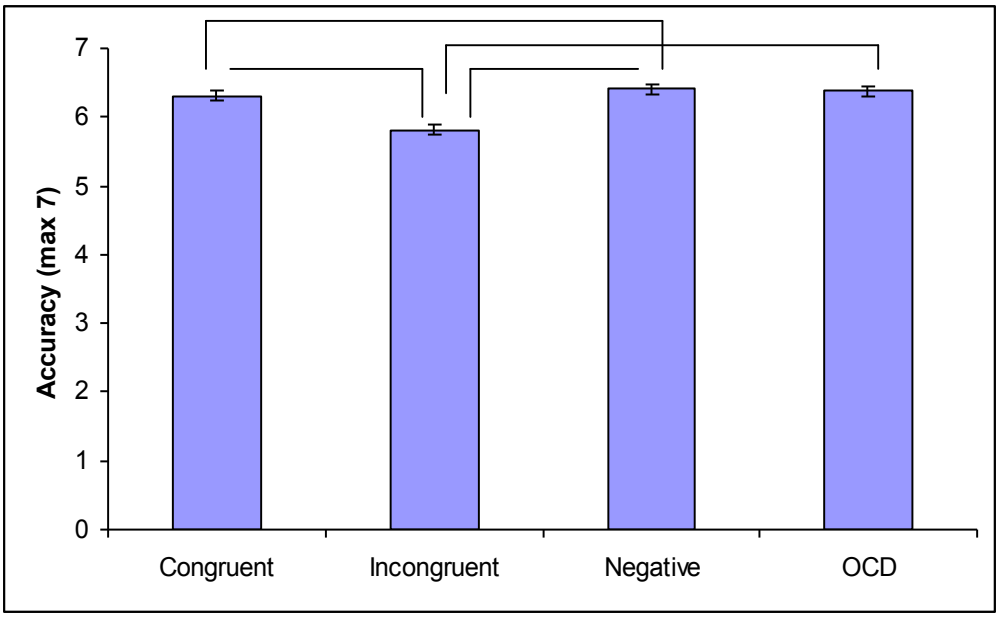


Figure 4.2. The main effect of word-type for accuracy to categorise words in the Stroop task. Error bars represent S.E.M. Comparison lines represent significant differences by paired samples t-tests.

There were no other significant main effects or interactions, maximum $F(15, 2145) = 1.255$, $p = .061$, $\eta^2 = .012$ for the interaction between word-type and blocks.

4.2.3 Discussion

The purpose of the Emotional Stroop Task was to examine response inhibition for colour in/congruent words and also emotionally related words: negative and

OCD. The results from the Emotional Stroop Task display a classic Stroop effect (Stroop, 1935). Participants were markedly less accurate to categorise the incongruent colour words compared to the other three word-types: congruent, OCD and negative. Participants were also markedly slower to categorise the incongruent words compared to the other three word-types: congruent, OCD and negative. The results suggest that participants experienced a cognitive interference; presenting the colour words in an incongruent colour interfered with the participant's ability to respond (pressing the corresponding key on the keyboard) as accurately and quickly. This result supports previous findings that have shown the same effect (Keele, 1972; MacLeod, 1991; Pritchatt, 1968; Stroop, 1935).

Further to the expected Stroop effect there were other significant differences; participants were more accurate for negative words compared to congruent words and faster to correctly categorise OCD words compared to negative and colour congruent words. In addition to this, participants were generally faster to categorise OCD words (but progressively slower over the blocks perhaps representing fatigue effects) compared to other word-types but overall there was no significant effect of word-type or interaction between word-type and blocks. The results suggest that OCD and negative words were causing participants to experience a cognitive interference and therefore affecting their ability to respond, both accuracy and reaction time, as other word-types. Past research that has examined the emotional Stroop (in relation to anxiety) is mixed. Some previous studies have reported slower response latencies on the emotional Stroop in relation to anxiety and mood disorders (Foa et al., 1993; Lavy et al., 1994; Williams et al., 1996). Other studies have also reported faster response latencies on the emotional Stroop (Amir et al., 1996; Shiffrin & Schneider, 1977) but this is contingent on anxiety levels at testing. The current task was carried out in a healthy sample and you would not typically expect to see any difference in responding in this sample. However, as mentioned, performance may be influenced by individual differences in anxiety. Participants were given four questionnaires to measure this: HADS, MOCI, BIS/BAS and EPQR-S. The relationship between task performance on the

Emotional Stroop Task and anxiety is discussed in Chapter 5. Overall, the results from this task (faster response latencies for negative and OCD words) are similar to previous studies (Amir et al., 1996; Shiffrin & Schneider, 1977) and in contrast to others (Foa et al., 1993; Lavy et al., 1994; Williams et al., 1996); this and individual differences effects will be reported in Chapter 5 and discussed in Chapter 7.

4.3 Go/No-Go Words Task

Individual difference measures in relation to performance on the Go/No-Go Words Task are discussed in Chapter 5.

4.3.1 Experiment 1 – Go/No-Go Words Task: Short Version 2 Word-Types

4.3.1.1 Methods

4.3.1.1.1 Participants

A total of 48 undergraduate and general population participants volunteered to take part in this experiment. There were 15 males and 33 females with a mean age of 24 (range from 18 - 48). All participants had normal or corrected to normal vision and were naïve to the current task and hypothesis.

4.3.1.1.2 Apparatus

Six neutral words (used in the practice trials), five OCD words and five negative words (used in the test trials) were used as the stimuli in the Go/No-Go Words Task. The words were selected from a task that demonstrated an emotional Stroop bias (Lavy et al., 1994). The neutral words were: square, fork, potato, percent, month and blanket, the OCD words were: filthy, mess,

guilty, doubt and fail the negative words were: murder, hate, deceit, abuse and war. The words were presented on a black background, white text, font Arial, point size 48, either in italics or normal font and positioned in the centre of the screen. The stimuli were presented in a random order. All stimuli were presented on a 15-inch screen of a personal computer using E-Prime (version 1.1) software. The computer was positioned approximately .5m at eyelevel away from the participant, the keyboard in front and mouse on their right hand side.

4.3.1.1.3 Procedure

All instructions were presented on a black background, white text, font Arial, point size 18, bold and positioned in the centre of the screen, and remained until the subject pressed the space bar.

Practice trials – The instructions informed the participant that they would be presented with a series of words and that they needed to categorise them by pressing the space bar as quickly as possible. The words (selected from a previous inhibitory task, Lavy et al., 1994) were presented in either italics or the equivalent non-italicized font. Presenting the words in italics, and requiring discriminated responding on this basis, provided a method to disguise the fact that anxiety, OCD and Panic Disorder were the focus of the study. It also means that the participants do not have to learn the categories of stimuli beforehand (which can be the method in Go/No-Go Tasks) and therefore distracting them from the task at hand. All trials were presented on a black screen with the word presented in white text aligned in the centre of the screen. A word would then appear on the screen and remained on the screen until the participant had categorised it. However there was an upper time limit of 750 ms, by which - if the participant had not categorised the word - the trial timed out. Participants were then given feedback about their response. In the practice trials there were five Go trials and five No-Go trials that used neutral words that would not be presented again at the testing stage.

Test trials – The protocol for the test trials was the same as the practice trials. There was no feedback at this stage. There were 90 Go trials and 90 No-Go trials.

4.3.1.1.4 Design

All data were analysed using SPSS (version 15.0) and used an alpha of $p = .05$. Before analysis data were blocked to make a more condensed version of the data suitable for ANOVA analysis. There were 90 trials of each category and both accuracy and reaction time were recorded. All practice trials were excluded.

Only data where the participant had categorised the stimuli correctly, were used for reaction time data. Data was blocked into 10 blocks of nine trials. The trials were averaged for each block. The data were entered into a 2 x 10 within subjects ANOVA with factors word-type (negative and OCD) and blocks (1-10).

Accuracy (Go and No-Go trials) was blocked into 10 blocks of nine trials. The trials were added together. The data was entered into a 2 x 10 within subjects ANOVA with factors word-type (negative and OCD) and blocks (1-10).

4.3.1.2 Results

4.3.1.2.1 Reaction Time

There was no significant main effect of word-type, $F(1,47) = .018$, $p = .893$, $\eta^2 = .001$. There was a significant main effect of blocks, $F(9,423) = 2.260$, $p = .018$, $\eta^2 = .046$. There were non-systematic fluctuations over the 10 blocks

(block 1 = *M* 492.370, *SD* 6.258, block 10 = *M* 480.941, *SD* 5.015) (see Table 4.3). Further to this, there was no significant interaction between blocks and word-type, $F(9,423) = .942$, $p = .488$, $\eta^2 = .020$. Participants were not rating the correctly categorised Go negative or Go OCD stimuli differently over the 10 blocks.

Table 4.3:

The main effect of blocks for the reaction time data on the Go/No-Go Words Task: Short Version 2 Word-Types

Block	Mean ± S.E.M
1	492.370 ± 6.258
2	489.325 ± 7.812
3	472.405 ± 9.513
4	481.315 ± 6.187
5	482.688 ± 6.450
6	476.380 ± 6.365
7	465.767 ± 8.565
8	473. 958 ± 7.306
9	481.973 ±6.590
10	480.941 ± 5.015

There were no other significant main effects or interactions, maximum *F* was the main effect of word-type.

4.3.1.2.2 Accuracy

Go Trials – There was no significant main effect of word type, $F(1,47) = .740$, $p = .394$, $\eta^2 = .016$. There was a significant main effect of blocks, $F(9,423) = 3.233$, $p = .001$, $\eta^2 = .064$. There were non-systematic fluctuations over the ten blocks of trials but generally participants were getting 85% accuracy (block 1 = *M* 8.250, *SD* .146, block 10 = *M* 8.562, *SD* .109). There were no other significant main effects or interactions, maximum $F(9,423) = 1.661$, $p = .096$, $\eta^2 = .034$, for the interaction between word-type and blocks.

No-Go Trials – There was a significant main effect of word-type, $F(1,47) = 7.336$, $p = .009$, $\eta^2 = .135$. Participants were more accurate on the No-Go trials for OCD words than they were for negative words (see Figure 4.3).

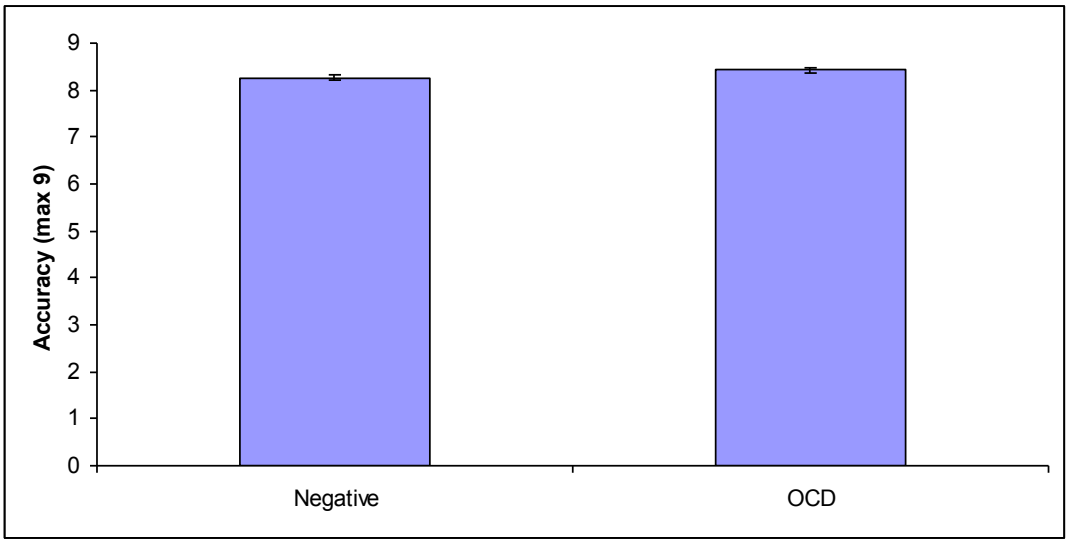


Figure 4.3. The main effect of word-type on accuracy with No-Go words on the Go/No-Go Words Task: Short Version 2 Word-Types. Error bars represent S.E.M.

There was a main effect of blocks, $F(9,423) = 3.299$, $p = .001$, $\eta^2 = .066$. There was a non-systematic fluctuation over the trials, but no evidence for any build up of inhibition over the course of the task (block 1 = *M* 8.000, *SD* 0.089, block 10 = *M* 8.375, *SD* .085). There was no significant interaction between word-type and blocks, $F(9,423) = .527$, $p = .542$, $\eta^2 = .018$.

4.3.1.3 Discussion

The function of the Go/No-Go Words Task was to examine response inhibition; participants were required to inhibit the pre-potent Go response to No-Go stimuli. The results from the first Go/No-Go Words Task version show that there was no overall response inhibition effect. Accuracy to categorise stimuli that signalled Go did not differ. Reaction time to correctly categorise stimuli that signalled Go and No-Go did not differ. Participants did not respond

differently to the stimuli and the emotional content of the stimuli also did not affect participants responding; the emotional significance of the stimuli did not affect performance. There was a difference in responding towards the No-Go stimuli, not overall, but for emotionally significant words; participants were more accurate for OCD words compared to negative words. Overall, there was variation in the accuracy and reaction time over the trials but further analysis showed that this was due to non-systematic fluctuations and not specific to the content of the stimuli or blocks of trials.

Previous studies have shown a difference in performance on the Go/No-Go Task (Bannon et al., 2002; Penadés et al., 2007) (in clinical samples) however, the current task did not demonstrate this and this could largely be due to methodological reasons. Although you would not typically expect to see a difference in a healthy sample in responding to emotionally valenced stimuli the task design may not have facilitated this. Normally in a Go/No-Go Task there are more Go trials than No-Go trials. This creates a pre-potent response to Go which participants have to inhibit on the No-Go trials. The current task had a ratio of 50:50 Go:No-Go trials therefore the chances of a Go or No-Go stimuli appearing on the screen were even. The proportion of Go trials compared to No-Go trials was not the typical 75:25 so therefore the pre-potent Go response was not created and this could be argued that is why in the current task version there is no significant result. To make the task more representative of a traditional Go/No-Go Task, the number of Go and No-Go trials will be adjusted. In the next task version the number of Go trials will be increased to create a ratio of 75:25 Go:No-Go trials. This will encourage the pre-potent response to the Go trials and the design will be more typical of a Go/No-Go Task.

4.3.2 Experiment 2 – Go/No-Go Words Task: Long Version 2 Word-Types

4.3.2.1 Methods

4.3.2.1.1 Participants

A total of 24 undergraduate and general population participants volunteered to take part in this experiment. There were four males and 20 females with a mean age of 21 (range from 18-28). All participants had normal or corrected to normal vision and were naïve to the current task and hypothesis.

4.3.2.1.2 Apparatus

The stimuli were the same as in the previous experiment.

4.3.2.1.3 Procedure

Minor adjustments were made to the procedure. The background colour was changed from black to white, (to keep it similar to the Go/No-Go Image Tasks described later in the Chapter) and therefore the instructions and words were changed from white to black. The corresponding key for Go trials was changed from the space bar to the 'g' key. The feedback stage was removed from the test trials. The ratio of each Go and No-Go trial was changed from 50:50 to 75:25 respectively. The number of trials changed from 180 to 95 overall.

4.3.2.1.4 Design

All data were analysed using SPSS (version 15.0) and used an alpha of $p = .05$. The reaction time (for correct Go trials) and accuracy data for the Go trials were blocked into five blocks of 15 trials. The accuracy data for the No-Go trials were blocked into two blocks of 10 trials. The reaction time data for the correct Go trials were entered into a 2 x 5 within subjects ANOVA with

factors, word-type (negative and OCD) and blocks (1-5). The accuracy data for the Go trials were entered into a 2 x 5 within subjects ANOVA with factors, word-type (negative and OCD) and blocks (1-5). The accuracy data for the No-Go trials were entered into a 2 x 2 within subjects ANOVA with factors, word-type, (negative and OCD) and blocks (1-2).

4.3.2.2 Results

4.3.2.2.1 Reaction Time

There was no significant main effect of word type, $F(1,23) = .395$, $p = .536$, $\eta^2 = .017$. There were no significant main effects or interactions, maximum $F(4,92) = .825$, $p = .512$, $\eta^2 = .035$ for the main effect of blocks.

4.3.2.2.2 Accuracy

Go Trials – There was no significant main effect of word type, $F(1,23) = .190$, $p = .667$, $\eta^2 = .008$. There were no significant main effects or interactions, maximum $F(4,92) = 2.049$, $p = .094$, $\eta^2 = .082$ for the interaction between word-type and blocks.

No-Go Trials – There was a significant main effect of word-type, $F(1,23) = 12.715$, $p = .002$, $\eta^2 = .356$, participants were more accurate for OCD words compared to negative words (see Figure 4.4).

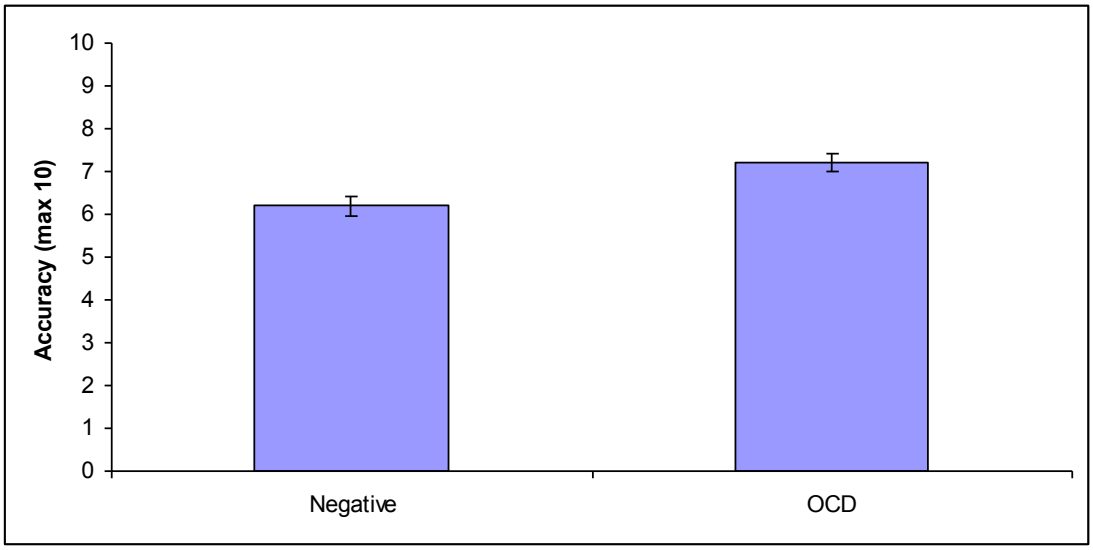


Figure 4.4. The main effect of word-type for accuracy with No-Go words on the Go/No-Go Words Task: Long Version 2 Word-Types. Error bars represent S.E.M.

There was a significant main effect of blocks, $F(1,23) = 4.493$, $p = .045$, $\eta^2 = .163$, participants were more accurate overall during the first 10 trials (*M* 7.021, *SD* .205) than they were in the last ten trials (*M* 6.375, *SD* .259). There was no significant interaction, maximum $F(1,23) = .385$, $p = .541$, $\eta^2 = .016$ for the interaction between word-type and blocks version.

4.3.2.3 Discussion

The purpose of the Go/No-Go Words Task: Long Version 2 Word-Types was to create a pre-potent Go response by increasing the number of Go trials from version 1 to make the task more representative of a typical Go/No-Go Task. Overall the results from the second Go/No-Go Words Task version show that there was no difference in reaction time to correctly categorise Go and No-Go trials, the emotional significance of the word did not influence responding. There was no difference in the accuracy to categorise Go trials. Participants were not more or less accurate for either negative or OCD Go words. There was a significant difference for the accuracy to categorise No-Go words. Participants were more accurate for No-Go OCD words compared to No-Go negative words; this result has been replicated from the Go/No-Go Words

Task: Short Version 2 Word-Types. The difference in accuracy for No-Go trials suggests that the emotional component of the word on these trials may have influenced participants' ability to correctly categorise the words. Participants build up a pre-potent Go response over the trials which they are required to inhibit on the No-Go trials. This task version was altered from the first version to include more Go trials to create this pre-potent response. On both task versions it was evident that the emotional content of the word affected with the participants' ability to accurately categorise OCD and negative word stimuli. Overall on the task participants were less accurate towards the end of the task to categorise either type of word, generally they became less accurate over the trials for both negative and OCD words. This result may represent fatigue effects in the participants and generally them getting tired of the repetitiveness of the task and this is reflected in their concentration and becoming less accurate.

Previous studies have shown that using stimuli associated with mood or mood disorders affects the participant's ability to respond to certain stimuli (Aycicegi et al., 2003; Foa et al., 1993; Lavy et al., 1994; Rosenberg et al., 1997; Watkins et al., 2004) in particular in clinical samples. Cognitive theories of OCD and Panic Disorder state that individuals high in anxiety should demonstrate response inhibition deficits, in particular for emotionally related stimuli. The current task version did use emotionally related stimuli, responding to negative and OCD related words were compared. A previous study by Lavy et al. (1994) showed (using the Stroop task) a significant difference in responding to emotional stimuli. This study compared OCD washers and checkers, positive and negative, overall negative and positive and neutral words. In particular participants responded differently to negative OCD words. Perhaps the stimuli used in the current study are too closely related and therefore this is reflected in the responding or rather lack of difference in responding to them. Individuals sensitive to anxiety words may also be sensitive to negative words; often anxiety and mood disorders are co-morbid. Although, the current sample tested was a healthy sample and not a formally diagnosed clinical sample and you would not typically expect differences in response inhibition (sample taken from a healthy population) it could potentially be the stimuli are too alike to

identify any differences. The next task version will incorporate further stimuli associated with mood and mood disorders and neutral stimuli. This will allow comparisons to be made with other response inhibition tasks detailed and by incorporating other arousing or non-arousing stimuli (positive and neutral) and therefore cognitive theories (Barlow, 1988; Beck, et al., 1985; Eysenck, 1992) can be examined. Both neutral and positive words will be introduced into the task and will be taken from the Lavy et al., (1994) study that has successfully shown response inhibition differences.

4.3.3 Experiment 3 – Go/No-Go Words Task: Long Version 4 Word-Types

4.3.3.1 Methods

4.3.3.1.1 Participants

A total of 72 undergraduate and general population participants volunteered to take part in this experiment. There were 24 males and 48 females with a mean age of 25 (range from 18-57). All participants had normal or corrected to normal vision and were naïve to the current task and hypothesis.

4.3.3.1.2 Apparatus

The OCD and negative words remained largely the same as the previous task versions but some changes were made to match for word length. The OCD words were: precise, doubt, dirty, tidy. The negative words were: abuse, deceit, hate, torture. Neutral and positive words were added into the test trials. The neutral words were: fork, month, potato and blanket, the positive words were: love, happy, party and friends. Again, the words were selected from the Lavy et al., (1994) study that had demonstrated an emotional Stroop bias. As a result of introducing neutral words at the test stage the neutral words at the practice

stage were changed so that words were not duplicated. The neutral words at the practice stage were: street, bowl, kettle and cable.

4.3.3.1.3 Procedure

The number of trials was changed in order to incorporate the two new word categories whilst keeping overall task duration within reasonable limits. There were 30 trials of each word category for the Go signal and there were 10 trials of each word category for the No-Go signal. The ratio of more Go trials was maintained (in this task version the ratio was 3:1) to encourage the pre-potent Go response. There were no other adjustments made to this stage of the experiment.

4.3.3.1.4 Design

All data were analysed using SPSS (version 15.0) and used an alpha of $p = .05$. The reaction time (for correct Go trials) and accuracy data for the Go trials were blocked into three blocks of 10 trials. The accuracy data for the No-Go trials were blocked into two blocks of 10 trials. The reaction time data for the correct Go trials were entered into a 4 x 3 within subjects ANOVA with factors, word-type (neutral, OCD, negative and positive) and blocks (1-3). The accuracy data for the Go trials were entered into a 4 x 3 within subjects ANOVA with factors, word-type (neutral, OCD, negative and positive) and blocks (1-3). The accuracy data for the No-Go trials were entered into a 4 x 2 within subjects ANOVA with factors, word-type, (neutral, OCD, negative and positive) and blocks (1-2).

4.3.3.2 Results

4.3.3.2.1 Reaction Time

There was no significant main effect or interaction, maximum $F(3,213) = .837$ $p = .475$, $\eta^2 = .013$ for the main effect of word-type

4.3.3.2.2 Accuracy

Go Trials – There was a significant main effect of blocks, $F(2,142) = 4.782$, $p = .010$, $\eta^2 = .070$. There were non-systematic fluctuations over the 3 blocks (block 1 = *M* 9.373, *SD* .111, block 3 = *M* 9.118, *SD* .101). There were no other significant main effects or interactions, maximum $F(3,213) = 1.820$, $p = .145$, $\eta^2 = .028$ for the main effect of word-type.

No-Go Trials - There was a significant main effect of blocks, $F(1,71) = 22.106$, $p = .001$, $\eta^2 = .257$. Participants were less accurate over the blocks of trials (block 1 = *M* 4.558, *SD* .047, block 2 = *M* 4.300 *SD* .065). There were no other significant main effects or interactions, maximum $F(3,213) = 1.241$, $p = .250$, $\eta^2 = .021$ for the main effect of word-type.

4.3.3.3 Discussion

The purpose of the Go/No-Go Words Task: Long Version 4 Word-types Task was to incorporate two further categories of emotional stimuli: positive and neutral to help identify any differences in performance on the Go/No-Go Task. Overall the results from the third Go/No-Go Words Task version show that there was no difference in responding between Go and No-Go stimuli. Participants were not more or less accurate for any type of word and they were not faster or slower for any type of word. The result from the previous two

versions (participants were more accurate for No-Go OCD words compared to No-Go negative words) was not replicated. There were changes in accuracy for all word-types over the blocks of trials. For the Go stimuli there were non-systematic fluctuations and there was no pattern. For the No-Go stimuli participants were less accurate over the blocks of trials. Again, as in the previous task version, this may represent general fatigue effects and participants were therefore not responding as accurately at the end of the task compared to the beginning. Due to the number of trials the participants were required to complete fatigue over the course of the task may have impacted on the results. Overall, the changes made over the 3 task versions did not encourage a difference in inhibition. Changing the ratio of Go and No-Go trials did not affect participant's accuracy or reaction time nor did adding other neutral, mood or mood disorder associated words did not affect participants' accuracy or reaction time. You would not typically expect to see a difference in responding on this task in a healthy sample. All participants were given 4 questionnaires to measure individual differences in anxiety and compare performance on the task; the results are reported in Chapter 5.

Previous studies have shown a difference in inhibition on the Go/No-Go Task (Aycicegi et al., 2003; Watkins et al., 2004). In these studies OCD participants showed response inhibition deficits towards Go stimuli compared with No-Go stimuli. However, most of these tasks have used either shapes or neutral words as the stimuli. Most individuals, in particular individuals that have been formally diagnosed with an OCD or Panic Disorder (individuals in the current tasks have been taken from a healthy sample), are aroused by images or actual representations of things that are salient to them and not as aroused by words that represent that salient thing. (Thorpe & Salkovskis, 1998) Therefore, the next task has been developed to incorporate this aspect and make the task more arousing for individuals that may be sensitive to them. In the next task, using the Go/No-Go design, images will be used as the stimuli. The images will be presented in colour and represent OCD symptom subtypes: symmetry, washing and hoarding (Calamari et al., 2004; Leckman et al., 1997; van Oppen et al., 1995). The signal to Go will be a black border around the image, the signal to No-Go will be the absence of a black border around the image. The hypothesis

would be that people that are sensitive to these images would be aroused and display a difference in accuracy and reaction time to respond to these stimuli.

4.4 Go/No-Go Border Images Task

4.4.1 Methods

Individual difference measures in relation to performance on the Go/No-Go Border Images Task are discussed in Chapter 5.

4.4.1.1 Participants

A total of 96 undergraduate and general population participants volunteered to take part in this experiment. There were 26 males and 70 females with a mean age of 24 (range from 18-57). All participants had normal or corrected to normal vision and were naïve to the current task and hypothesis.

4.4.1.2 Apparatus

Fifteen neutral images and 15 OCD images were used as the stimuli in the Go/No-Go image task. The neutral images were taken from the IAPS images, 10 were used for practice and were not shown again in the test trials and five were used in the test trials. The 15 OCD images were selected to be representative of OCD triggers (see Figure 4.5 for examples of the images used). There were five OCD images related to symmetry and exactness symptoms, five OCD images related to cleanliness and washing symptoms and five OCD images related to hoarding symptoms. The images were presented in a random order on a white background and positioned in the centre of the screen, with either a black border (Go signal) or no black border (No-Go

signal). Both the OCD and neutral images were shown with and without the black border. All stimuli were presented on a 15-inch screen of a personal computer using E-Prime (version 1.1) software. The computer was positioned approximately .5m at eye level away from the participant, the keyboard in front and mouse on their right hand side.

Figure 4.5. Two of the images used in the Go/No-Go Border Images Task. The stimuli above represent symmetry, the first has a black border around the image representing Go and the second has no black border representing No-Go.

4.4.1.3 Procedure

All instructions were presented on a white background, black text, font Courier New, point size 18, bold and positioned in the centre of the screen, and remained until the subject pressed the 'g' key.

Practice trials – The instructions informed the participant that they would be presented with a series of images and that they needed to categorise them by pressing the 'g' key as quickly as possible. The images were categorised into either in with a black border (Go signal to press the 'g' key) or without a black border (No-Go signal, do not need to press any key). All trials were presented on a white screen with the image aligned in the centre of the screen. An image would then appear on the screen and remained on the screen until the participant had categorised it. However there was an upper time limit of 750 ms, if the participant had not categorised the image by this time the trial timed out. Participants were then given feedback about their response. In the practice

trials there were 11 Go trials and four No-Go trials that used neutral images that would not be presented again in the real testing stage.

Test trials – The protocol for the test trials was the same as the practice trials. There was no feedback at this stage. There were 120 Go trials and 40 No-Go trials.

4.4.1.4 Design

All data were analysed using SPSS (version 15.0) and used an alpha of $p = .05$. The reaction time (only correct Go trials) were blocked into three blocks of 10 trials. The accuracy data for the Go trials were blocked into three blocks of 10 trials. The accuracy data for the No-Go trials were blocked into two blocks of 10 trials. The reaction time data were entered into a within subjects 4 x 3 ANOVA with factors, image-type (neutral, OCD hoarding, OCD washing and OCD symmetry) and blocks (1-3). The Go accuracy data were entered into a 4 x 3 within subjects ANOVA with factors, image-type (neutral, OCD hoarding, OCD washing and OCD symmetry) and blocks (1-3). The No-Go accuracy data were entered into a 4 x 2 within subjects ANOVA with factors, image-type (neutral, OCD hoarding, OCD washing and OCD symmetry) and blocks (1-2).

4.4.2 Results

4.4.2.1 Reaction Time

There was a significant main effect of blocks, $F(2,190) = 21.305$, $p = .001$, $\eta^2 = .195$. Participants got faster over the three blocks of trials (block1 = *M* 411.587, *SD* 3.492, block 2 = *M* 400.592, *SD* 4.132, block 3 = *M* 390.315, *SD* 4.038). There was no other significant main effect or interaction, maximum $F(6,570) = 2.129$, $p = .395$, $\eta^2 = .012$ for the interaction between image-type and blocks.

4.4.2.2 Accuracy

Go Trials – There was no significant main effect of image-type, $F(3,284) = .760$, $p = .517$, $\eta^2 = .090$. There were no significant main effects or interactions, maximum $F(6,570) = 2.561$, $p = .080$, $\eta^2 = .028$ for the interaction between image-type and blocks.

No-Go Trials – There was no significant main effect of image-type, $F(2,264) = .689$, $p = .559$, $\eta^2 = .008$. There were no significant main effects or interactions, maximum $F(1,95) = .521$, $p = .512$, $\eta^2 = .009$ for the main effect of blocks.

4.4.3 Discussion

The purpose of the Go/No-Go Border Images Task was to incorporate stimuli, in particular images of OCD symptom subtypes and not words that would be more arousing for individuals sensitive to them. The results from the Go/No-Go Border Images Task show that there was no difference in responding to Go and No-Go stimuli. There was no difference in the accuracy for the different image-types and there was no difference in the reaction times for the different image-types. Reaction time changed over the blocks of trials, participants got faster when responding to the images. This could represent individuals getting accustom to the task design and aim and therefore their responses were quicker. The results suggest that there was no difference, accuracy or reaction time, in responding to the different images. This is actually a result which would be expected in a sample of healthy participants however, performance may be affected by individual differences in anxiety (each participant was given four questionnaires to examine this); the results are reported in Chapter 5.

The images that were selected were representative of OCD symptom subtypes (Calamari et al., 2004; Leckman et al., 1997; van Oppen et al., 1995) and it was

hypothesised that there potentially may have been differences in accuracy or speed of processing in relation to individual differences (as mentioned this is discussed in Chapter 5). However, there was no theoretical basis to predict any overall difference in response to OCD-related images in a healthy population (although some differences have been demonstrated in the Stroop task, participants showed a Stroop effect and differences in relation to the OCD and negative stimuli). There was no difference in responding to any of the stimuli, representative of OCD symptom subtypes or neutral, this could also be due to the methodological design of the task. In fact, many participants actually reported using the black border, the Go signal, as their main focus in the task and ignoring the content of the images completely. Although, the black border was the Go signal and the participants were completing the task correctly it meant that there was no attention paid to the images. The black border surrounded the edge of the images and it is possible that participants focused purely on that and not on the content of the image. They were therefore ignoring the emotional part of the task and this could have influenced responding to these images. In the next task the Go and No-Go signals and emotional content will be incorporated into one and not spatially separated. This is so participants will be encouraged to pay attention to both cues, Go or No-Go and the emotional content of the image, and that they cannot purely focus on the Go signal. The images in the next task will remain largely the same and therefore the same OCD symptom subtype groups: washing, hoarding, symmetry and neutral. However, instead of the 'Go' signal being the black border the Go signal will be whether the image is presented in colour or black and white. This means that the participant has to attend directly to the image itself and not just the perimeter of it. This modification was introduced in order to encourage participants to focus not only on the Go signal but also on the content of the image.

4.5 Go/No-Go Colour Images Task

4.5.1 Methods

4.5.1.1 Participants

A total of 12 undergraduate and general population participants volunteered to take part in this experiment. There were four males and eight females with a mean age of 25 (range from 20-30). All participants had normal or corrected to normal vision and were naïve to the current task and hypothesis.

4.5.1.2 Apparatus

The same images as in the previous Go/No-Go image experiment were used as the stimuli, 15 neutral images and 15 OCD images. The images were presented in either colour (Go signal) or black and white (No-Go signal). Both the OCD (hoarding, symmetry and washing) and neutral images were shown in both black and white and colour. All stimuli were presented on a 15-inch screen of a personal computer using E-Prime (version 1.1) software. The screen was positioned approximately .5m at eye level away from the participant, the keyboard in front and mouse on their right hand side.

4.5.1.3 Procedure

All instructions were presented on a white background, black text, font Courier New, point size 18, bold and positioned in the centre of the screen, and remained until the subject pressed the ‘g’ key.

Practice trials – The instructions informed the participant that they would be presented with a series of images and that they needed to categorise them by pressing the 'g' key as quickly as possible. The images were categorised into either colour (Go signal to press the 'g' key) or black and white (No-Go signal, do not need to press any key). All trials were presented on a white screen with the image aligned in the centre of the screen. An image would then appear on the screen and remained on the screen until the participant had categorised it. However there was an upper time limit of 750 ms, if the participant had not categorised the image by this time the trial timed out. Participants were then given feedback about their response. In the practice trials there were 11 go trials and four No-Go trials that used neutral images that would not be presented again in the real testing stage.

Test trials – The protocol for the test trials was the same as the practice trials. There was no feedback at this stage. There were 120 Go trials and 40 No-Go trials.

4.5.1.4 Design

The design was the same as the Go/No-Go Border Images Task.

4.5.2 Results

4.5.2.1 Reaction Time

There was no significant main effect of image-type, $F(3,12) = .221$, $p = .880$, $\eta^2 = .052$. There was no significant main effect of interaction, maximum $F(6,66) = 1.271$, $p = .226$, $\eta^2 = .241$ for the interaction between image-type and blocks

4.5.2.2 Accuracy

Go Trials – There was no significant main effect or interaction, maximum $F(3,33) = 1.65$, $p = .220$, $\eta^2 = .248$ for the main effect of image-type.

No-Go Trials – There was no significant main effect of image-type, $F(3,27) = .417$, $p = .742$, $\eta^2 = .044$. There was no significant main effect or interaction, maximum $F(3,33) = 3.012$, $p = .057$, $\eta^2 = .251$ for the interaction between image-type and blocks.

4.5.3 Discussion

The point of the Go/No-Go Colour Images Task was to merge both the Go and No-Go cues with the emotional cues. This was done by presenting the images (emotional cue) in black and white and colour (Go and No-Go cues). Therefore, encouraging the participant to attend to the content of the image. The results from the Go/No-Go Colour Images Task show that there was no difference in participants' accuracy or reaction time and this did not vary by image-type. Participants were not more or less accurate for different image-types and they were not faster or slower for different image-types. Incorporating the Go/No-Go signal in the stimuli did not affect the participant's accuracy or reaction time.

As mentioned, previous studies have shown differences in responding on the Go/No-Go Task and in particular with a clinical sample (Aycicegi et al., 2003; Bannon et al., 2002; Penadés et al., 2007; Watkins et al., 2004). The sample used in the current task was taken from a healthy population (you would not expect a difference in responding to emotionally significant words) and the sample was relatively small. Given these two facts, perhaps any effect that is apparent was not drawn out in this current sample. These results only provide a

preliminary indication of the results from this task version. The relationship between performance and individual differences are discussed in Chapter 5.

4.6 Chapter Discussion

Inhibition can be defined as our ability to prevent or restrict responses and this can be demonstrated across many different processes (Harnishfeger, 1995; Nigg, 2000). Our ability to control inhibitory processes could contribute to the maintenance of our thoughts and behaviours. Specifically in this study, inhibitory processes were investigated in relation to individual differences in anxiety. This Chapter looked at a variety of tasks, the Emotional Stroop Task, Go/No-Go Words Task and the Go/No-Go Images Tasks (Border and Colour) in a healthy population. The tasks detailed in this Chapter investigated both cognitive and behavioural inhibition and in general the results show that on the Stroop task there was some variation in performance by word-type. In a healthy population, as would be expected, the sample under test showed the typical Stroop effect, whereby participants were less accurate and slower for colour incongruent words. In the healthy sample, there were also some differences between congruent and negative words for accuracy and OCD and congruent words and OCD and negative words for reaction time; participants were more accurate for negative words compared to congruent words and generally faster for OCD words compared to negative and congruent words.

The Emotional Stroop Task was used to examine cognitive inhibition. The results showed that, as expected, there was a colour word Stroop effect, participants were slower and less accurate to respond to incongruent words than any other word-type. This is a result typical for a healthy population and commonly cited in the literature (for a review see MacLeod, 1991; Stroop, 1935). There were some differences in accuracy and reaction time to words related to anxiety or OCD and negative words; participants were more accurate for negative words compared to congruent and faster to correctly categorise

OCD words compared to negative and congruent words. The evidence for this kind of emotional Stroop effect in clinical populations is mixed (Kyrios & Iob, 1998; Foa et al., 1993; Lavy et al., 1994; McNally et al., 1992; 1994; McNeil et al., 1999). Some studies report faster response latencies, some report slower and some report no difference at all. The participants in the present study were selected based on specific criteria, which included not having been diagnosed with an OCD, Panic Disorder or any other mental health disorder. On this basis, there were no grounds to predict any difference in accuracy or reaction time when presented with anxiety-related words. However, as mentioned in Chapter 1, anxiety is an emotion that is commonly experienced at subclinical levels. Therefore it would be interesting to examine the results further to determine the relationship with the individual differences questionnaires (discussed in Chapter 5).

The Go/No-Go Task used provided a measure of behavioural inhibition. In this task, a pre-potent response is established (more Go stimuli are presented compared to No-Go stimuli) and participants are subsequently required to inhibit the response. In the Go/No-Go Words Task variants used in the present study, the Go and No-Go stimuli included neutral, negative, positive and OCD related words. The Go versus No-Go requirements of the word stimuli task were represented by the presence or absence of italics respectively. There was no difference in responding, accuracy or reaction time, to Go stimuli on any of the task versions. On the first two task versions, participants more accurate for No-Go OCD words compared to No-Go negative words however this effect was not reproduced in the third task version. An inhibitory deficit in the ability to withhold responding to anxiety related words would be expected in participants who are particularly sensitive to such stimuli (in relation to the individual differences in anxiety investigated in Chapter 5). Although studies have previously shown a Go/No-Go effect in a healthy population (Donders, 1868; 1969) typically in a healthy population you would not expect there to be an attentional bias, as measured by being less accurate or slower, to anxiety related words. Previous studies using the Go/No-Go task with an OCD and Panic Disorder population have shown a difference (Bannon et al., 2002;

Penadés et al., 2007) and further investigation about the relationship between individual differences and the task is examined in Chapter 5. Overall, the results from this study did not show a difference in responding.

Such experimental word tasks may underestimate participants' sensitivities. It is often reported that people that suffer from anxiety, OCD, Panic Disorder or other DSM anxiety disorder are triggered by images or what they see and perceive as threatening and fearful to them. Therefore the Go/No-Go Words Task was adapted to use images as potential triggers, in order to provide a more ecologically valid task, and draw out any differences related to anxiety. The images selected relate to a range of OCD symptom subtypes (hoarding, washing and symmetry (Calamari et al., 2004; Leckman et al., 1997; van Oppen et al., 1995). The Go versus No-Go requirements of the images tasks were represented by a black border (for Go in the first task variant) or the use of colour and black and white (for Go and No-Go in the second task variant). Again, as above, only participants who are sensitive to such stimuli would be expected to show a response inhibition deficit (individual differences are reported in Chapter 5). Overall, in the sample of healthy participants tested in the present study, there was no difference in accuracy or reaction time to the images. Although this is not surprising and in fact a result that is to be expected in a healthy population (Donders, 1868; 1969), many participants who reported using the black frame as the cue for Go/No-Go further explained that they did not even look at the content of the images. Such a marked lack of attention to the key features of the images would potentially compromise the experimental results. Therefore, the task was further adapted to include black and white versus colour images. In this second task variant, the Go versus No-Go signal was provided by whether the images were presented in colour or not. This manipulation encouraged participants to look directly at the content of the images and not only at the periphery. Moreover, the Go signal was integrated with the emotional component of the stimuli. The fact that participants had to attend to the content of the image should have made the task more sensitive. However, even with this second task variant, there were no overall differences in accuracy or reaction time to categorise the different image-types. The sample size was small (n = 12) and therefore it could be the task was

underpowered. Nonetheless, as above, this was the result to be expected overall in a healthy population as - for the most part - these participants should not be emotionally triggered by anxiety-related stimuli.

Thus, the response inhibition tasks developed to test for individual differences showed a typical Stroop effect overall, together with some differences in performance with OCD-related and negative words. No differences were found, by word or image-type, on any of the three versions of the Go/No-Go tasks, in which the Go versus No-Go requirement was specified by the use of italics for the words, and the presence of a frame or use of colour for the images. As explained above, participants recruited from a healthy population were not expected to show overall differences in response to anxiety-related stimuli. However, all the participants who completed the tasks detailed in this Chapter also completed four questionnaires (MOCI, HADS, BIS/BAS, EPQR-S) to investigate the relationship between individual differences and accuracy and reaction time to respond appropriately to the different word-types and images. These results, together with further discussion about the relationship between individual differences and performance on the tasks, are detailed in Chapter 5.

Chapter 5: Individual Differences in Inhibitory Task Performance in a Normal Population

5.1 Introduction

Anxiety is an emotion that is common, experienced by a range of individuals, can be triggered by life situations, manifest in different forms and does not necessarily meet diagnostic criteria in many individuals. As a result individuals vary in the degree of anxiety they experience and the symptoms exhibited. These symptoms differ in their form, severity and longevity across individuals. As anxiety is a normal adaptive response, individual differences in anxiety are normal, and thus subclinical levels of anxiety are quite common. Up to 80% can experience obsessions (Rachman & De Silva, 1978), 55% can experience compulsions (Muris et al., 1997), experience specific fears or phobias (Depla et al., 2008) and generally anxiety symptoms that occur as brief repeated episodes (Rickels & Rynn, 2001). Often people do not view or recognise their anxiety as excessive and do not seek diagnosis or treatment (Ruscio et al., 2005). Individual differences in anxiety can be measured using questionnaires that have been specifically developed to evaluate aspects of mood and personality. Questionnaires provide a self-report of how individuals perceive their symptoms and can assess the variation in symptoms.

This chapter details the relationship between individual differences and performance on the inhibitory tasks reported in the previous chapters. OCD was the principle anxiety disorder under investigation and often co-morbid with OCD are general anxiety symptoms (Austin et al., 1990) and depression (Hirschfield, 2001). To examine individual differences the MOCI (a widely used questionnaire to assess OCD symptoms, in particular obsessive behaviours) (Hodgson & Rachman, 1977) and the HADS scale (again, a widely used questionnaire to determine broad levels of anxiety and depression symptoms) (Zigmond & Snaith, 1983) were administered. The BIS/BAS and

personality traits such as neuroticism have been linked to anxiety and anxiety disorders so the BIS/BAS questionnaire (Carver & White 1994) and EPQR-S (Eysenck et al., 1985) were used to examine the association. All questionnaires that were selected were done so to be able to assess subclinical OCD and co-morbid symptoms and related personality traits. The inhibitory tasks that are reported in this chapter are: Negative Images Conditioned Inhibition Task: Retardation Test, 'Mission to Mars' Conditioned Inhibition Test: Summation Test, Negative Images Conditioned Inhibition Task: Summation Test, Emotional Stroop Task, Go/No-Go Words Task and Go/No-Go Border Images Task and Go/No-Go Colour Images Task. After completing the computer tasks four questionnaires were administered to the participants. They were asked to complete them as accurately and honestly as they could. Correlations provide a useful analysis of the strength of relationships. Bivariate correlations, Pearsons r, were carried out to measure the linear relationship between the variables. The aim was to determine what, if any, relationship existed between performance on inhibitory tasks and individual differences. As mentioned previously, the hypothesis would be individuals that reported higher levels of individual differences of anxiety as measured by the questionnaires would in fact correlate positively with performance outcomes. Individuals that are more anxious would show better discrimination learning and learning about inhibitors on the conditioned inhibition tasks and would be slower and less accurate on the response inhibition tasks. The method and results of each questionnaire and task are detailed and discussed.

5.2 Methods

5.2.1 Participants

The number of participants who completed the questionnaires and the final task versions varies, due to when the questionnaires were introduced into the design and the number of participants that completed the different task versions (see Table 5.1). Only participants that had completed the incongruent transfer

Negative Images CI Task: Retardation Test were included in the correlational analysis. The age and sex of the participants are reported in the corresponding task Chapters.

Table 5.1

Numbers of participants that completed the final tasks and questionnaires. Slight variations in the total number of participants vary from the final task numbers described in the corresponding Chapters due to whether the participant completed in/congruent transfer for the Negative Images CI Task: Retardation Test and when the questionnaire was introduced into the task design

Tasks	**Questionnaires**			
	MOCI	**HADS**	**BIS/BAS**	**EPQR-S**
Negative Images CI Task: Retardation Test	60	60	60	60
'Mission to Mars' CI Task: Summation Test	46	46	46	46
Negative Images CI Task: Summation Test	12	12	12	12
Emotional Stroop Task	144	144	144	84
Go/No-Go Words Task	72	72	72	72
Go/No-Go Border Images Task	96	96	96	96
Go/No-Go Colour Images Task	12	12	12	12

5.2.2 Apparatus

Four questionnaires were given to the participants to assess normal variation. These were the MOCI to assess obsessive compulsive thoughts and behaviours, the HADS to assess generally anxiety and depression thoughts and behaviours,

the BIS/BAS to assess approach and avoidance behaviour and finally the EPQR-S to assess extraversion, neuroticism, psychoticism and lie personality traits. The questionnaires were selected based on their past use on non-psychiatric normal participants.

Maudsley Obsessive Compulsive Inventory

The MOCI (Hodgson & Rachman, 1977) was used. This is a 30-item questionnaire and participants can answer either true or false. Some items are reversed scored (5, 9, 11 13, 15-17, 19, 21-25, 27, and 29). There are four subscales: checking (sum of items 2, 6, 8, 14, 15, 20, 22, 26, 28), cleaning (sum of items 1, 4, 5, 9, 13, 17, 19, 21, 24, 26, 27), slowness (sum of items 2, 4, 8, 16, 23, 25, 29) and doubting (sum of items 3, 7, 10-12, 18, 30). Subscales were determined by factor analysis so some items load onto more than one subscale.

Hospital Anxiety and Depression Scale

The HADS was used (Zigmond & Snaith, 1983). This is a 14-item questionnaire. Participants can respond to a four point likert scale, the four points include: Not at all, time to time occasionally, a lot of the time, most of the time. Items 2, 4, 6, 7, 12, and 14 are reversed scored. There are two subscales: anxiety (sum of item 1, 3, 5, 7, 9, 11, 13) and depression (sum of items 2, 4, 6, 8, 10, 12, 14). The HADS was adapted slightly so that any reference to hospital was removed.

Behavioural Inhibition System and Behavioural Activation System Questionnaire

The BIS/BAS was used (Carver & White 1994). This is a 20-item questionnaire. Participants respond to a four point likert scale, the four points

include: very false for me, somewhat false for me, somewhat true for me, very true for me. Items other than 2 and 22 are reverse-scored. There are five subscales: BAS drive seeking (sum of items 3, 9, 12, 21), BAS fun seeking (sum of items 5, 10, 15, 20), BAS reward responsiveness (sum of items 4, 7, 14, 18, 23), BAS total score (sum of items 3, 4, 5, 7, 9, 10, 12, 14, 15, 18, 20, 21, 23), and BIS total score (sum of items 2, 8, 13, 16, 19, 22, 24), items 1, 6, 11, 17, are fillers.

Eysenck's Personality Questionnaire – Revised Short Scale

The EPQR-S (Eysenck et al., 1985) is a 48 item questionnaire which participants can respond either Yes or No. There are four subscales: Extraversion/Introversion (1 point if responded yes: 3, 7, 11, 15, 19, 23, 32, 36, 44, 48 No: 27, 41), Neuroticism/Stability (1 point if responded yes: 1, 5, 9, 13, 17, 21, 25, 30, 34, 38, 42, 46), Psychoticism/Socialisation (1 point if responded yes: 10, 14, 22, 31, 39 No: 2, 6, 18, 26, 28, 35, 43), Lie (1 point if responded yes: 4, 16, 45 No: 8, 12, 20, 24, 29, 33, 37, 40, 47).

5.2.3 Procedure

All questionnaires were in English, paper version and completed at the end of all the computer tasks. All instructions about how to complete the questionnaires were provided. The questionnaires took no more than 15 minutes to complete. All information was kept confidential.

5.2.4 Design

Bivariate correlations were carried out to determine the relationship between the questionnaire measures and performance on the tasks. Due to the number of

comparisons that were being analysed the alpha level was set at α = .003 to ensure that any significant result was true and not due to type one error. Generally averages over the trials/blocks for ratings, reaction times and correctly categorising were used to compare with the questionnaire measures. Difference scores were calculated for the Negative Images CI Task: Retardation Test. They were calculated to examine the difference in ratings from the first trial and the last trial. The bigger difference between the two scores suggests more learning as there was a larger change in how participants were ratings the images.

5.3 Results

The final task versions for the six tasks discussed in the previous Chapters: Chapter 2: Negative Images CI Task: Retardation Test, Chapter 3: Negative Images CI Task: Summation Test and 'Mission to Mars' CI Task: Summation Test, Chapter 4: Emotional Stroop Task, Go/No-Go Words Task, Go/No-Go Border Images Task, Go/No-Go Colour Images Task have been compared to performance with questionnaire measures: HADS, MOCI, BIS/BAS and EPQR-S.

5.3.1 Negative Images Conditioned Inhibition Task: Retardation Test – Average Results

5.3.1.1 Hospital Anxiety and Depression Scale

There were no significant correlations between the HADS or its subscales and ratings of the stimuli at any of the stages of the Negative Images CI Task: Retardation Test, maximum $r(58) = -.385$, $p = .005$ for the relationship between HADS depression and the [CS + CI] at the discrimination stage.

5.3.1.2 Maudsley Obsessive Compulsive Inventory

There were no significant correlations between the MOCI or its subscales and ratings of the stimuli at any of the stages of the Negative Images CI Task: Retardation Test, maximum $r(58) = .304$, $p = .021$ for the relationship between MOCI check subscale and the CS at the pre-discrimination stage.

5.3.1.3 Behavioural Inhibition System and Behavioural Activation System Questionnaire

There were no significant correlations between the BIS/BAS or its subscales and ratings of the stimuli at any of the stages of the Negative Images CI Task: Retardation Test, maximum $r(58) = .329$, $p = .006$ for the relationship between BAS and the [CS + CI] at the discrimination stage.

5.3.1.4 Eysenck's Personality Questionnaire – Revised Short Scale

There were no significant correlations between the EPQR-S or any of its subscales and ratings of the stimuli at any of the stages of the Negative Images CI Task: Retardation Test, maximum $r(58) = .208$, $p = .072$ for the relationship between the extraversion subscale and the [CS + CI] at the discrimination stage.

5.3.2 Negative Images Conditioned Inhibition Task: Retardation Test – Difference Scores

5.3.2.1 Hospital Anxiety and Depression Scale

There were no significant correlations between the HADS or any of its subscales and the CI/CS difference scores at the retardation stage of the Negative Images CI Task: Retardation Test, maximum $r(58) = -.245$, $p = .100$

for the relationship between HADS and the difference score for the CI at the retardation stage.

5.3.2.2 Maudsley Obsessive Compulsive Inventory

There were no significant correlations between the MOCI or any of its subscales and the CI/CS difference scores at the retardation stage of the Negative Images CI Task: Retardation Test, maximum $r(58) = .365$, $p = .02$ for the relationship between the MOCI clean subscale and the difference score for the CI at the retardation stage.

5.3.2.3 Behavioural Inhibition System and Behavioural Activation System Questionnaire

There were no significant correlations between the BIS/BAS or any of its subscales and the CI/CS difference scores at the retardation stage of the Negative Images CI Task: Retardation Test, maximum $r(58) = .296$, $p = .031$ for the relationship between the BAS reward responsiveness subscale and the difference score for the CI at the retardation stage.

5.3.2.4 Eysenck's Personality Questionnaire – Revised Short Scale

There were no significant correlations for the EPQR-S or any of its subscales and the CI/CS difference scores at the retardation stage of the Negative Images CI Task: Retardation Test, maximum $r(58) = .272$, $p = .068$ for the relationship between extraversion subscale and the difference score for the CI at the retardation stage.

5.3.3 'Mission to Mars' Conditioned Inhibition Task: Summation Test

5.3.3.1 Hospital Anxiety and Depression Scale

There were no significant correlations between the HADS or its subscales and ratings of the stimuli on the 'Mission to Mars' CI: Summation Test, maximum $r(44) = -.275$, $p = .074$ for the relationship between the HADS anxiety subscale and the S_g.

5.3.3.2 Maudsley Obsessive Compulsive Inventory

There were no significant correlations between the MOCI or any of its subscales and ratings of the stimuli on the 'Mission to Mars' CI: Summation Test, maximum $r(44) = -.382$, $p = .012$ for the relationship between the MOCI clean subscale and the S_g.

5.3.3.3 Behavioural Inhibition System and Behavioural Activation System Questionnaire

There were no significant correlations between the BIS/BAS or any of its subscales and ratings of the stimuli on the 'Mission to Mars' CI: Summation Test, maximum $r(44) = .261$, $p = .090$ for the relationship between the BAS fun seeking subscale and [CI,S_g].

5.3.3.4 Eysenck's Personality Questionnaire – Revised Short Scale

There were no significant correlations between the EPQR-S or any of its subscales and ratings of the stimuli on the 'Mission to Mars' CI: Summation Test, maximum $r(44) = .375$, $p = .013$ for the relationship between the extraversion subscale and the ratings of the S_g.

5.3.4 Negative Images Conditioned Inhibition Task: Summation Test

5.3.4.1 Hospital Anxiety and Depression Scale

There were no significant correlations between the HADS or its subscales and ratings of the stimuli of the Negative Images CI Task: Summation Test, maximum $r(10) = .444$, $p = .052$ for the relationship between HADS depression subscale and the CS and the pre-discrimination stage.

5.3.4.2 Maudsley Obsessive Compulsive Inventory

There were no significant correlations between MOCI or its subscales and ratings of the stimuli on Negative Images CI Task: Summation Test, maximum $r(10) = -.654$, $p = .021$ for the relationship between the MOCI slow subscale and the CSt at the extinction stage.

5.3.4.3 Behavioural Inhibition System and Behavioural Activation System Questionnaire

There were no significant correlations between the BIS/BAS or any of its subscales and ratings of the stimuli on the Negative Images CI Task: Summation Test, maximum $r(10) = .732$, $p = .012$ for the relationship between the BAS fun seeking subscale and the ratings of the CS_t at the summation stage.

5.3.4.4 Eysenck's Personality Questionnaire – Revised Short Scale

There were no significant correlations between the EPQR-S or any of its subscales and ratings of the stimuli on the Negative Images CI task:

Summation Test, maximum $r(10) = .584$, $p = .056$ for the relationship between the lie subscale and the CS at the extinction stage.

5.3.5 Emotional Stroop Task

5.3.5.1 Reaction Time

5.3.5.1.1 Hospital Anxiety and Depression Scale

There was no significant correlations between the HADS or any of its subscales and reaction time on the Stroop task, maximum $r(142) = -.127$, $p = .216$ for the relationship between the HADS depression subscale and negative words.

5.3.5.1.2 Maudsley Obsessive Compulsive Inventory

There were no significant correlations with the MOCI or any of its subscales and reaction time on the Stroop task, maximum $r(142) = .195$, $p = .048$ for the relationship between MOCI doubt and colour incongruent words.

5.3.5.1.3 Behavioural Inhibition System and Behavioural Activation System Questionnaire

There were no significant correlations with the BIS/BAS or any of its subscales and reaction time on the Stroop task, maximum $r(142) = .272$, $p = .008$ for the relationship between BAS drive subscale and the reaction time for colour congruent words.

5.3.5.1.4 Eysenck's Personality Questionnaire – Revised Short Scale

There were no significant correlations with the EPQR-S or any of its subscales and reaction time on the Stroop task, maximum $r(82) = .171$, $p = .03$ for the relationship between the lie subscale and the reaction time for negative words.

5.3.5.2 Accuracy Measures

5.3.5.2.1 Hospital Anxiety and Depression Scale

There were no significant correlations with the HADS or any of its subscales and accuracy on the Stroop task, maximum $r(142) = .190$, $p = .031$ for the relationship between the HADS anxiety subscale and negative words.

5.3.5.2.2 Maudsley Obsessive Compulsive Inventory

There were no significant correlations between MOCI or any of its subscales and accuracy on the Stroop task, maximum $r(142) = -.114$, $p = .167$ for the relationship between the MOCI check subscale and colour incongruent words.

5.3.5.2.3 Behavioural Inhibition System and Behavioural Activation System Questionnaire

There were no significant correlations between BIS/BAS or any of its subscales and accuracy on the Stroop task, maximum $r(142) = -.156$, $p = .061$ for the relationship between the BAS drive subscale and colour congruent words.

5.3.5.2.4 Eysenck's Personality Questionnaire – Revised Short Scale

There were no significant correlations between EPQR-S or any of its subscales and accuracy on the Stroop task, maximum $r(82) = -.192$, $p = .076$ for the relationship between the extraversion subscale and negative words.

5.3.6 Go/No-Go Words Task

5.3.6.1 Reaction Time

5.3.6.1.1 Hospital Anxiety and Depression Scale

There was no significant correlations between the HADS or any of its subscales and the reaction time for correctly categorised Go words, maximum $r(70) = -.191$, $p = .277$ for the relationship between the HADS depression subscale and positive words.

5.3.6.1.2 Maudsley Obsessive Compulsive Inventory

There was no significant correlations between the MOCI or any of its subscale and the reaction time for correctly categorised Go words, maximum $r(70) = -.147$, $p = .233$ for the relationship between the MOCI slow subscale and positive words.

5.3.6.1.3 Behavioural Inhibition System and Behavioural Activation System Questionnaire

There were no significant correlations between the BIS/BAS or any of its subscales and the reaction time for correctly categorised Go words, maximum $r(70) = .279$, $p = .027$ for the relationship between BAS drive subscale and reaction time for Go OCD words.

5.3.6.1.4 Eysenck's Personality Questionnaire – Revised Short Scale

There were no significant correlations between the EPQR-S or any of its subscales and the reaction time for correctly categorised Go words, maximum $r(70) = .320$, $p = .046$ for the relationship between the psychoticism subscale and positive words.

5.3.6.2 Accuracy for Go Words

5.3.6.2.1 Hospital Anxiety and Depression Scale

There were no significant correlations between the HADS or any of its subscales and the accuracy for Go words, maximum $r(70) = -.231$, $p = .057$ for the relationship between the HADS anxiety subscale and negative words.

5.3.6.2.2 Maudsley Obsessive Compulsive Inventory

There were no significant correlations between MOCI or any of its subscales and the accuracy for Go words, maximum $r(70) = -.502$, $p = .009$ for the relationship between MOCI clean subscale and negative words.

5.3.6.2.3 Behavioural Inhibition System and Behavioural Activation System Questionnaire

There were no significant correlations between the BIS/BAS or any of its subscales and accuracy for Go words, maximum $r(70) = -.553$, $p = .006$ for the relationship between BAS drive subscale and Go OCD words.

5.3.6.2.4 Eysenck's Personality Questionnaire – Revised Short Scale

There were no significant correlations between the EPQR-S or any of its subscales and the accuracy for Go words, maximum $r(70) = -.270$, $p = .079$ for the relationship between the extraversion subscale and positive words.

5.3.6.3 Accuracy for No-Go Words

5.3.6.3.1 Hospital Anxiety and Depression Scale

There were no significant correlations between the HADS or any of its subscales and the accuracy for No-Go words, maximum $r(70) = -.184$, $p = .128$ for the relationship between the HADS anxiety subscale and accuracy for neutral No-Go words.

5.3.6.3.2 Maudsley Obsessive Compulsive Inventory

There were no significant correlations between the MOCI or any of its subscales and the accuracy for No-Go words, maximum $r(70) = -.388$, $p = .034$ for the relationship between the MOCI clean subscale and accuracy for No-Go neutral words.

5.3.6.3.3 Behavioural Inhibition System and Behavioural Activation System Questionnaire

There were no significant correlations between the BIS/BAS or any of its subscales and the accuracy for No-Go words, maximum $r(70) = -.473$, $p = .005$ for the relationship between the BAS drive subscale and accuracy for No-Go neutral words.

5.3.6.3.4 Eysenck's Personality Questionnaire – Revised Short Scale

There were no significant correlations between the EPQR-S or any of its subscales and the accuracy for No-Go words, maximum $r(70) = .509$, $p = .008$ for the relationship between the extraversion subscale and No-Go OCD words.

5.3.7 Go/No-Go Border Images Task

5.3.7.1 Reaction Time

5.3.7.1.1 Hospital Anxiety and Depression Scale

There were no significant correlations between the HADS or any of its subscales and the reaction time to correctly categorise Go images, maximum $r(94) = -.070$, $p = .354$ for the relationship between the HADS anxiety subscale and OCD hoarding images.

5.3.7.1.2 Maudsley Obsessive Compulsive Inventory

There were no significant correlations between the MOCI or any of its subscales and the reaction time to correctly categorise Go images, maximum $r(94) = -.185$, $p = .090$ for the relationship between the MOCI clean subscale and OCD hoarding images.

5.3.7.1.3 Behavioural Inhibition System and Behavioural Activation System Questionnaire

There were no significant correlations between the BIS/BAS and any of its subscales and the reaction time to correctly categorise Go images, maximum $r(94) = .169$, $p = .067$ for the relationship between BIS and OCD symmetry images.

5.3.7.1.4 Eysenck's Personality Questionnaire – Revised Short Scale

There were no significant correlations between the EPQR-S and any of its subscales and the reaction time to correctly categorise Go images, maximum $r(94) = .247$, $p < .04$ for the relationship between neuroticism and Go neutral images.

5.3.7.2 Accuracy for Go Images

5.3.7.2.1 Hospital Anxiety and Depression Scale

There were no significant correlations between the HADS or any of its subscales and the accuracy for Go images, maximum $r(94) = -.064$, $p = .521$ for the relationship between the HADS depression subscale and the OCD washing images.

5.3.7.2.2 Maudsley Obsessive Compulsive Inventory

There were no significant correlations between the MOCI or any of its subscales and the accuracy for Go images, maximum $r(94) = -.158$, $p = .114$ for the relationship between the MOCI clean subscale and OCD washing images.

5.3.7.2.3 Behavioural Inhibition System and Behavioural Activation System Questionnaire

There were no significant correlations between the BIS/BAS or any of its subscales and the accuracy for Go images, maximum $r(94) = .185$, $p = .149$ for the relationship between BIS and OCD symmetry images.

5.3.7.2.4 Eysenck's Personality Questionnaire – Revised Short Scale

There were no significant correlations between the EPQR-S score total or any of its subscales and the accuracy for Go images, maximum $r(94) = .218$, $p = .111$ for the relationship between the neuroticism subscale and OCD symmetry images.

5.3.7.3 Accuracy for No-Go Images

5.3.7.3.1 Hospital Anxiety and Depression Scale

There were no significant correlations between the HADS or any of its subscales and the accuracy for No-Go images, maximum $r(94) = -.139$, $p = .211$ for the relationship between the HADS depression subscale and OCD hoarding images.

5.3.7.3.2 Maudsley Obsessive Compulsive Inventory

There were no significant correlations between the MOCI or any of its subscales and the accuracy for No-Go images, maximum $r(94) = -.196$, $p = .128$ for the relationship between the MOCI doubt subscale and OCD hoarding images.

5.3.7.3.3 Behavioural Inhibition System and Behavioural Activation System Questionnaire

There were no significant correlations between the BIS/BAS or any of its subscales and the accuracy for No-Go images, maximum $r(94) = .137$, $p = .181$ for the relationship between BIS and OCD washing images.

5.3.7.3.4 Eysenck's Personality Questionnaire – Revised Short Scale

There were no significant correlations between the EPQR-S or any of its subscales and the accuracy to categorise No-Go images, maximum $r(94) = -.261$, $p = .038$ for the relationship between the extraversion subscale and No-Go neutral images.

5.3.8 Go/No-Go Colour Images Task

5.3.8.1 Reaction Time

5.3.8.1.1 Hospital Anxiety and Depression Scale

There were no significant correlations between the HADS or any of its subscales and the reaction time for correctly categorised Go images, maximum $r(10) = .826$, $p = .085$ for the relationship between the HADS anxiety subscale and reaction time for Go symmetry images.

5.3.8.1.2 Maudsley Obsessive Compulsive Inventory

There were no significant correlations between the MOCI or any of its subscales and the reaction time for correctly categorised Go images, maximum $r(10) = .698$, $p = .189$ for the relationship between the MOCI clean subscale and reaction time for Go symmetry images.

5.3.8.1.3 Behavioural Inhibition System and Behavioural Activation System Questionnaire

There were no significant correlations between the BIS/BAS or any of its subscales and the reaction time for correctly categorised Go images, maximum

$r(10) = -.861$, $p = .061$ for the relationship between BIS and reaction time for Go neutral images.

5.3.8.1.4 Eysenck's Personality Questionnaire – Revised Short Scale

There were no significant correlations between the EPQR-S or any of its subscales and the reaction time for correctly categorised Go images, maximum $r(10) = .769$, $p = .128$ for the relationship between the EPQR-S psychoticism subscale and reaction time for Go neutral images.

5.3.8.2 Accuracy for Go Images

5.3.8.2.1 Hospital Anxiety and Depression Scale

There were no significant correlations between the HADS or any of its subscales and the accuracy for Go images, maximum $r(10) = .795$, $p = .059$ for the relationship between the HADS anxiety subscale and accuracy for Go neutral images.

5.3.8.2.2 Maudsley Obsessive Compulsive Inventory

There were no significant correlations between the MOCI or any of its subscales and the accuracy for Go images, maximum $r(10) = .667$, $p = .086$ for the relationship between the MOCI slow subscale and accuracy for Go symmetry images.

5.3.8.2.3 Behavioural Inhibition System and Behavioural Activation System Questionnaire

There were no significant correlations between the BIS/BAS or any of its subscales and the accuracy for Go images, maximum $r(10) = .880$, $p = .021$ for the relationship between the BIS and accuracy for Go hoarding images.

5.3.8.2.4 Eysenck's Personality Questionnaire – Revised Short Scale

There were no significant correlations between the EPQR-S or any of its subscale and the accuracy for Go images, maximum $r(10) = .866$, $p = .026$ for the relationship between the EPQR-S lie subscale and accuracy for Go hoarding images.

5.3.8.3 Accuracy for No-Go Images

5.3.8.3.1 Hospital Anxiety and Depression Scale

There were no significant correlations between the HADS or any of its subscales and the accuracy for No-Go images, maximum $r(10) = .599$, $p = .057$ for the relationship between the HADS depression subscale and accuracy for No-Go hoarding images.

5.3.8.3.2 Maudsley Obsessive Compulsive Inventory

There were no significant correlations between the MOCI or any of its subscales and the accuracy for No-Go images, maximum $r(10) = .674$, $p = .033$ for the relationship between MOCI slow and accuracy for No-Go washing images.

5.3.8.3.3 Behavioural Inhibition System and Behavioural Activation System Questionnaire

There were no significant correlations between the BIS/BAS or any of its subscales and the accuracy for No-Go images, maximum $r(10) = -.584$, $p = .076$ for the relationship between the BAS fun seeking subscale and accuracy for No-Go neutral images.

5.3.8.3.4 Eysenck's Personality Questionnaire – Revised Short Scale

There were no significant correlations between the EPQR-S or any of its subscale and the accuracy for No-Go images, maximum $r(10) = .513$, $p = .051$ for the relationship between the EPQR-S lie subscale and accuracy for No-Go hoarding images.

5.4 Chapter Discussion

Anxiety is a broad emotion and one that can be experienced by all individuals, as a result of a wide variety of situations, which can alter behaviours and produce symptoms and in some individuals developing into a debilitating anxiety disorder such as OCD or Panic Disorder. Questionnaires provide a useful way to measure individual differences in anxiety. This Chapter has examined the data from four different questionnaires (HADS, MOCI, BIS/BAS and EPQR-S) which measure a range of anxiety and anxiety-related symptoms. The scores have been used to examine the relationship between anxiety and the performance on the inhibitory tasks detailed in the previous Chapters.

5.4.1 Conditioned Inhibition Tasks

People that suffer from OCD or Panic Disorder could be using conditioned inhibitors as safety signals which in turn maintains the symptoms or disorder. There are two key tests to determine a true inhibitor: retardation and summation. As detailed in Chapter 2 the fifth version of the CI retardation test successfully demonstrated that the CI was a true inhibitor; learning about the CI was slower (when being trained to be a CS at the retardation stage) compared with a novel CS. Chapter 3 also successfully demonstrated conditioned inhibition via a summation test in two tasks; The inhibitory properties of the inhibitor had transferred over onto the conditioned stimulus, both the CS_t and S_g and this was reflected in the way the participants rated the images. Further to this in both the retardation task and summation task (where data was captured) the discrimination was learnt – a necessary pre-requisite for conditioned inhibition – participants learnt that the CS and [CS + CI] signalled the presence and absence of an outcome respectively. Both of these tasks had decent sample sizes and thus strong statistical power. In order to examine the effects of individual differences four questionnaires were administered to the participants. Overall, there were no correlations between performance on any of the conditioned inhibition tasks (Negative Images CI Task: Retardation Test, 'Mission to Mars' CI Task: Summation Test, and Negative Images CI Task: Summation Test) and any of the individual differences questionnaires (HADS, MOCI, BIS/BAS, and EPQR-S). The absence of any correlations indicates that conditioned inhibition and discrimination learning was not affected by individual differences in anxiety. This lack of correlation could be due to the sample tested (taken from a healthy population) and low scores and thus limited range on the individual differences questionnaires. However, as argued previously anxiety is an emotion that all individuals experience and therefore are a useful population to sample from.

Previous studies have reported a different pattern of results – a relationship between excitatory conditioning, anxiety and mood disorders (Grillon & Davis, 1997; Grillon, 2002) and with aversive outcomes (animal study, Mineka & Kihlstrom, 1978; Odling-Smee, 1975). Studies that have investigated

conditioned inhibition in humans have also successfully demonstrated conditioned inhibition and a relationship with schizotypy and BAS reward responsiveness (Migo et al., 2006). From a theoretical perspective conditioning and specifically examined in this thesis learning processes are hypothesised to be key to the development and maintenance of anxiety and anxiety disorders. The two process theory (Mowrer, 1956; 1960) states that anxiety is initially learnt through Pavlovian conditioning experiences, anxiety is conditioned to the signal. This is then maintained through instrumental responding, avoidance responses carried out to escape the signal, which are negatively reinforcing. Escaping from a signal that elicits fear serves as a function to avoid the anxiety provoking event. Gray (1970) expanded on this to take account of the persistence of avoidance behaviour by introducing the concept of safety signals. These are signals that are generated from the avoidance behaviour. The signal safety, become secondarily rewarding and preserves the avoidance response (Gray, 1987). In this thesis it was argued that the safety signals that are elicited when carrying out the avoidance behaviour are CIs. Individuals with reported higher levels of anxiety may therefore display a facilitated learning effect, better learning about discrimination and also conditioned inhibitors. The results from the current study do not support this and do not support previous studies that have shown a link between learning and anxiety. A more comprehensive analysis of the results and any limiting factors of the study are explored in Chapter 7.

5.4.2 Response Inhibition Tasks

As mentioned and hypothesised, inhibitory learning process may be involved in the development and maintenance of anxiety, OCD and Panic Disorder however other inhibitory processes may also be involved and association. Response inhibition is the ability to withhold a behavioural response to certain stimuli. Cognitive theories and models of anxiety, OCD and Panic Disorder posit that a function of anxiety is hyper vigilance towards perceived threatening stimuli. Once the stimulus has been identified attention becomes focused on it and for the individual it becomes hard to disengage. Therefore on the response inhibition tasks used in the current study you would expect to see

individuals higher in reported anxiety are slower and less accurate on the tasks. Three key tests were used to examine response inhibition differences in relation to anxiety in the current study. The Stroop task is a classic test of response inhibition, as described in Chapter 4 and examines whether a cognitive interference occurs between colour in/congruent words and emotional words. Participants that completed the Emotional Stroop Task showed a classic Stroop effect; they were less accurate and slower for colour incongruent words than other word-types. There were some differences with OCD and negative words for accuracy and reaction time, participants were more accurate to categorise negative words compared to congruent words and they were quicker to categorise OCD words compared to negative words and compared to congruent words. The Go/No-Go task also provides a reliable test of response inhibition and examines whether participants behaviourally respond differently to either neutral or emotionally related stimuli. The Go/No-Go tasks used in the current thesis were in two formats, the Go/No-Go Words Task and the Go/No-Go Images tasks (Border and Colour). There was no difference in performance for accuracy or reaction time on any of the tasks. In order to examine the effects of individual differences four questionnaires were administered to the participants. Overall, there were no correlations between performance on the Emotional Stroop, the Go/No-Go Words Task and the Go/No-Go Images Tasks (Border and Colour) either reaction time or accuracy (Go and No-Go) and any of the individual differences questionnaires (HADS, MOCI, BIS/BAS, and EPQR-S). These results and the absence of any correlations indicates that response inhibition was not affected by individual differences in anxiety. The lack of any correlation could be due to methodological reasons; although the Emotional Stroop Task successfully demonstrated response inhibition none of the Go/No-Go Tasks successfully demonstrated response inhibition. Individuals did not display a Go/No-Go effect: slower and less accurate to categorise the No-Go stimuli. The design of the task could be preventing any demonstration of response inhibition. Also, as mentioned for the conditioned inhibition tasks, the sample and the healthy population could be a limiting factor however this should not impact too heavily as anxiety is experienced ay many points and times in an individual. These results do not corroborate previous research that has reported a

relationship between response inhibition and anxiety, OCD or Panic Disorder (Amir et al., 1996; Bannon et al., 2002; Penadés et al., 2007; Shiffrin & Schneider, 1977). Nor do they suggest, as cognitive theories do, that an inability to disengage to certain stimuli is involved in the maintenance of anxiety, OCD or Panic Disorder. The methodological limitations and theoretical implications are discussed in more detail in Chapter 7.

Six different inhibitory tasks (two conditioned inhibition tasks and 4 response inhibition tasks) and four different individual differences questionnaires were tested on a sample taken from a healthy population. Performance on the conditioned inhibition tasks (detailed in Chapter two and three) successfully demonstrated discrimination learning and conditioned inhibition as measured by both the retardation and summation test. Performance on the Emotional Stroop Task displayed the classic colour Stroop and also some differences to emotional stimuli. There was no difference in responding on any of the Go/No-Go Tasks. Moreover, the aim of this chapter was to identify any relationships between performance and individual differences. Once corrected for multiple comparisons there were no significant correlations between performance on these tasks and individual differences in anxiety. Overall the pattern of results shows that individual differences in anxiety as measured by the questionnaires did not influence performance on these inhibitory tasks. The results are discussed in further detail in Chapter 7 (General Discussion).

Chapter 6: Inhibitory Task Performance in a Clinical Population

6.1 Introduction

Anxiety disorder is a broad term to cover several different manifestations of perceived anxiety. There are six main types of anxiety disorders: Generalised Anxiety Disorder (GAD), Panic Disorder with or without agoraphobia, Obsessive Compulsive Disorder (OCD), Post Traumatic Stress Disorder (PTSD), Phobias including Social Phobia, and Acute Stress Disorder, (DSM-IV, DSM-IV, 2000). The two main anxiety disorders that are under investigation in the current study are Panic Disorder and OCD.

Panic disorder develops when a person experiences severe and recurring panic attacks. These are frightening experiences for the individual and after an attack they often then change their behaviours or thoughts to avoid any further attacks (DSM-IV, 2000; Klein & Flink, 1962). As a result in some circumstance agoraphobia can develop; this is where the individual avoids situations where potentially a panic attack may occur and it is difficult to escape (DSM-IV, 2000). OCD develops when an individual experiences obsessions, intrusive thoughts or images, which are distressing, and as a result carries out compulsions which are often rituals or habits to temporarily alleviate the obsessions (DSM-IV, 2000). Both Panic Disorder and OCD are extremely distressing for the individual and because of this those who meet diagnostic criteria for these disorders also often meet diagnostic criteria for substance abuse (this included all substances with an above chance occurrence) (Hasin et al., 2007; Kessler et al., 1997). It can be argued that either people self medicate their anxiety by overusing a substance to alleviate the symptoms and this becomes negatively reinforced or that because of chronic misuse of substances

anxiety symptoms develop as a consequence (Allan, 1995; George et al., 1990).

It has been hypothesised that anxiety disorders develop and are maintained through classical conditioning processes; anxieties and fears are acquired through Pavlovian conditioning and are maintained through negative reinforcement of avoidance behaviour (Mowrer, 1960). Further to this, it could be speculated that conditioned inhibition, a classical conditioning phenomena, could play a role in the maintenance of anxiety disorders, in particular to this thesis OCD and Panic Disorder (Gray, 1987). Anxieties and fears are learnt through classical conditioning processes and in parallel the subsequent avoidance behaviours that are carried out generate safety signals, conditioned inhibitors' (Gray, 1987), reinforcing and maintaining this behaviour, they are secondarily rewarding (Cándido et al., 1991; Cook et al., 1987; Dinsmoor, 2001). For example, for an individual with OCD (see Chapter 1 for diagram of this example) anxieties and fears are learnt through CS → US associations. Washing is the avoidance behaviour that generates safety signals, CIs, which accompany it, such as the smell of the soap being used, the sound of the water, and thus both the washing and safety signals that are generated negatively reinforce the behaviour. Therefore, it could be hypothesised that individuals that suffer with OCD and Panic Disorder are, in fact, better at learning about conditioned inhibitors.

Further to this, differences in other types of inhibitory processes, behavioural and cognitive, are thought to be fundamental to the development and maintenance of OCD and Panic Disorder. Individuals who suffer from these disorders may be slower to respond to certain anxiety provoking stimuli as they may experience a cognitive interference or an inability to inhibit responding to stimuli that are particularly relevant to them (Bannon et al., 2002; Penadés et al., 2007; Williams et al., 1996).

The aim of the next experiments was to examine in a clinical population the tasks detailed in previous Chapters. Thus, the present Chapter describes the recruitment of two clinical populations: an anxiety disorder and a substance abuse sample. Anxiety disorders are a common mental health problem and often people develop substance abuse disorders as a result. Therefore samples from both populations were recruited. Participants completed five different inhibitory tasks. Conditioned inhibition was tested by both the retardation test and summation test using the final task version as detailed in Chapter 2 and the 'Mission to Mars' version as detailed in Chapter 3. Response inhibition tasks included the Emotional Stroop Task, Go/No-Go Tasks (Go/No-Go Words Task and Go/No-Go Border Images Task) both with anxiety related words as the stimuli and OCD related images because individuals may be aroused by a pictorial representation of their anxiety (Lavy & Van Den Hout, 1993; Lavy et al., 1993; Mansell et al., 1999). Participants were also required to complete four individual differences measures: HADS, MOCI, BIS/BAS and EPQR-S. The results are detailed and discussed.

6.2 Methods

6.2.1 Participants

Participants that had been diagnosed with an anxiety disorder were recruited from King Mill Hospital, Millbrook and Millfields Clinics. Participants diagnosed with a substance abuse problem were from Oxford Corner Centre. Matched controls were recruited from the University of Nottingham.

Over the course of seven months 220 potential participants were approached from Millbrook and Millfields Clinics and six agreed to participate. Ideally a clinical sample of 24 would have been recruited and ethical approval was given for up to a maximum of 48 participants, this allowed any symptom subtypes and co-morbidity to be taken into account. As reported in this thesis (Chapter 2 and 3) discrimination learning has been shown with this sample size and in

published studies conditioned inhibition via a summation test (Migo et al., 2006; Kantini et al., 2011a, Kanitini et al., 2011b). From previous successful demonstrations and the practicalities of recruiting a clinical sample, 24 was determined to be the ideal number to recruit. Power was calculated using G*Power (Erdfelder et al., 1996) to determine the sample size for the meaningful main effects/interactions at the discrimination training and retardation stage for a medium effect of .25 (Cohen, 1977). At the discrimination stage for the interaction between clinical group and inhibition the required sample size is 128, the critical is F = 1.19 and the actual power would be .996. At the retardation stage for the interaction between clinical group, inhibition and blocks the required sample size is 60 and the critical F = 1.15 and the actual power would be .986. The sample size reported in this thesis had four males and two females with a mean age of 43 (range from 22 – 52). All participants had normal or corrected to normal vision and were naïve to the current task and hypothesis. Over the page is a summary of the diagnosis, treatment and medication information available (see Table 6.1).

Table 6.1

The formal clinical diagnosis, medication and psychological treatment history of the participants for the anxiety disorder sample recruited from Millbrook and Millfields Clinic.

Participant	Current Diagnosis	Past Diagnoses	Medication	Psychological Treatment
1	Panic Disorder	None	None	None
2	Low mood and sleep problems	Alcohol Abuse	None	Counselling
3	Low mood, Panic Disorder	None	Diazepam, Citalopram	None
4	Panic Disorder	Substance Abuse, Personality Issues	Nitrazapam, Citalopram	None
5	Low mood, sleep problems	None	Lofepramine, Zopiclone	None
6	Acute Stress Reaction	None	None	Counselling

This study was approved by NHS Research Ethics (Leicestershire, Northamptonshire & Rutland Research Ethics Committee 2, 09/H0402/103). All participants received an inconvenience allowance (£5) to cover their travel expenses.

Over the course of three months 35 potential participants were approached from Oxford Corner Centre and two agreed to participate. A third participant was recruited from the University of Nottingham, the participant volunteered to complete the study and when asked about how much alcohol they consumed disclosed they had been diagnosed with a substance abuse problem. There was one male and two females with a mean age of 39 (range 35-45). All participants had been diagnosed with a substance abuse problem and were

currently either receiving or waiting for treatment. All participants had normal or corrected to normal vision and were naïve to the current task and hypothesis.

An amendment to the original NHS approval was made and the additional directorate 'Drug and Alcohol Services' was approved under the previous ethical clearance authorised by NHS Research Ethic (Leicestershire, Northamptonshire & Rutland Research Ethics Committee 2, 09/H0402/103). All participants received an inconvenience allowance (£5 Boots voucher) for their time.

Six matched controls agreed to complete the study. Participants were matched on age, sex and socioeconomic status (employment and highest level of education). They were principally matched to the anxiety disorder group but also provided a suitable match for the substance abuse group. There were four males and two females with a mean age of 39 (range 22 – 57). All participants had normal or corrected to normal vision and were naïve to the current task and hypothesis. Matched controls were also approved by NHS Research Ethics (Leicestershire, Northamptonshire & Rutland Research Ethics Committee 2, 09/H0402/103). All participants received an inconvenience allowance (£5) to cover their travel expenses.

Table 6.2 reports all the demographic details of the participants and group means for the questionnaire data, both clinical and healthy, that volunteered to be involved in the study. This information was collected to determine that the participants were suitable matches and did not vary in demographics but that the groups themselves (anxiety disorder, substance abuse and healthy) varied in reported individual differences. Paired samples t-tests were carried out to determine if differences in the group means for the questionnaire data was significant, results revealed that the anxiety group was significantly different to the healthy group, $t(5) = 3.432$, $p = .019$ for the difference between the anxiety and healthy group on the HADS and $t(5) = 3.764$, $p = .013$ for the difference between the anxiety and healthy group on the MOCI. There were no other

significant differences. Previous studies that have used these questionnaires have reported means in a similar range to the ones reported in the table: Non-clinical sample, MOCI, *M* = 7.58, *SD* = 4.28, Sternberger & Burns, (1990), and *M* = 7.12, *S*D = 4.33, Thomas et al., (2000), HADS, *M* = 9.82, *SD* = 5.98 (Crawford et al., 2001) BIS *M* = 20.11 *SD* = 3.12, BAS *M* = 37.95 *SD* = 5.15 (Alloy et al., 2008) and EPQR-S, E - *M* = 7.96 *SD* = 3.18, P - *M* = 3.69 *SD* = 2.48, N – *M* = 4.54 *SD* = 3.49, L – *M* = 3.67 *SD* = 5.17 (Aluja et al., 2003).

Table 6.2

The demographic information of the clinical sample: anxiety and substance disorder and healthy matched controls.

	Anxiety Disorder	**Substance Abuse**	**Healthy Matched Controls**
Education	4 participants had GCSE's, 2 participants had no formal qualifications	1 participant had a Bachelors degree, 2 participants had GCSE's	5 participants had GCSE's, 1 participant had no formal qualifications
Occupation	3 participants were employed, 3 participants were not in any employment at the time of testing	1 participant was employed, 2 participants were not in any employment at the time of testing	5 participants were employed, 1 participant was not in any employment at the time of testing
Caffeine: Cups of tea/coffee a day	*M* = 12.83	*M* = 9	*M* = 5
Alcohol: Units a week	*M* = 6.67[2]	*M* = 0	*M* = 10.83
Nicotine: Cigarettes/day	*M* = 13.83	*M* = 13.34	*M* = 0
HADS	*M* = 27.17, *SD* = 11.33	*M* = 25.00, *SD* = 6.55	*M* = 7.50, *SD* = 3.20
MOCI	*M* = 16.83, *SD* = 7.05	*M* = 9.00, *SD* = 4.35	*M* = 6.30, *SD* = 3.32
BIS	*M* = 22.50, *SD* = 5.95	*M* = 26.67, *SD* = 2.3	*M* = 20.00, *SD* = 5.65
BAS	*M* = 32.67, *SD* = 10.53	*M* = 31.00, *SD* = 6.57	*M* = 39.16, *SD* = 5.23
EPQR-S:			
Extraversion	*M* = 5.33, *SD* = 5.50	*M* = 10.50, *SD* = 3.2	*M* = 1.66, *SD* = 1.15
Psychoticism	*M* = 2.83, *SD* = 1.83	*M* = 2.33, *SD* = 1.75	*M* = 1.66, *SD* = 1.15
Neuroticism	*M* = 2.83, *SD* = 2.48	*M* = 4.33, *SD* = 2.33	*M* = 10.00, *SD* = 1.00
Lie	*M* = 5.67, *SD* = 2.42	*M* = 4.33, *SD* = 2.80	*M* = 4.33, *SD* = 2.80

[2] It should be noted that only two participants actually reported consuming alcohol on a weekly basis therefore affecting the mean.

6.2.2 Apparatus

All the materials were the same as the final task version carried out on a healthy population: Negative Images CI Task: Retardation Test (Chapter 2), 'Mission to Mars' CI Task: Summation Test (Chapter 3), Emotional Stroop Task (Chapter 4), Go/No-Go Words Task (Chapter 4) Go/No-Go Border Images Task (Chapter 4).

6.2.3 Procedure

All procedures were the same as the final task version carried out on a healthy population: Negative Images CI Task: Retardation Test (Chapter 2), 'Mission to Mars' CI Task: Summation Test (Chapter 3), Emotional Stroop Task (Chapter 4), Go/No-Go Words Task (Chapter 4) Go/No-Go Border Images Task (Chapter 4).

6.2.4 Design

All data were analysed using SPSS (version 15.0) and used an alpha of $p = .05$ and paired samples t-tests used a 95% confidence interval. The designs were the same as when the task was carried out on a healthy population as detailed in previous Chapters: Negative Images CI Task: Retardation Test (Chapter 2), 'Mission to Mars' CI Task: Summation Test (Chapter 3), Emotional Stroop Task (Chapter 4), Go/No-Go Words Task (Chapter 4) Go/No-Go Border Images Task (Chapter 4).

Previously the designs were all carried out within subjects, to analyze for clinical group in one design and sex in another design, a between subjects factor was introduced. The between subjects factor were 'clinical group' which had three levels, anxiety, substance and healthy. The number of participants in

each clinical group was unbalanced, six anxiety disorder participants, three substance abuse participants and six matched control participants. A second analysis was run with the between subjects factor 'sex' which had two levels, male and female. Estimated effect sizes, Partial eta, were calculated for all analyses.

For the bivariate correlational analysis the data from all three groups was pooled. This was possible because the same individual differences measures were tested in all samples. Due to the number of comparisons that were being analysed the alpha level was set at $\alpha = .003$ to ensure that any significant result was true and not due to type one error.

6.3 Results

6.3.1 Negative Images Conditioned Inhibition Task: Retardation Test

6.3.1.1 Pre-Discrimination

CS ratings

Clinical group – There was no significant interaction between trials and clinical group, $F(18,108) = .720$, $p = .784$, $\eta^2 = .107$. There was no significant main effect of trials, $F(9,108) = .600$, $p = .795$, $\eta^2 = .048$. The maximum F was the interaction between trials and clinical group.

Sex – There was no significant interaction between trials and sex, $F(9,117) = 1.560$, $p = .135$, $\eta^2 = .107$. There was no significant main effect of trials, $F(9,117) = 1.560$, $p = .135$, $\eta^2 = .107$. The maximum F was the main effect of trials and the interaction between trials and sex.

US ratings

Clinical group – There was no significant interaction between trials and clinical group, $F(18,108) = .930$, $p = .545$, $\eta^2 = .134$. There was no significant main effect of trials, $F(9,108) = .738$, $p = .673$, $\eta^2 = .058$. The maximum F was the interaction between trials and clinical group.

Sex – There was no significant interaction between trials and sex, $F(9,117) = .517$, $p = .860$, $\eta^2 = .038$. There was no significant main effect of trials, $F(9,117) = 1.024$, $p = .425$, $\eta^2 = .073$, this was also the maximum F.

6.3.1.2 Discrimination Training

CS and [CS + CI] ratings

Clinical group – There was no significant interaction between inhibition and clinical group, $F(2,12) = 3.636$, $p = .058$, $\eta^2 = .377$. There was no significant main effect of inhibition, $F(1,12) = 1.441$, $p = .253$, $\eta^2 = .107$. Participants were not rating the CS significantly differently to the [CS + CI]. The maximum F was the interaction between inhibition and clinical group.

Sex – There was no significant interaction between inhibition and sex, $F(1,13) = 1.823$, $p = .200$, $\eta^2 = .123$. There was no significant main effect of inhibition, $F(1,13) = .497$, $p = .493$, $\eta^2 = .037$. The maximum F was the interaction between inhibition and sex.

US ratings

Clinical group – There was no significant interaction between clinical group and valence, $F(2,12) = 2.343$, $p = .090$ $\eta^2 = .163$. There was a significant main effect of valence, $F(1,12) = 33.468$, $p = .001$, $\eta^2 = .736$. The US negative

images were being rated lower (nastier) than the US off white images (see Figure 6.1).

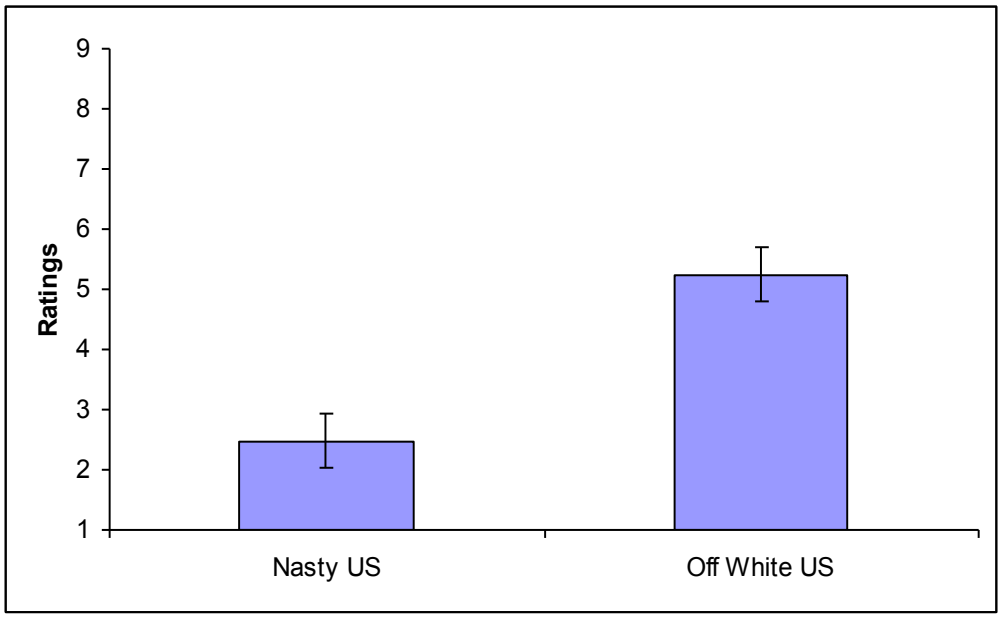


Figure 6.1. The main effect of inhibition, the nasty US stimuli were being rated as more negative than the off white US stimuli. Error bars represent S.E.M.

The maximum *F* was the interaction between inhibition and clinical group.

Sex – There was no significant interaction between valence and sex, $F(1,13) = 2.023$, $p = .178$, $\eta^2 = .135$. There was a significant main effect of valence, $F(1,13) = 41.384$, $p = .001$, $\eta^2 = .761$. The US nasty images were being rated as nasty and the US blank images were being rated as neutral (see Figure 6.2).

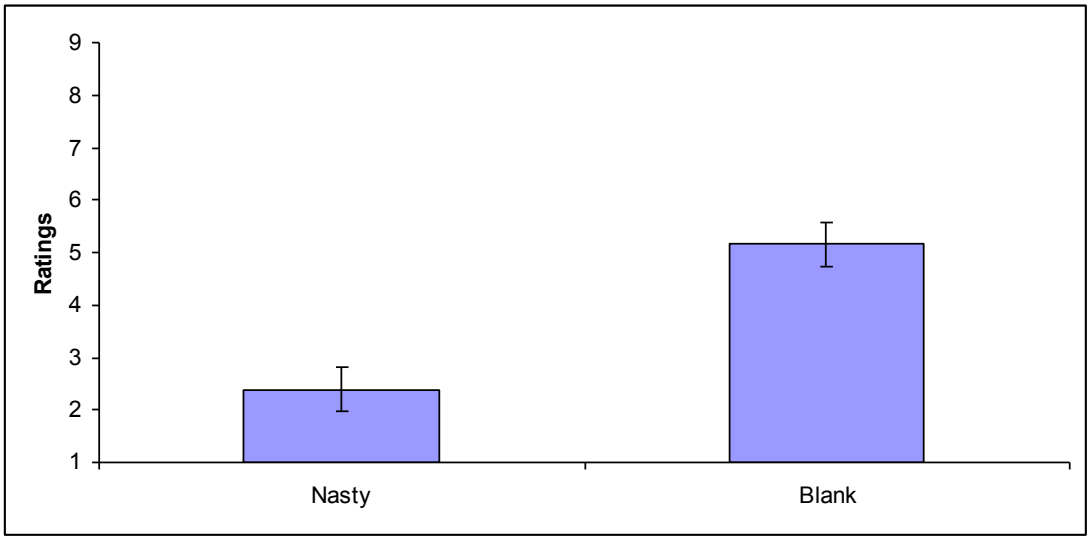


Figure 6.2. The main effect of valence for the US stimuli at the discrimination training stage. Error bars represent S.E.M.

There was a significant main effect of trials, $F(7,91) = 3.156$, $p = .005$, $\eta^2 = .195$. There were non systematic fluctuations but over the course of the 8 trials generally the US nasty and US blank were being rated as more neutral (see Table 6.3).

Table 6.3

The significant main effect of trials for the US ratings at the discrimination training stage. Non systematic fluctuations occurred over the 8 trials but overall the US nasty and US blank stimuli were being rated progressively more neutral.

Trials	Mean	S.E.M
1	3.444	0.365
2	3.75	0.272
3	3.569	0.35
4	3.639	0.333
5	3.486	0.354
6	3.708	0.348
7	4.056	0.327
8	4.514	2.82

There was a significant interaction between valence and trials, $F(7,91) = 2.616$, $p = .017$, $\eta^2 = .168$. There were non systematic fluctuations but over the course of the 8 trials generally the US nasty was being rated progressively neutral and the US blank remained being rated as neutral (see Table 6.4).

Table 6.4

The interaction between valence and trials. There were non systematic fluctuations but over the course of the 8 trials the US nasty was being rated more neutral and the US blank remained being rated as neutral.

US Nasty	Mean	S.E.M	US Blank	Mean	S.E.M
T1	1.722	± .350	**T1**	5.167	± .470
T2	2.778	± .388	**T2**	4.722	± .558
T3	1.806	± .313	**T3**	5.333	± .534
T4	1.944	± .282	**T4**	5.333	± .534
T5	2.250	± .397	**T5**	4.722	± .558
T6	2.083	± .317	**T6**	5.333	± .534
T7	3.222	± .415	**T7**	4.889	± .525
T8	3.306	± .284	**T8**	5.722	± .518

There were no other significant main effects or interactions, maximum F was the interaction between valence and sex.

6.3.1.3 Retardation Stage

Incongruent transfer for the CI

CS and CI ratings

Clinical group – There was no significant interaction between inhibition and clinical group, $F(1,12) = .351$, $p = .711$, $\eta^2 = .055$. There was no significant interaction between inhibition and blocks, $F(4,9) = .833$, $p = .602$, $\eta^2 = .137$. Participants were not rating the previously trained CI now being presented as a

CS significantly differently to the novel CS and ratings did not interact with blocks. There was no significant main effect of inhibition, $F(1,12) = 1.242$, $p = .287$, $\eta^2 = .094$, this was the maximum F. There was a significant main effect of blocks, $F(4,48) = 7.983$, $p = .001$, $\eta^2 = .400$ over the five blocks. The stimuli were being rated progressively lower (nastier) (see Figure 6.3).

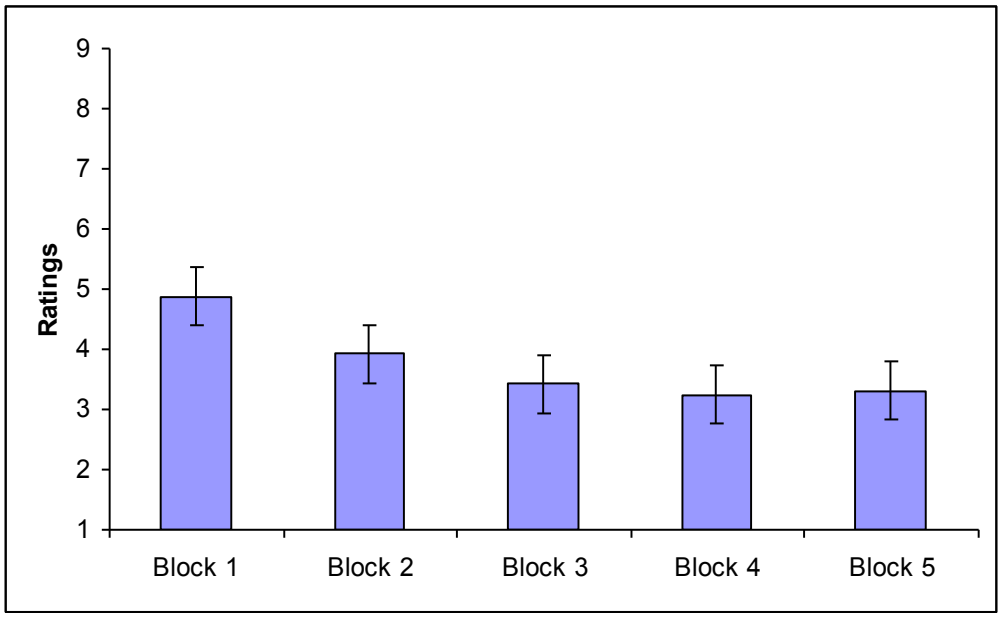


Figure 6.3. The main effect of blocks, over the 5 blocks stimuli were being rated progressively more negative. Error bars represent S.E.M.

Sex – There was no significant interaction between inhibition and sex, $F(1,13) = .423$, $p = .527$, $\eta^2 = .032$. There was no significant interaction between inhibition and blocks $F(4,52) = 1.077$, $p = .377$, $\eta^2 = .077$. There was no significant main effect of inhibition, $F(1,13) = 1.390$, $p = .260$, $\eta^2 = .097$. There was a significant main effect of blocks, $F(4,52) = 10.903$, $p = .001$, $\eta^2 = .456$, generally over the five blocks the CS and CI were being rated more negative, nastier (see Table 6.5).

Table 6.5

The main effect of blocks for the CS and CI ratings for incongruent transfer at the retardation stage. Over the five blocks overall both the CS and CI were being rate progressively more negative, nasty.

Block	Mean	S.E.M ±
1	4.799	.353
2	3.715	.557
3	3.201	.514
4	3.056	.478
5	3.087	.496

There were no other significant main effects or interactions, maximum $F(4,52) = 2.263$, $p = .075$, $\eta^2 = .148$ for the interaction between inhibition, blocks and sex.

6.3.1.4 Extinction Stage

Incongruent transfer for the CI

CS and CI ratings

Clinical group – There was no significant interaction between inhibition and clinical group, $F(2,12) = .149$, $p = .863$, $\eta^2 = .024$. There was a significant interaction between inhibition and blocks, $F(4,48) = 4.195$, $p = .005$, $\eta^2 = .259$. There was no significant main effect of inhibition, $F(1,12) = 1.837$, $p = .200$, $\eta^2 = .133$. There were non-systematic fluctuations for both the CS and CI stimuli over the 5 blocks but generally the CI was being rated progressively more negatively, $t(14) = 3.404$, $p = .004$ (for block 1 to block 5) and the CS was being rated the same, negative, $t(14) = -.470$, $p = .645$ (for block 1 to block 5) (see Figure 6.4).

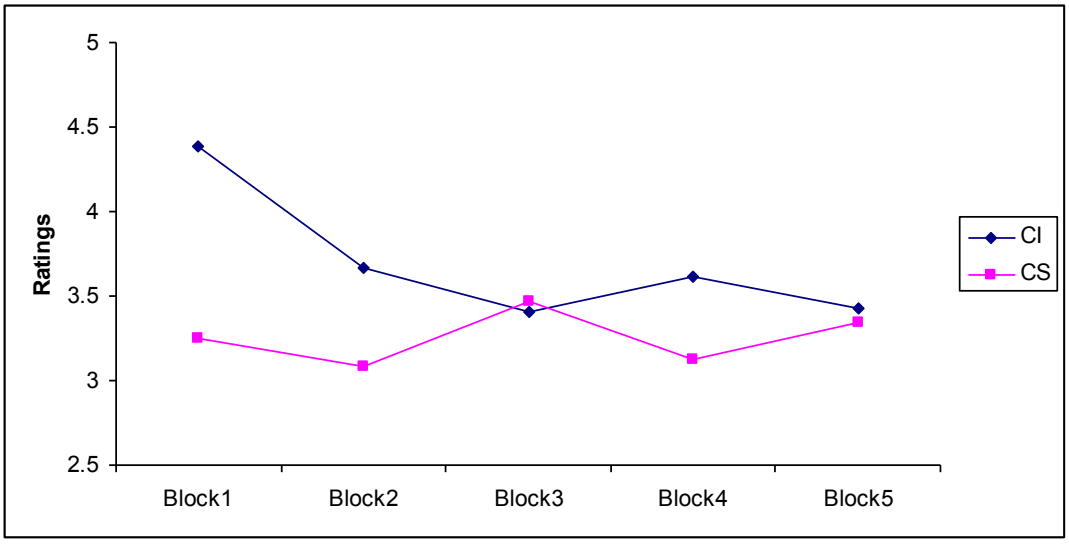


Figure 6.4. The interaction between inhibition and blocks. There were non-systematic fluctuations for both the CI and CS stimuli over the 5 blocks but overall the CI was statistically different over the 5 blocks. Error bars represent S.E.M.

There were no other significant main effects or interactions, the maximum *F* was the effect of inhibition.

Sex – There was no significant interaction between inhibition and sex, $F(1,13) = .003$, $p = .954$, $\eta^2 = .001$. There was no significant interaction between inhibition and blocks, $F(1,2) = 5.603$, $p = .054$, $\eta^2 = .301$. There was no significant main effect of inhibition, $F(1,13) = 1.761$, $p = .207$, $\eta^2 = .119$. There were no significant main effects or interactions, maximum was the interaction between inhibition and blocks.

6.3.1.5 Awareness Check

Participants were asked at the end of the task if they could explain to the experimenter what they thought predicted a negative or positive image would appear on the screen. Out of the six anxiety disorder participants tested, three reported that they were aware of the contingencies. These participants correctly articulated what piece of street furniture was associated with a negative or positive US at the third stage of the task (retardation stage). One participant thought the order predicted what appeared next and the other two participants

thought the images were everyday images with no relation to the outcome. Out of the three substance abuse participants tested, one reported that they were aware of the contingencies. This participant correctly articulated what piece of street furniture was associated with a negative or positive US at the third stage of the task (retardation stage). The other two participants explained that they were not aware of what the contingencies were. Out of the six matched control participants tested, four reported that they were aware of the contingencies, they correctly stated that certain street furniture indicated whether a negative positive images would appear. One participant thought it was completely random and one participant thought that it was 50/50 as to which image appeared next.

6.3.1.6 Correlations

6.3.1.6.1 Hospital Anxiety and Depression Scale

There were no significant correlations between the HADS or any of its subscales and ratings of the stimuli of the Negative Images CI Task: Retardation Test, maximum $r(13) = -.654$, $p = .008$ for the relationship between the HADS anxiety subscale and the CI ratings at the discrimination stage.

6.3.1.6.2 Maudsley Obsessive Compulsive Inventory

There were no significant correlations between the MOCI and any of its subscales and ratings of the stimuli of the Negative Images CI Task: Retardation Test, maximum $r(13) = .619$, $p = .014$ for the relationship between MOCI and the CS ratings at the pre-discrimination stage.

6.3.1.6.3 Behavioural Inhibition System and Behavioural Activation System Questionnaire

There were no significant correlations, between the BIS/BAS or any of its subscales and ratings of the stimuli of the Negative Images CI Task: Retardation Test, maximum $r(13) = .641$, $p = .010$ for the relationship between BAS fun seeking subscale and CI ratings at the extinction stage.

6.3.1.6.4 Eysenck's Personality Questionnaire – Revised Short Scale

There were no significant correlations between the EPQR-S and any of its subscales and ratings of the stimuli of the Negative Images CI Task: Retardation Test, maximum $r(13) = -.693$, $p = .004$ for the relationship between the neuroticism subscale and the [CS + CI] ratings at the discrimination stage.

6.3.2 'Mission to Mars' Conditioned Inhibition Task: Summation Test

Clinical group – There was no significant interaction between inhibition and clinical group, $F(1,13) = .269$, $p = .613$, $\eta^2 = .020$. A formal clinical diagnosis did not effect how participants rated the stimuli. Moreover, there was no significant main effect of inhibition, $F(1,13) = .739$, $p = .405$, $\eta^2 = .054$. Participants were not overall rating the CS stimuli significantly different from the CI stimuli at the summation test stage. There were no significant main effects or interactions, maximum $F(8,48) = 1.983$, $p = .111$, $\eta^2 = .132$ for the interaction between stimulus-type, trials and clinical group.

Sex – There was no significant interaction between inhibition and sex, $F(1,13) = .938$, $p = .350$, $\eta^2 = .067$; gender did not effect how participants rated the stimuli. Moreover, there was no significant main effect of inhibition, $F(1,11) = .938$, $p = .350$, $\eta^2 = .067$. There were no significant main effects or

interactions, maximum $F(4,52) = 2.434$, $p = .059$, $\eta^2 = .158$ for the interaction between inhibition, trials and sex.

6.3.2.1 Awareness Check

Participants were asked at the end of the task if they could explain to the experimenter what it was that meant an intact or exploded rocket appeared on the screen. Out of the six anxiety disorder participants tested, no participants were aware of the contingencies. three participants thought it was the colour that determined what came next, the other three were not aware of what predicted the next image on the screen. Out of the three substance abuse participants tested, no reported that they were aware of the contingencies. One participant thought it was something to do with the colour of the planets and the other two had no awareness of what predicted the next image on the screen. Out of the six matched control participants, two participants thought it was dependant on the planet before, one participant thought it was the number of planets on the screen, one participant thought it was the more 'whole' looking planets, one participant thought it was the colour, and one participant had no idea what predicted an intact or exploded rocket.

6.3.2.2 Correlations

6.3.2.2.1 Hospital Anxiety and Depression Scale

There were no significant correlations between the HADS or any of its subscales and ratings of the stimuli on the 'Mission to Mars' CI Task: Summation Test, maximum $r(13) = -.333$, $p = .225$, for the relationship between HADS depression subscale and CS_t ratings.

6.3.2.2.2 Maudsley Obsessive Compulsive Inventory

There were no significant correlations between MOCI or any of its subscales and ratings of the stimuli on the 'Mission to Mars' CI Task: Summation Test,

maximum $r(13) = -.490$, $p = .063$ for the relationship between MOCI check subscale and CS_t ratings.

6.3.2.2.3 Behavioural Inhibition System and Behavioural Activation System Questionnaire

There were no significant correlations between the BIS/BAS or any of its subscales and ratings of the stimuli on the 'Mission to Mars' CI Task: Summation Test, maximum $r(13) = .669$, $p = .006$ for the relationship between BAS fun seeking subscale and $[S_g + CI]$ ratings.

6.3.2.2.4 Eysenck's Personality Questionnaire – Revised Short Scale

There were no significant correlations between EPQR-S or any of its subscales and ratings of the stimuli on the 'Mission to Mars' CI Task: Summation Test, maximum $r(13) = .513$, $p = .050$ for the relationship between the extraversion subscale and S_g ratings.

6.3.3 Emotional Stroop Task

6.3.3.1 Reaction Time

Clinical group – There was no significant interaction between word-type and clinical group, $F(3,36) = .776$, $p = .594$, $\eta^2 = .114$.There were no significant main effects or interactions, maximum $F(3,36) = 1.349$, $p = .274$, $\eta^2 = .101$ for the main effect of word-type.

Sex – There was no significant interaction between word-type and sex, $F(3,39) = .121$, $p = .947$, $\eta^2 = .009$.There were no significant main effects or interactions, maximum $F(3,39) = 1.752$, $p = .172$, $\eta^2 = .119$ for the main effect of word-type.

6.3.3.2 Accuracy

Clinical group – There was no significant interaction between word-type and clinical group, $F(6,36) = 1.162$, $p = .348$, $\eta^2 = .162$. There was a significant main effect of word-type, $F(3,36) = 15.877$, $p = .001$, $\eta^2 = .570$, paired t-tests revealed that participants were less accurate for incongruent words compared to congruent colour words $t(14) = 3.623$, $p = .003$, negative words $t(14) = -8.070$, $p = .001$ and OCD words $t(14) = -5.409$, $p = .003$ participants were also less accurate for congruent words compared to negative words $t(14) = -2,738$, $p = .001$ (this result was also significant in the healthy sample, see Chapter 4) (see Figure 6.5).

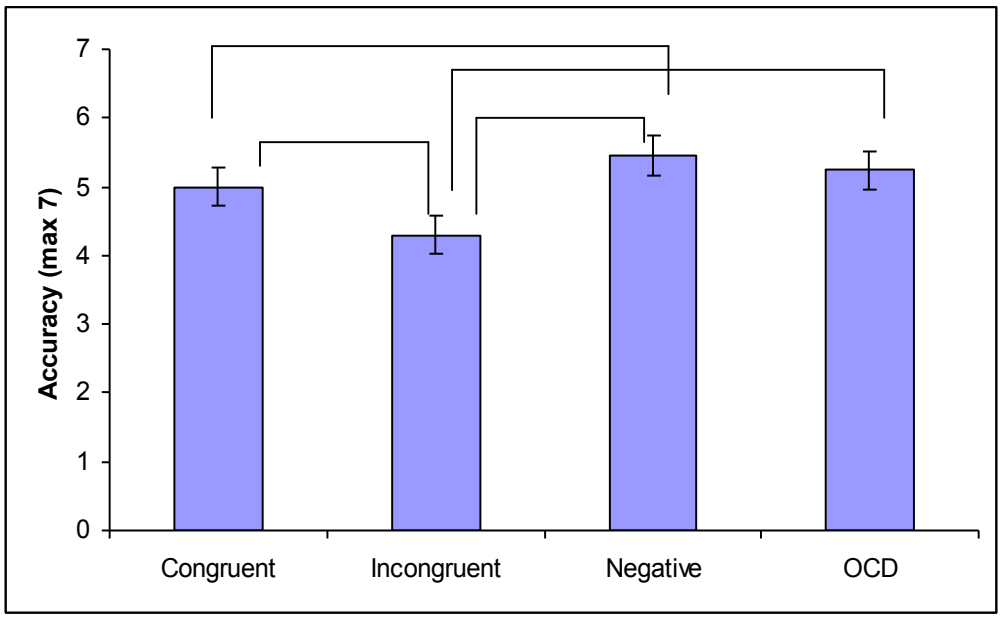


Figure 6.5. The main effect of word-type, paired t-tests showed that all word-types were significantly different from incongruent words and negative and congruent words. Error bars represent S.E.M. Comparison lines represent significant differences by t-test.

There were no other significant main effects or interactions, maximum $F(5,60) = 1.478$, $p = .210$, $\eta^2 = .110$ for the main effect of blocks.

Sex – There was no significant interaction between word-type and sex, $F(3,39) = 1.405$, $p = .256$, $\eta^2 = .098$. There was a significant main effect of word-type, $F(3,39) = 16.332$, $p = .001$, $\eta^2 = .557$, paired t-tests revealed that participants were less accurate for incongruent words compared to congruent colour words $t(14) = 4.287$, $p = .030$, negative words $t(14) = 5.431$, $p = .031$ and OCD words $t(14) = 5.181$, $p = .027$ participants were also less accurate for congruent words compared to negative words $t(14) = 4.884$, $p = .031$.

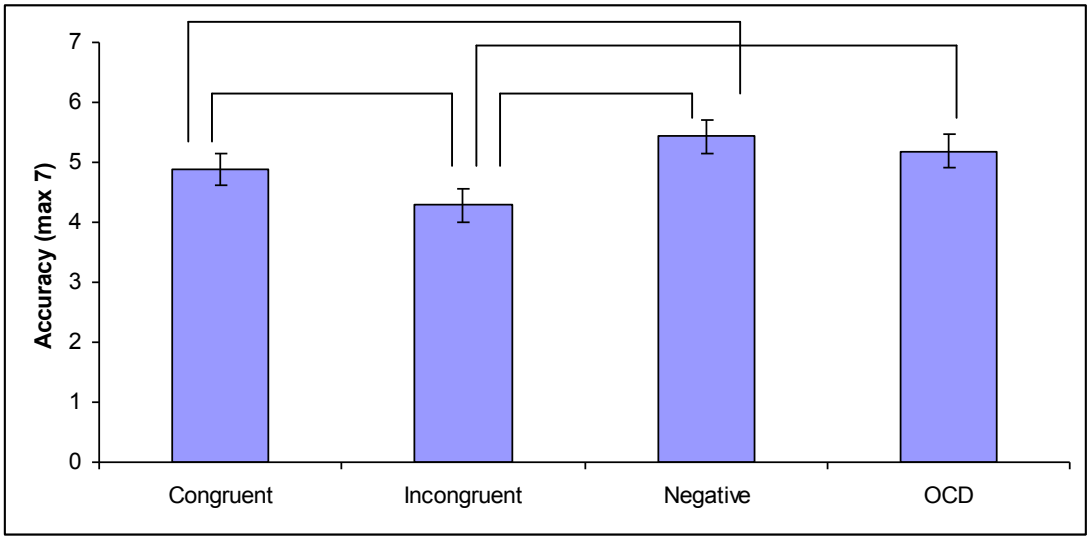


Figure 6.6. The significant main effect of word-type, participants were less accurate for incongruent words compared to all other word-types, they were also less accurate for congruent words compared to negative words. Error bars represent S.E.M. Comparison lines represent significant differences by t-test.

There were no other significant main effects or interactions, maximum $F(5,65) = 2.155$, $p = .070$, $\eta^2 = .142$ for the main effect of blocks.

6.3.3.3 Correlations

6.3.3.3.1 Reaction Time

6.3.3.3.1.1 Hospital Anxiety and Depression Scale

There were no significant correlations between the HADS and reaction time on the Stroop task, maximum $r(13) = .456$, $p = .088$ for the relationship between HADS and reaction time for negative words.

6.3.3.3.1.2 Maudsley Obsessive Compulsive Inventory

There were no significant correlations between the MOCI and reaction time on the Stroop task, maximum $r(13) = .662$, $p = .007$ for the relationship between MOCI clean subscale and reaction time for negative words.

6.3.3.3.1.3 Behavioural Inhibition System and Behavioural Activation System Questionnaire

There were no significant correlations between the BIS/BAS and reaction time on the Stroop task, maximum $r(13) = .497$, $p = .060$ for the relationship between BAS drive subscale and reaction time for colour incongruent words.

6.3.3.3.1.4 Eysenck's Personality Questionnaire – Revised Short Scale

There were no significant correlations between the EPQR-S and reaction time on the Stroop task, maximum $r(13) = .638$, $p = .010$ for the relationship between lie subscale and reaction time for negative words.

6.3.3.3.2 Accuracy

6.3.3.3.2.1 Hospital Anxiety and Depression Scale

There were no significant correlations between the HADS and accuracy to correctly categorise words on the Stroop task, maximum $r(13) = -.313$, $p = .255$ for the relationship between HADS depression subscale and accuracy for colour congruent words.

6.3.3.3.2.2 Maudsley Obsessive Compulsive Inventory

There were no significant correlations between the MOCI and accuracy to correctly categorise words on the Stroop task, maximum $r(13) = -.586$ for the relationship between MOCI clean subscale and accuracy for colour congruent words.

6.3.3.3.2.3 Behavioural Inhibition System and Behavioural Activation System Questionnaire

There were no significant correlations between BIS/BAS and accuracy on the Stroop task, maximum $r(13) = -.414$, $p = .125$ for the relationship between the BAS drive subscale and accuracy for colour incongruent words.

6.3.3.3.2.4 Eysenck's Personality Questionnaire – Revised Short Scale

There were no significant correlations between the EPQR-S and accuracy to correctly categorise words on the Stroop task, maximum $r(13) = -.631$, $p = .012$ for the relationship between the lie subscale and accuracy for colour congruent words.

6.3.4 Go/No-Go Words Task

6.3.4.1 Reaction Time

Clinical group – There was no significant interaction between word-type and clinical group, $F(6,36) = .118$, $p = .994$, $\eta^2 = .019$. There was no significant main effect of word-type, $F(3,36) = .775$, $p = .516$, $\eta^2 = .061$. There were no significant main effects or interactions, maximum $F(2,24) = 1.656$, $p = .212$, $\eta^2 = .121$ for the main effect of blocks.

Sex – There was no significant interaction between word-type and sex, $F(3,39) = .206$, $p = .891$, $\eta^2 = .016$. There was no significant main effect of word-type, $F(3,39) = 1.035$, $p = .388$, $\eta^2 = .074$. There were no significant main effects or interactions, maximum $F(6,78) = 1.445$, $p = .208$, $\eta^2 = .100$ for the main effect of blocks.

6.3.4.2 Accuracy Go Words

Clinical group – There was no significant interaction between word-type and clinical group, $F(6,36) = 1.590$, $p = .178$, $\eta^2 = .209$. There was no significant main effect of word-type, $F(3,36) = .727$, $p = .543$, $\eta^2 = .057$. There were no significant main effects or interactions, maximum $F(2,24) = 2.000$, $p = .157$, $\eta^2 = .143$ for the main effect of blocks.

Sex – There was no significant interaction between word-type and sex, $F(3,39) = 1.026$, $p = .392$, $\eta^2 = .073$. There was no significant main effect of word-type, $F(3,36) = 1.043$, $p = .384$, $\eta^2 = .074$. There were no significant main effects or interactions, maximum $F(2,26) = 2.426$, $p = .108$, $\eta^2 = .157$ for the main effect of blocks.

6.3.4.3 Accuracy No-Go Words

Clinical group – There was no significant interaction between word-type and clinical group, $F(6,36) = .786$, $p = .587$, $\eta^2 = .116$. There was no significant main effect of word-type, $F(3,36) = .634$, $p = .598$, $\eta^2 = .050$. There were no significant main effects or interactions, maximum $F(6,36) = 2.100$, $p = .077$, $\eta^2 = .259$ for the main interaction between word-type, blocks and clinical group.

Sex – There was no significant interaction between word-type and sex, $F(3,39) = 1.604$, $p = .204$, $\eta^2 = .110$. There was no significant main effect of word-type, $F(3,39) = .569$, $p = .598$, $\eta^2 = .050$. There were no significant main effects or interactions, maximum F was the interaction between word-type and sex.

6.3.4.4 Correlations

6.3.4.4.1 Reaction Time

6.3.4.4.1.1 Hospital Anxiety and Depression Scale

There were no significant correlations between the HADS and reaction time on the Go/No-Go Words Task, maximum $r(13) = .213$, $p = .446$ for the relationship between the HADS depression subscale and reaction time to correctly categorise Go positive words.

6.3.4.4.1.2 Maudsley Obsessive Compulsive Inventory

There were no significant correlations between the MOCI and reaction time on the Go/No-Go Words Task, maximum $r(13) = .353$, $p = .196$ for the relationship between the MOCI clean subscale and reaction time to correctly categorise Go positive words.

6.3.4.4.1.3 Behavioural Inhibition System and Behavioural Activation System Questionnaire

There were no significant correlations between the BIS/BAS and reaction time on the Go/No-Go Words Task, maximum $r(13) = .475$, $p = .073$ for the relationship between the BAS reward responsiveness subscale and reaction time to correctly categorise Go negative words.

6.3.4.4.1.4 Eysenck's Personality Questionnaire – Revised Short Scale

There were no significant correlations between the EPQR-S and reaction time on the Go/No-Go Words Task, maximum $r(13) = -.459$, $p = .085$ for the relationship between the psychoticism subscale and reaction time to correctly categorise Go OCD words.

6.3.4.4.2 Accuracy Go Words

6.3.4.4.2.1 Hospital Anxiety and Depression Scale

There was a significant correlation between the HADS depression subscale and Go positive words $r(13) = -.743$, $p = .001$. There were no other significant correlations between the HADS and accuracy for Go words, maximum $r(13) = -.681$, $p = .005$ for the relationship between the HADS and Go positive words.

6.3.4.4.2.2 Maudsley Obsessive Compulsive Inventory

There was a significant correlation between MOCI and Go positive words, $r(13) = -.857$, $p = .001$, MOCI clean subscale and Go positive words, $r(13) = -.870$, $p = .001$, There were no other significant correlations between the MOCI and accuracy for Go words, maximum $r(13) = -.760$, $p = .004$ for the relationship between MOCI slow subscale and Go positive words.

6.3.4.4.2.3 Behavioural Inhibition System and Behavioural Activation System Questionnaire

There was a significant correlation between and BAS reward responsiveness and Go neutral words, $r(13) = .751$, $p = .001$. There were no other significant correlations between the BIS/BAS and accuracy for Go words, maximum $r(13) = .641$, $p = .010$ for the relationship between BAS and Go neutral words.

6.3.4.4.2.4 Eysenck's Personality Questionnaire – Revised Short Scale

There were no significant correlations between the EPQR-S and accuracy for Go words, maximum $r(13) = -.674$, $p = .006$for the relationship between the EPQR-S lie subscale and Go positive words.

6.3.4.4.3 Accuracy No-Go Words

6.3.4.4.3.1 Hospital Anxiety and Depression Scale

There were no significant correlations between the HADS and accuracy for No-Go words, maximum $r(13) = -.587$, $p = .021$ for the relationship between the HADS and No-Go neutral words.

6.3.4.4.3.2 Maudsley Obsessive Compulsive Inventory

There were no significant correlations between the MOCI and accuracy for No-Go words, maximum $r(13) = -.631$, $p = .021$ for the relationship between MOCI slow subscale and No-Go neutral words.

6.3.4.4.3.3 Behavioural Inhibition System and Behavioural Activation System Questionnaire

There were no significant correlations between the BIS/BAS and accuracy for No-Go words, maximum $r(13) = .489$, $p = .064$ for the relationship between the BAS reward responsiveness subscale and No-Go OCD words.

6.3.4.4.3.4 Eysenck's Personality Questionnaire – Revised Short Scale

There were no significant correlations between the EPQR-S and accuracy for No-Go words, maximum $r(13) = -.433$, $p = .107$ for the relationship between the EPQR-S lie subscale and No-Go OCD words.

6.3.5 Go/No-Go Border Images Task

6.3.5.1 Reaction Time

Clinical group – There was no significant interaction between image-type and clinical group, $F(6,36) = 1.076$, $p = .395$, $\eta^2 = .152$. There was no significant main effect of image-type, $F(3,36) = .776$, $p = .515$, $\eta^2 = .061$. There was a significant main effect of blocks, $F(2,24) = 5.688$, $p = .010$, $\eta^2 = .322$. Over the three blocks participants were progressively quicker to respond (see Figure 6.7).

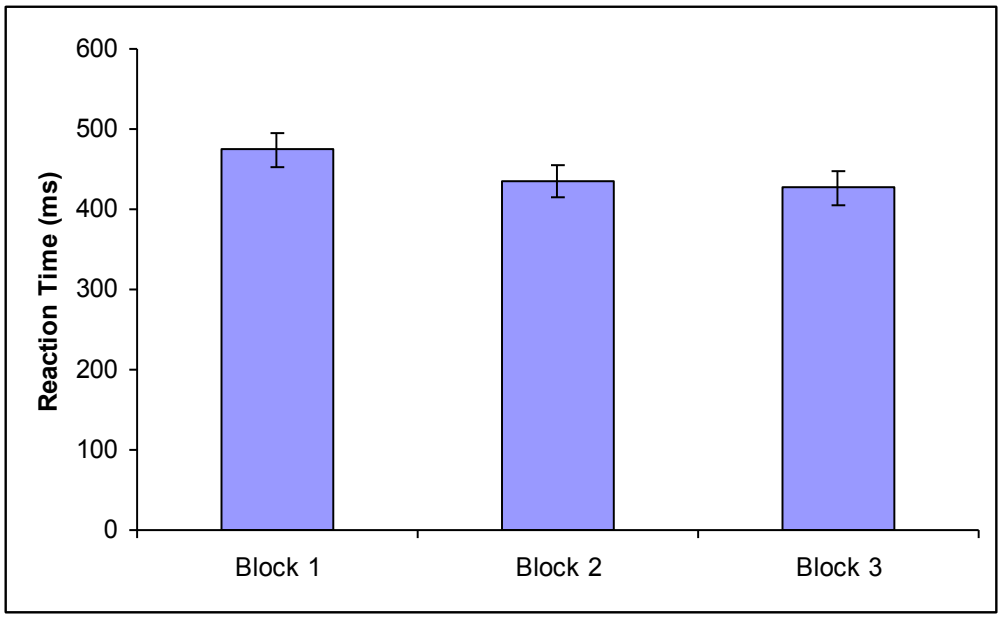


Figure 6.7. The main effect of blocks, participants were quicker over the 3 blocks to correctly categorise Go stimuli. Error bars represent S.E.M.

There were no other significant main effects or interactions, maximum $F(6,72) = 1.105$, $p = .368$, $\eta^2 = .084$ for the interaction between image-type and blocks.

Sex – There was no significant interaction between image-type and sex, $F(3,39) = .183$, $p = .907$, $\eta^2 = .014$. There was no significant main effect of image-type, $F(3,39) = 1.258$, $p = .302$, $\eta^2 = .088$, this was also the maximum F.

6.3.5.2 Accuracy Go Words

Clinical group – There was no significant interaction between image-type and clinical group, $F(6,36) = .511$, $p = .796$, $\eta^2 = .078$. There was no significant main effect of image-type, $F(3,36) = .339$, $p = .797$, $\eta^2 = .028$. There were no significant main effects or interactions, maximum $F(12,72) = 1.496$, $p = .146$, $\eta^2 = .200$ for the main interaction between image-type, blocks and clinical group.

Sex – There was no significant interaction between image-type and sex, $F(3,39) = 1.648$, $p = .073$, $\eta^2 = .103$. There was no significant main effect of

image-type, $F(3,39) = .737$, $p = .536$, $\eta^2 = .054$. There were no significant main effects or interactions, maximum $F(6,78) = 1.040$, $p = .406$, $\eta^2 = .074$ for the main interaction between image-type, blocks and sex.

6.3.5.3 Accuracy No-Go Words

Clinical group – There was no significant interaction between image-type and clinical group, $F(6,36) = .547$, $p = .769$, $\eta^2 = .083$. There was no significant main effect of image-type, $F(3,36) = .080$, $p = .971$, $\eta^2 = .007$. There were no significant main effects or interactions, maximum $F(6,36) = .670$, $p = .675$, $\eta^2 = .100$ for the main interaction between image-type, blocks and clinical group.

Sex – There was no significant interaction between image-type and sex, $F(3,39) = 3.412$, $p = .088$, $\eta^2 = .208$. There was no significant main effect of image-type, $F(3,39) = .396$, $p = .756$, $\eta^2 = .030$. There were no significant main effects or interactions, the maximum F was the interaction between image-type and sex.

6.3.5.4 Correlations

6.3.5.4.1 Reaction Time

6.3.5.4.1.1 Hospital Anxiety and Depression Scale

There were no significant correlations between the HADS and reaction time, maximum $r(13) = .561$, $p = .029$ for the relationship between HADS anxiety subscale and reaction time for correctly categorised Go washing images.

6.3.5.4.1.2 Maudsley Obsessive Compulsive Inventory

There were no significant correlations between the MOCI and reaction time, $r(13) = .620$, $p = .014$ for the relationship between MOCI clean subscale and reaction time for correctly categorised Go neutral images.

6.3.5.4.1.3 Behavioural Inhibition System and Behavioural Activation System Questionnaire

There were no significant correlations between BIS/BAS and reaction time to correctly categorise Go images, $r(13) = -.219$, $p = .432$ for the relationship between BAS drive subscale and reaction time for correctly categorised Go neutral images.

6.3.5.4.1.4 Eysenck's Personality Questionnaire – Revised Short Scale

There were no significant correlations between EPQR-S and reaction time to correctly categorise Go images, $r(13) = .369$, $p = .144$ for the relationship between EPQR-S lie subscale and reaction time for correctly categorised Go hoarding images.

6.3.5.4.2 Accuracy Go Words

6.3.5.4.2.1 Hospital Anxiety and Depression Scale

There were no significant correlations between the HADS and accuracy for Go images, maximum $r(13) = -.592$, $p = .020$ for the relationship between HADS depression subscale and accuracy for Go neutral images.

6.3.5.4.2.2 Maudsley Obsessive Compulsive Inventory

There were no significant correlations between the MOCI and accuracy for Go words, maximum $r(13) = -.717$, $p = .003$ for the relationship between MOCI and accuracy for Go hoarding images and $r(13) = -.715$, $p = .003$ for the relationship between MOCI clean subscale and accuracy for Go symmetry images.

6.3.5.4.2.3 Behavioural Inhibition System and Behavioural Activation System Questionnaire

There was a significant correlation between BAS reward responsiveness subscale and accuracy for Go hoarding images, $r(13) = .799$, $p = .001$, and Go neutral images, $r(13) = .754$, $p = .001$. There were no other significant correlations between the BIS/BAS and accuracy for Go words, maximum $r(13) = .647$, $p = .009$ for the relationship between the BAS and accuracy for Go hoarding images.

6.3.5.4.2.4 Eysenck's Personality Questionnaire – Revised Short Scale

There were no significant correlations between the EPQR-S and accuracy to correctly categorise Go stimuli, maximum $r(13) = -.646$, $p = .009$ for the relationship between EPQR-S neuroticism subscale and accuracy for Go washing images.

6.3.5.4.3 Accuracy No-Go Words

6.3.5.4.3.1 Hospital Anxiety and Depression Scale

There were no significant correlations between the HADS and accuracy for No-Go images, maximum $r(13) = -.675$, $p = .006$ for the relationship between HADS depression subscale and accuracy for No-Go hoarding images.

6.3.5.4.3.2 Maudsley Obsessive Compulsive Inventory

There were no significant correlations between the MOCI and accuracy for No-Go images, maximum $r(13) = -.619$, $p = .014$ for the relationship between accuracy for MOCI doubt subscale and No-Go hoarding images.

6.3.5.4.3.3 Behavioural Inhibition System and Behavioural Activation System Questionnaire

There were no significant correlations between the BIS/BAS and accuracy for No-Go images, maximum $r(13) = -.530$, $p = .042$ for the relationship between BAS fun seeking subscale and accuracy for No-Go washing images.

6.3.5.4.3.4 Eysenck's Personality Questionnaire – Revised Short Scale

There were no other significant correlations between the EPQR-S and accuracy for No-Go images, maximum $r(13) = .463$, $p = .082$ for the relationship between EPQR-S lie subscale and accuracy for No-Go washing images.

6.4 Chapter Discussion

The overall pattern of results shows that inhibitory processes were not affected by clinical diagnosis, sex or individual differences in anxiety. Conditioned inhibition was not demonstrated via a retardation test (Negative Images CI Task: Retardation Test) or via a summation test ('Mission to Mars' CI Task: Summation Test) nor was the discrimination learnt (Negative Images CI Task: Retardation Test). Individual differences in anxiety, clinical diagnosis or sex did not affect performance on these tasks. Response inhibition was not demonstrated on the Go/No-Go Words Task or Go/No-Go Border Images Task; participants did not differ on accuracy or speed to categorise different stimuli. On the Emotional Stroop Task there were some differences in accuracy (less accurate for colour incongruent compared to all other word-types and less accurate for negative words compared to congruent words) but this was pattern was not replicated in the response time data. Individual differences, clinical diagnosis or sex did not affect performance on the Emotional Stroop or Go/No-Go Border Images Task but there were some reported individual differences on the Go/No-Go Words Task.

Individual differences in anxiety, clinical diagnosis or sex did not impact on conditioned inhibition on either task version (Negative Images CI Task: Retardation Test or the 'Mission to Mars' CI Task: Summation Test). The critical tests, summation and retardation (Rescorla, 1969) were not passed and although the two tasks were different in format and content the overall design was comparable to achieve the same outcome. The acquisition data was recorded and analysed in the Negative Images CI Task: Retardation Test but due to the implicit nature of the 'Mission to Mars' CI Task: Summation Test this data was not collected. Learning the discrimination between the two key stimuli was not achieved in the current sample. The CS and [CS + CI] comprise the acquisition training stage and it is essential that this stage is 'passed' in order for conditioned inhibition to be demonstrated. In comparison to the healthy sample again there were no reported individual differences but the healthy sample did show conditioned inhibition and learnt the discrimination. Theoretically it has been argued that anxiety develops through two processes (Mowrer 1947; 1956). Associations are formed when conditioning occurs to a fear stimuli and subsequent instrumental behaviours that are carried out to alleviate the anxiety are negatively reinforcing and ultimately aid in the maintenance of the disorder. Central to this thesis it was argued that the behaviours elicit safety signals, conditioned inhibitors, which accompany the actions and also serve to sustain the anxiety. The results from the current study did not demonstrate this and consequently this does not support previous studies that have demonstrated conditioned inhibition in human populations (Kantini et al., 2011a; 2011b; Migo et al., 2006; Urcelay et al., 2008) or studies that have shown discrimination learning in relation to anxiety (Grillon & Davis, 1997; Grillon, 2002). As mentioned, individual differences in anxiety did not influence performance on the conditioned inhibition tasks. However, any differences that may have potentially been found would need to be interpreted with caution as the key stages tested were not passed overall.

As reported previously in this thesis conditioned inhibition was successfully demonstrated (Chapters 2 and 3) in a healthy sample. The same task was used in both samples recruited the major difference between the two is the sample

size. The null effect is likely due to the low power of the study. On pg 177 a power analyses was reported; this determined the sample size required to report a significant effect at medium power (Cohen, 1977). The ideal required sample size was calculated to be 128 to demonstrate discrimination learning and 60 to demonstrate retardation. Arguably these sample sizes are unrealistic in expectation to be able to recruit such large participant numbers from a clinical population. Considerable efforts were carried out to recruit potential participants with an unexpectedly low compliance rate. Nonetheless the power calculation shows that our sample size is grossly under representative of the population as a whole and therefore the task was significantly underpowered. The lack of any significant statistical power is also corroborated by the partial eta squared calculations that on the whole are typically reported as less than .1, and generally speaking as a rule of thumb is considered a small effect size. It could strongly be concluded that any null results reported from the clinical sample are due to the study being underpowered. Power and recruitment will be discussed in more detail in Chapter 7.

Individual differences in anxiety, clinical diagnosis or sex did not affect performance on the response inhibition tasks: Emotional Stroop Task and Go/No-Go Border Images Task. The typical colour Stroop interference was observed for accuracy, responding was less accurate for colour incongruent words compared to other word-types, but this was not replicated for response times. The Emotional Stroop task also incorporated the use of anxiety and mood related stimuli and individuals displayed a difference in accuracy to respond; accuracy was worse for negative words compared to colour congruent words but again there were no demonstrated differences in reaction time for these stimuli. Response time and accuracy did not differ significantly on either of the Go/No-Go Tasks (Words or Border Images); neutral or emotional stimuli did not impact on individual's ability to categorise the word/image-type stimuli accordingly. There were some reported significant correlations between performance on the Go/No-Go Words Task but interpretation of these results need to be cautious as performance overall was not significant (see Table 6.6).

Table 6.6

Pearson correlation matrix to show the significant correlations between accuracy for Go stimuli and individual differences measures on the Go/No-Go Words Task

	Go Positive	Go Neutral
HADS Depression	*r = -.743***	
MOCI	*r = .857***	
MOCI Clean	*r = -.760***	
BAS reward responsiveness		*r = .751***

***p* < .003

Individuals were quicker over the three blocks of trials on the Go/No-Go Border Images Task; this may demonstrate adapting and understanding the task and this is reflected in the speed to respond. Performance on the Go/No-Go task could largely be due to methodological and sample size issues which will be discussed in more detail in Chapter 7. In comparison to the healthy sample tested, there were no individual differences reported and no difference on the response inhibition tasks overall apart from the Emotional Stroop Task – classic colour Stroop effect and differences in responding to negative and OCD word-types. In general though the task design went through developmental stages and, as mentioned previously, the sample was relatively small therefore limiting the findings. The stimuli used were taken from a published study, Lavy et al., (1994). Lavy et al., (1994) reported that in individuals diagnosed with OCD there was a response inhibition deficit to negative OCD words compared to positive OCD words. The current study also demonstrated a difference in responding to negatively valenced words but only for accuracy. It could be argued that the small sample size restricted any response inhibition deficits. Cognitive theories of anxiety hypothesise that the development and maintenance of anxiety disorders centre around thought processing, the control, interpretation and suppression. Evidence for this effect has been demonstrated in many studies (Bannon et al., 2002; Foa et al., 1993; Lavy et al., 1994; Penadés et al., 2007) but most of the research is mixed (Abramowitz et al., 2001; Purdon & Clark, 2001). However, generally speaking, our study has not

provided evidence to support the previous research suggesting a response inhibition deficit in individuals diagnosed with an anxiety disorder and therefore also for cognitive theories of anxiety disorders.

Response inhibition is attributed to the ability to overcome an inappropriate response. The tasks selected in the current study were selected as being representative of key common tasks used to demonstrate this effect. Adaptations were made to the design protocol to incorporate the novel (specifically for the Go/No-Go tasks) use of emotional stimuli but aim of the tasks remained comparable. However, it has been reported that subtle differences in design and task format may results in response differences (Goghari & MacDonald, 2008). Blocking the Stroop task design and the Go/No-Go task design may have impacted on the results reported; potentially inter-mixing trials may have demonstrated different results (Bunge et al., 2002). Further to this it has been hypothesised that response inhibition is more broadly speaking actually response selection (Mostofsky & Simmonds, 2008); response inhibition is simply a facet of response selection. For example, to inhibit a response in intentional and involves a lack of movement towards a stimulus and the ability to do this is simply an aspect of the ability to control movement towards a stimulus. Subsequently, what the task involves, design and overall measures and stimuli appear to have a widespread impact on if there are any demonstrated differences. The results from the current study over three different task versions did not show differences therefore although, as mentioned previously, power may have affected results it would also appear the task design may have implications for any differences. The task designs, sample recruited and how this relates to theoretical to anxiety are discussed in further detail in Chapter 7.

Broadly, in the clinical sample recruited and tested, individual differences (some differences on the Go/No-Go Words Task), clinical diagnosis or sex did not impact on performance on the inhibitory tasks but performance on the tasks overall were not significant (effect of accuracy in the Emotional Stroop Task). The theoretical aspects, limitations, methodological issues and future recommendations are examined and discussed in further detail in Chapter 7.

Chapter 7: General Discussion

The purpose of this thesis was to investigate inhibitory processes in relation to individual differences in anxiety. The hypothesis was that anxiety would relate to performance levels on inhibitory tasks. Tasks were developed and successfully demonstrated conditioned inhibition in Chapters 2 and 3 (healthy sample) via retardation and summation respectively. Response inhibition tasks, the Emotional Stroop and Go/No-Go were developed (Chapter 4, healthy sample) to incorporate emotional stimuli. Performance varied on these tasks and a classic colour Stroop effect was displayed with some differences in responding to emotional stimuli however no differences were shown on the Go/No-Go task but this could be due to methodological reasons. In a healthy population individual differences in anxiety did not affect performance on these tasks. This was further examined in a clinical sample, anxiety disorder and substance abuse (Chapter 6) and although the sample size was preliminary and consequently the tasks were underpowered overall individual differences, clinical diagnosis or sex, did not affect performance on these tasks but overall there was no difference in performance. The clinical groups did not demonstrate conditioned inhibition via retardation or summation nor did they learn the discrimination – a pre-requisite for the key tests of conditioned inhibition. Further to this there were no response differences on any of the Go/No-Go Tasks.

Previous studies have investigated backward conditioned inhibition procedures in humans (Urcelay et al., 2008), conditioned inhibition using a summation test in relation to schizoptypy (Migo et al., 2006), ADHD (Kantini et al., 2011a) and Tourette's Syndrome (Kantini et al., 2011b). However, none to date have investigated conditioned inhibition, tested by retardation and summation tests, in humans in relation to anxiety, OCD and Panic Disorder. Associative learning processes have long been implicated in anxiety disorders (Mineka, 1985; Mowrer, 1947; Watson & Raynor, 1920) and are specifically investigated in this thesis. Stimulus – stimulus associations can be readily

learned and effectively establish triggers for anxiety. For example, in an individual with OCD tendencies, dirt may trigger the anxiety of illness. The subsequent avoidance behaviours that typically occur in anxiety, OCD and Panic Disorder could generate safety signals (conditioned inhibitors) (Gray, 1987). Safety signals are generated as a result of the behavioural response and accompany them. They become negatively reinforced and sustain avoidance behaviours (Cándido et al., 1991; Cook et al., 1987; Dinsmoor, 2001). Therefore, conditioned inhibition may play a role in the aetiology and maintenance of anxiety, OCD and Panic Disorder. As mentioned, the primary aim was to investigate conditioned inhibition in relation to OCD and Panic Disorder; three tasks were developed to do this: Negative Images CI Task: Retardation Test, Negative Images CI Task: Summation Test and 'Mission to Mars' CI Task: Summation Test. The results from the healthy population show no evidence of a relationship between conditioned inhibition and self reported higher levels of individual differences in HADS, MOCI, BIS/BAS and EPQR-S.

Further to this, response inhibition differences, both cognitive and behavioural, are thought to contribute to the development and continuation of OCD and Panic Disorder (Baxter et al., 1987; Bower, 1981; Williams et al., 1988). Previous studies have used response inhibition procedures such as the Stop task (Penadés et al., 2007), Stroop task (Bannon et al., 2002), and the Hayling task (Van Der Linden et al., 2005) to demonstrate differences in relation to anxiety, OCD and Panic Disorder. It is suggested that individuals who are sensitive to anxiety related stimuli should show an attentional bias towards such stimuli, and that this bias would be reflected in differential responding on such tasks (Bower, 1981; Williams et al., 1988). Therefore, incorporating emotionally relevant stimuli into task procedures should facilitate the demonstration of response inhibition differences. The second aim of the thesis was to examine response inhibition in relation to anxiety, OCD and Panic Disorder; this was done through the development of four novel tasks. The Emotional Stroop Task was a partial replication of a previous study (Lavy et al., 1994). Three Go/No-Go tasks were developed: Go/No-Go Words Task, Go/No-Go Border Images

Task, Go/No-Go Colour Images Task. These tasks were all novel and incorporated emotional stimuli as the Go and No-Go signals to examine whether there was a difference in responding to anxiety related stimuli and individual differences in anxiety did not affect performance.

Based on the theory that conditioned inhibitors may act as safety signals in the maintenance of anxiety theories it was hypothesised that there would be a relationship between conditioned inhibition, anxiety, OCD and Panic Disorder; specifically that individuals who reported elevated levels of anxiety as measured by a questionnaire would show enhanced learning about conditioned inhibitors. It was further hypothesised that performance on the response inhibition tasks would also be dependent on reported levels of anxiety, individuals high in reported anxiety would be less accurate and slower to categorise anxiety related stimuli.

7.1 Conditioned Inhibition Tasks

Chapter 2 and Chapter 3 of the current thesis investigated conditioned inhibition as tested by a retardation test (Chapter 2) and a summation test (Chapter 3) in a healthy sample. Individual differences in anxiety were measured by the HADS, MOCI, BIS/BAS and the EPQR-S and the relationship with performance on these tasks are discussed in Chapter 5.

Conditioned inhibition was successfully demonstrated in a healthy sample in the Negative Images CI Task: Retardation Test, Negative Images CI Task: Summation Test, and the 'Mission to Mars' CI Task: Summation Test. In the Negative Images CI Task: Retardation Test, the participants took longer to learn about a previously trained CI now being presented as a CS compared to a novel CS. Learning about the CI was retarded compared to the novel CS. In the Negative Images CI Task: Summation Test conditioned inhibition was demonstrated, the summation test was passed; overall CS stimuli were being rated differently to [CS + CI] stimuli. The was also an effect of stimulus type,

the CS_t and [CS_t + CI] and S_g and [S_g + CI] stimuli were being rated differently to each other (in version 1, in version 2 there was an overall difference in inhibition but not by stimulus type). Also, in the 'Mission to Mars' CI Task: Summation Test conditioned inhibition was demonstrated, the summation test was passed; overall CS stimuli were being rated differently to [CS + CI] stimuli. There was no effect of stimulus type on this task; conditioned inhibition was demonstrated irrespective of stimulus type. For both the Negative Images CI Task: Summation Test and the 'Mission to Mars' CI Task: Summation Test the results suggest conditioned inhibition was demonstrated and that the inhibitory properties of the CI had transferred over. Discrimination learning was successfully demonstrated in a healthy sample in both the Negative Images CI Task: Retardation Test and the Negative Images CI Task: Summation Test. Participants were rating the CS and [CS + CI] stimuli differently from each other thus the first stage of the CI procedure required to demonstrate conditioned inhibition had been passed.

7.2 Clinical Diagnosis and Individual Differences in Discrimination Learning

At the pre-discrimination and discrimination stage, clinical diagnosis, sex or individual differences in anxiety did not impact on performance. As mentioned, in the healthy sample tested discrimination between reinforced and non-reinforced stimulus presentations was successfully learnt in all of the current task variants where it was recorded and analysed. In the 'Mission to Mars' CI Task: Summation Test the discrimination data was not recorded and therefore not analysed because at this stage task instructions were implicit to minimise any direct associations. The clinical sample tested did not learn the discrimination between the two stimuli. As reported in Chapter 6 the clinical sample power analyses revealed the study was underpowered and only provided a preliminary sample.

Previous studies that have examined effects in clinical populations have demonstrated differences in discrimination learning (Grillon & Morgan, 1999; Orr et al., 2000; Pitman & Orr, 1986). Further to this, gender differences are also apparent in anxiety symptomatology with females suffering a higher degree than males (Lewinsohn et al., 1998). Studies have shown that individuals clinically diagnosed with an anxiety disorder have demonstrated a facilitated discrimination learning effect; they are better and quicker to learn about the discrimination between two stimuli. Furthermore, conditioning to aversive and appetite stimuli is contingent on BIS/BAS sensitivities; BIS condition with aversive and BAS condition with rewarding stimuli (Gray, 1987). Valence of stimuli was specifically incorporated to examine these effects in the current tasks. It has been theorised that a heightened ability to learn discrimination serves a purpose in anxiety. If something is perceived as aversive then it can make sense to learn more quickly about a predictor of it. The ease by which these new associations are learned could then adversely facilitate the development of an anxiety disorder (Grillon & Morgan, 1999; Orr et al., 2000; Pitman & Orr, 1986). If new associations are formed easily this inadvertently assists anxieties to develop and for the individual to be heightened to these stimuli. As mentioned previously, anxieties tend to self perpetuate and escalate into an anxiety disorder potentially as a consequence of a facilitated ability to be able to discriminate between stimuli. The data from the current study does not appear to fit this theoretical view. Anxiety, in the healthy sample, did not impact on the speed with which associations were learnt in the healthy sample and discrimination was not learnt in the clinical sample. Alternatively, it has been argued that anxious individuals will display poorer discrimination learning; responding to predictors or non-predictors of aversive outcomes are equivalent and do not differ (Davis et al., 2000). The assumption behind a reduced ability to differentiate between stimuli is that individuals prone to anxiety are not able to inhibit fear responses. An anxiety provoking stimulus may be presented but an individual sensitive to this would not be able to inhibit their fear response and therefore regardless of whether the stimulus predicts an aversive outcome or not the fear response is shown. In essence fear and their accompany responses are always ready to act and regardless of whether the outcome is aversive the fear response is carried out.

However, it could be argued that this pattern of responding simply reflects stimulus generalisation (Davis et al., 2000). Potentially the results from the clinical sample reflect this pattern of inability to inhibit the fear response as there was no difference in ratings for reinforced and non reinforced trials. Closer inspection of the ratings though suggests this is not the case as individuals largely rated the stimuli as neutral and not negative meaning they were not demonstrating a fear response. Furthermore this did not correlate with anxiety and the clinical sample size is limiting (discussed later in this section). The results from the healthy sample did demonstrate discrimination learning therefore the data do not fit this theoretical view point either. Although, arguably learning processes are involved in some manner in anxiety disorders potentially the development and maintenance of anxiety disorders are reliant on cognitive processes; both of these are discussed in further detail later in this Chapter.

Two different task formats were employed to develop conditioned inhibition; both used a feature negative discrimination procedure but in one task the format was sequential and in the second task the format was serial. This is further compounded by the explicit/implicit nature of task instructions. Previous studies have reported that task formats impact on whether learning occurs with simultaneous stimuli presentation more easily demonstrating discrimination than serial presentation (Baeyens et al., 2004; Holland, 1984; Holland & Lamarre, 1984) and greater learning with explicit than implicit instructions (Arcediano et al., 1996). Only simultaneous explicit discrimination data was captured and analysed; based on previous research these should provide the ideal conditioned to facilitate any demonstrations of discrimination learning in relation to anxiety. However, for the current study this was not the case. Although discrimination learning overall was shown (in the healthy sample not the clinical sample) this was not impacted on by individual differences in anxiety. However, a healthy sample would not typically expect to show a difference dependent on anxiety and the clinical sample recruited was underpowered. Potentially if these methodological issues were addressed the evidence may reflect a different pattern.

7.3 Clinical Diagnosis and Individual Differences at the Retardation and Summation Test Stages

Clinical diagnosis of an anxiety or substance abuse disorder, sex or individual differences in anxiety did not impact on whether conditioned inhibition was demonstrated via a retardation test method or a summation test method. The healthy sample tested successfully demonstrated that conditioned inhibition had been learnt: the inhibitory properties had retarded learning in the retardation test and transferred over in the summation test. The lack of any relationship between performance and individual differences could be simply a result that the healthy sample was within a normal and comparable to previously published studies range. Clinical diagnosis of an anxiety or substance abuse disorder or gender did not impact on how individuals learnt about conditioned inhibitors furthermore conditioned inhibition was overall not demonstrated; at the key test stages the inhibitory properties did not retard learning in the retardation test nor did they transfer across in the summation test. However, as mentioned in the previous section, overall the clinical groups did not learn the discrimination – a pre-requisite to show conditioned inhibition. Therefore any conclusions about the impact of clinical diagnosis of an anxiety or substance abuse disorder are tenuous.

The hypothesis being tested in the current tasks was based on the theoretical ideas from Mowrer (1947;1960) and Gray (1970). These theories attempt to explain both the development and maintenance of anxiety through learning procedures. Mowrer's (1947; 1960) two process theory states that anxiety and anxiety disorders develop through two processes. Anxiety is initially developed and learnt through classical conditioning: the anxiety conditions to a signal. Avoidance response or behaviours are carried out to signals of anxiety which become negatively reinforcing and serve to maintain the anxiety. Gray (1970) elaborated on the two process theory and suggested that safety signals also support the maintenance of the anxiety. A signal to anxiety causes avoidance behaviour and whilst carrying out the avoidance behaviour safety signals are generated. The safety signals are secondarily rewarding and help to preserve

the avoidance behaviour and ultimately the anxiety. It was argued in this thesis that the safety signals that are generated act as conditioned inhibitors. Conditioned inhibitors accompany the avoidance behaviour and act as safety signals and represent the absence of an aversive outcome simultaneously negatively reinforcing and sustaining the anxiety. Individuals that are prone to anxiety would show a facilitated learning effect specifically for conditioned inhibitors. In addition to this gender was also examined as anxiety manifests differently in females and males (Stewart et al., 1997). The results from the current study do not provide evidence in support of this theoretical view. Arguably this is largely due to the samples and power of the study.

Recruitment to the clinical sample experienced sampling issues and consequently caused the study to be underpowered. The final sample size (anxiety disorder = 6, substance abuse = 3) offers great restrictions for the interpretation of the null results found. Power analyses were calculated to determine the ideal sample size to achieve a medium effect (Cohen, 1977). Ideally a sample of 128 and 60 were required for the key main results at the discrimination and retardation stages of the experiment respectively. Statistical power is the probability of not committing a type II error. In order to show an effect and have statistical power an adequate number of participants is required. The final sample size recruited to the study was significantly smaller than these ideal numbers therefore impacting on the power of the study and limiting any interpretation of the results. Not only does the power analysis suggest more participants are required but also previous research has successfully demonstrated effects in clinical populations with larger sample sizes (Kantini et al., 2011a; 2011b). The sampling limitations and how to address them are discussed in more detail in the limitations and future directions section of this Chapter. The final clinical sample restricts any firm conclusions about clinical diagnosis however a healthy sample was also recruited which successfully learnt the discrimination, conditioned inhibition and the task had sufficient power. There was no impact of individual differences in this sample either. Anxiety as evidenced by the questionnaire data did not affect whether the discrimination was learnt or conditioned inhibition. Despite sampling and power constraints this evidence coupled with

the evidence from the discrimination suggests that learning processes are not implicated in individual difference in anxiety.

Theoretically alternative explanations have been proposed about the manifestation of anxiety and anxiety disorders, notably others based on learning theory and cognitive theories are the most prominent. As mentioned previously the Rescorla & Wagner theory (Rescorla & Wagner, 1972) suggest that learning occurs when there is a discrepancy between the outcome predicted and the outcome that occurs on a trial. The outcome is predicted by all stimuli presented on one trial. Inhibition occurs when it is presented along with an excitor and the presence of the inhibitor subtracts from the excitors expectancy of a US. In essence the inhibitor prevents the extinction of the excitor (Soltysik et al., 1983). For example, in an OCD situation, carrying around hand gel extinguishes the signal for danger. However, arguably anxiety does not develop through the presence of one CS in fact multiple CSs are typically present in these situations and even contextual CSs (Bouton & Nelson, 1998). Clinical interventions, such as CBT, actually aim to incorporate any and all CSs when carrying out exposure work as this has the most additive beneficial effects for extinction. Again according to the Rescorla & Wagner theory (1972) a combination of CSs signals the over prediction of a US increasing the discrepancy. Additional CSs and the implications they have towards the development and maintenance of anxiety would help to identify the role both the CS and CI operate at within anxiety.

7.4 Awareness Check

Participants' awareness of the contingencies was dependent on the task. For both the Negative Images CI Task: Retardation Test and the Negative Images Task: Summation Test the majority of participants asked reported they were aware of the contingencies. For the 'Mission to Mars' CI Task: Summation Test task the majority of the participants asked reported they were not aware of the contingencies. This result, the variability of awareness, is not dissimilar to

other studies where awareness has been enquired about. Haggard et al., (1943) reported most participants were unaware of the contingencies whereas Chan & Lovibond (1996) found most participants were aware of the contingencies; awareness results are generally mixed and this is obviously dependent on the task. It could be argued that participants ensure they are aware of the contingencies and learn about what predicts certain outcomes and this could be linked to ease of conditioning (Grillon & Morgan, 1999; Orr et al., 2000, Pitman & Orr, 1986). Participants want to 'pass' the task and so therefore focus on any cues and try and deduce the aim of the task therefore facilitating conditioning. Conversely, it is also possible that higher reported individual differences in anxiety could distract the participant from learning about the contingencies. For example, an individual that has high reported levels of anxiety may give more attention to emotional stimuli and therefore become distracted from the task. The current format of the awareness check results is not suitable for any formal analysis. Obtaining information about participants' awareness suitable for formal analysis and its relationship to individual differences would help to develop an understanding of how contingency awareness interacts with task performance.

7.5 Clinical Diagnosis and Individual Differences in Response Inhibition Tasks

Clinical diagnosis of an anxiety or substance abuse disorder, sex or largely individual differences in anxiety did not impact on response inhibition to either neutral or emotionally valenced stimuli. The healthy sample tested successfully demonstrated the classic colour Stroop effect; responses were less accurate and slower for incongruent colour words compared to other word-types. Further to this there was an emotional response difference; responses, reaction time and accuracy were different for negative and OCD word-types. The clinical sample also displayed the classic colour Stroop and emotional effect however this was only present for accuracy data and the same pattern was not shown in the response time data. Across both samples responses did not differ on any

version of the Go/No-Go Task: Words or Border Images. Individuals were not responding differently to neutral or emotionally valenced stimuli. There were some reported relationships between performance on the Go/No-Go Words Task in the clinical sample – individual differences in depression, OCD, OCD cleaning and BAS reward responsiveness correlated with performance. However, as there was no direct difference in responding overall to Go or No-Go stimuli these correlations need to be considered with caution. As with the conditioned inhibition task, in the healthy sample, the lack of any relationship between performance and individual differences could be simply a result that they were displaying behaviour within a normal range. The clinical sample tested although some relationships were reported between individual differences and performance on the Go/No-Go Task Words overall there was no performance effects on the response inhibition tasks.

Cognitive theories of the development and maintenance of anxiety disorders suggest the reason lies within the thoughts and processes that occur. Some theorists have suggested that the content of the thoughts provides an evolutionary advantage (De Silva et al., 1987) whereas some suggest that individuals catastrophically misinterpret their thoughts and cause their anxieties to evolve (Clark, 1988). One of the most prominent cognitive theories is thought suppression. Fundamentally, thought suppression is the act of suppressing an unwanted, repugnant or negative thought causes that thought to rebound and the individual actually has that thought more frequently; the classic white bear task demonstrates this (Wegner et al., 1987). Although a standardised laboratory paradigm exists to measure the suppression of thoughts and the rebound effect it has been argued that self reported measures of cognitive action: verbalising or writing thoughts down, recording tallies (Clark et al., 1991; Kelly & Kahn, 1994; Wenzlaff et al., 1988) are not the most reliable method to assess thoughts and are open to bias and prejudices. Therefore automatic cognitive measures are an alternative favourable method, such as the Stroop task (Wegner & Erber, 1992) to assess thought suppression; if a response is in inhibited for a word the corresponding thought would be suppressed. The latency to respond to stimuli is taken as a measure of the accessibility of it. If an individual is attempting to suppress a target stimulus

they would show greater accessibility to it, the paradoxical phenomenon termed the hyper accessibility of suppressed thoughts. Specific to Stroop Task paradigm individuals would demonstrate slower response latencies to words that were more accessible to them as a result of trying to suppress them. However, it must be acknowledged that this is not conclusively agreed upon, Morein-Zamir (2010) found that the Stroop task cannot be used as a marker to assess thought suppression. The current analysis suggests that the individuals tested actually demonstrated an enhanced response effect – faster and more accurate for emotional word-types. Instead of a delay in responses they were actually quicker and more accurate suggesting a facilitated response to emotional stimuli. Theoretically this result can be interpreted in terms of evolutionary advantages. It could be argued, from the current results, that individuals display a 'vigilance avoidance model of information processing' (Amir et al., 1998; Mogg et al., 1992; Williams et al., 1998). Once threatening stimuli have been detected individuals will demonstrate a facilitated diversion of attention away from threat (Mogg et al., 1997); individuals become over vigilant for threat. This fits with an evolutionary perspective that threatening stimuli should be identified more quickly so it can be correctly responded to. As mentioned, the Stroop task does not conclusively represent an analogous marker to assess thought suppression. Further to this, in the current task design participants were not asked to suppress thoughts or given an additional cognitive load therefore to extrapolate the findings in terms of thought suppression theory is somewhat tenuous. However, it would appear the data, from both the healthy and clinical samples, fits more appropriately with 'vigilance avoidance model' and supports previous research (Tata et al., 1996).

One difficulty with this interpretation of the results is the equivocal findings across the response inhibition tasks used in the current study. A facilitated effect was found on the Emotional Stroop Task however no difference in responding was found on three versions of the Go/No-Go Task. It has been questioned to what extent the Stroop task requires response inhibition (Tipper, 2001). As mentioned previously, different task designs and formats may restrict the findings (Goghari & MacDonald, 2008) and even within tasks it has been shown different stages of tasks may involve different inhibitory processes

(Braver et al., 2007). On a more general level it has even been argued that response inhibition is a facet of response selection in that the individual is selecting to prevent movement to that stimulus (Mostofsky & Simmonds, 2008). Response inhibition tasks therefore pose difficulties with results and comparisons across designs. Further compounding the interpretation of the results from the Go/No-Go task version is the development and potential strategies participants were engaging in to solve and complete the tasks. Emotional stimuli were incorporated into all of the Go/No-Go Task designs which provided a unique and novel aspect as previous studies have not included such stimuli (Costantini & Hoving, 1973; Hagopian & Ollendick, 1994; Waters & Valvoi, 2009; White, 1981) and meant response inhibition and emotional processing could be compared in one task design (Murphy et al., 1999). Initially this was assessed through the use of word stimuli. However, it has been questioned whether lexical representations of threatening stimuli are appropriate to assess attentional biases (Lavy & Van Den Hout, 1993; Lavy et al., 1993; Mansell et al., 1999). It has been argued that pictorial representations may be more evocative for individuals whose concerns are particularly linked to visual cues (Snider et al., 2000), for example, specific phobias: blood, spiders, vomit, or OCD: dirt, objects unordered. Individuals that find these stimuli fearful are triggered by visual representations and therefore pictorial stimuli were incorporated into the task design. A design complication arose when participants reported focuses purely on the black border and not the content of the stimuli. To address this issue two cues were integrated together ensuring participants paid attention to both cues. Across all three task versions there was no difference in responding and in the last task version (where the two cues, Go/No-Go and emotion were integrated) the sample size was small and therefore the study was likely underpowered. The Emotional Stroop task that is also reported in this thesis reported response inhibition differences with a larger sample (n = 144); the difference in sample sizes between the two tasks is quite significant. Given the format and design complications that arose from the current study and are a continual obstacle in response inhibition literature it has been proposed certain tasks should be uniformly employed to overcome this. One such task that omits any interpretative difficulties is the dot probe task. In dot probe paradigms, words pairs are presented on a computer screen

and when they disappear one word is replaced by a dot. An additional benefit of the dot probe design is that emotionally related stimuli can be easily incorporated. In support of the current studies Emotional Stroop Task findings, Tata et al., (1996) found an increased vigilance towards anxiety related stimuli on the dot probe task. On examination of the data and with respect to the common difficulties that arise from response inhibition tasks it appears the results show evidence for hyper vigilance towards anxiety related stimuli and the 'vigilance avoidance model of information processing' (Amir et al., 1998; Mogg et al., 1992; Williams et al., 1998).

7.6 Relevance to Clinical Interventions

As mentioned previously in this thesis, theoretically associative learning processes have been suggested as the cause of the development and maintenance of anxiety disorders (Mineka, 1985; Mowrer, 1947; Watson & Raynor, 1920); this was the hypothesis specifically investigated in this thesis. To reiterate, classical conditioning associations once established are effective triggers for anxiety. Successive avoidance or safety behaviours that is carried out potentially generates safety signals; in a learning context are conditioned inhibitors (Gray, 1987). For example, in an individual that has OCD for example, dirt triggers the anxiety of fear of illness, contamination, potential harm, subsequently causing washing behaviour which generates safety signals, CIs, the smell of the soap, touch of the towel, sound of the water. In an individual that has panic disorder, the heart palpitations trigger the fear of impending death or heart attack which causes the behaviour of breathing into a paper bag which generates safety signals, CIs, the rustle of the bag, the smell of the paper. It is the safety signals, the CIs that are elicited as a result of the behavioural response to anxiety. They accompany the behaviour and become negatively reinforced therefore sustaining the behaviour (Cándido et al., 1991; Cook et al., 1987; Dinsmoor, 2001). It was argued in this thesis that learning processes, in particular, the development of CIs as safety signal is key to the maintenance of anxiety, OCD and Panic Disorder. Therefore, anxiety is initially established through an adaptation in behaviour but this adaptation

generates other stimuli that negatively reinforce and maintain the behaviour and ultimately the anxiety.

This has implications for clinical interventions, namely CBT, that aim to treat and help individuals suffering from such anxieties. CBT is the generally the first choice and typically effective psychological treatment for anxiety disorders specifically OCD and Panic Disorder. CBT for OCD and Panic Disorder is based on identifying any existing negative thoughts and behaviours and then through therapy, reevaluating these, 'unlearning' and establishing new healthy thoughts and behaviours – ultimately a new ethos of cognitions and approaches to the previously feared stimulus. In this thesis it has been argued that the behaviours that are adopted when anxious generate other stimuli that maintain the anxiety, conditioned inhibitors. Conditioned inhibitors are generated when avoidance or safety behaviours are acted out. As explained, CBT is fundamentally based on identifying and changing behaviours and thoughts that maintain anxieties. If conditioned inhibitors are generated when carrying out the behaviours in order for CBT therapies to be efficient and effective they would need to incorporate this. If conditioned inhibitors can be identified then this would impact positively on therapy. Conditioned inhibitors that are generated could be identified in therapy and, as well as changing thoughts and behaviors, therapy would aim to incorporate and challenge conditioned inhibitors that have been established. For example, an OCD example, CBT at the moment would aim to prevent washing to anxiety provoking stimuli but if CIs were identified this would be incorporated, such as changing the rituals – the smell of the soap, the touch of the towel, the sound of the water. CBT would not therefore not only identify thoughts or behaviours that need to be altered but also the accompanying conditioned inhibitors that aid the maintenance of the disorder. In theory, this would benefit the format of CBT therapies and ultimately clinical outcomes.

7.7 Limitations and Future Directions

Due to the nature of the PhD thesis there were some general limitations such as working within the NHS ethics approval guidelines and the time limits. The limitations and future directions to address the restrictions that were imposed in the current study or further advance the tasks will be discussed in this section.

As mentioned previously, NHS ethical approval was allowed for certain pre-determined venues and tasks and recruitment from these venues was only permissible until a certain date. This therefore imposed some limitations on the overall sample recruited. Substantial efforts were made to ensure a large proportion of individuals that access those venues were approached to be involved in the study and a considerable amount of participants were approached through various methods to volunteer to be involved in the research project. Further to this, the logistics of what the centres primary operation is (to provide therapy to individuals that require it) means the throughput of those requiring the services of the centres is not quick. In addition to this there are perceptions about how this will impact on future care from the service from those who use them and whether to participate in research studies. An additional difficulty arises that any willing participants that did volunteer only represent a subset of the population this forces further limitations on the sample recruited and the study. For example, an individual that has been formally clinically diagnoses with Panic Disorder and Agoraphobia that is obliging to volunteer to participate in a research study displays a different pathology to an individual with Panic Disorder and Agoraphobia that will not leave their house. A further complication, commonly individuals with mental health difficulties, including those with anxiety disorders, are often co-morbid with other mental health difficulties and are either on prescribed medication or participating in a type of psychological therapy. The current sample had many co-morbid and medicated participants. This was recorded and also their therapy status for the purpose of the thesis but there were no participants on anti-anxiety medication nor had they received

therapy based on learning principles (CBT) therefore the effects of these treatments could not be examined within the current clinical sample recruited. Individuals with anxiety may be prescribed anti-anxiety medication to decrease their symptoms, typically benzodiazepines or beta blockers (see BNF, British National Formulary (2010) for a full list of recommended medication). CBT based therapies provide individuals with the tools to gradually expose themselves to anxiety provoking situations. As a result of medication or psychological therapy treatment the individual is often less inhibited and able to be involved or approach stimuli/activities that they may have 'off medication/therapy' found anxiety provoking and perhaps even avoided or carried out behaviours to tolerate them. Ultimately this means that it is very difficult to obtain a 'clean' sample. Considerable effort was made to ensure these limitations were addressed in the current study but nonetheless the issues mentioned have still restricted the power of the study, the results and their interpretation and they must be acknowledged.

Inhibitory processes were examined in the current thesis through a variety of tasks, conditioned inhibition (Negative Images CI Task: Retardation Test, 'Mission to Mars' CI Task: Summation Test, Negative Images CI Task: Summation Test) and response inhibition (Emotional Stroop Task, Go/No-Go Words Task, Go/No-Go Border Images and Go/No-Go Colour Images Task). As mentioned in Chapter 1, there are 6 main anxiety disorders and within a disorder itself often there are many symptom subtypes. For example, OCD has many different symptom subtypes such as washing, hoarding, checking. In the current thesis this was addressed to an extent; stimuli in the response inhibition tasks reflected symptoms of anxiety and subtypes of those symptoms, e.g. washing, hoarding, and symmetry. Nonetheless a limitation exists in that participants would have encountered stimuli that were not anxiety provoking for them; if a participant was aroused by washing they may not have been aroused by hoarding and therefore these stimuli would have been somewhat irrelevant or even neutral to them. Obviously, this restricts the results and the interpretation of them as the tasks were not idiosyncratic and arguably if the stimuli were wholly anxiety provoking for each individual tested. An

additional layer to this limitation is the previous one described, often anxiety disorders are co-morbid and therefore customising tasks becomes a difficult to achieve. Nonetheless, the current study did address this limitation as optimally as possible by incorporating a range of anxiety provoking stimuli.

This PhD has allowed the opportunity to investigate inhibitory processes in relation to anxiety and naturally the process encourages reflection on what has been carried out and ideas about how to advance the findings. In hindsight there are some noteworthy observations that if the project was repeated or for future work would ideally be addressed. Firstly, the venues/sources and recruitment of the clinical sample. This was a major obstacle and having been through the process some solutions are offered about how to overcome this. Future work could look at primary care venues and other methods or centers for potential recruitment could be approached rather than only secondary care. This would mean more potential participants were considered and offered the opportunity to be involved increasing the sample size and statistical power. A General Practitioner (GP) is the first port of call for any individual suffering from any mental health difficulty and, specifically for this study, many people live with anxiety disorders without the requirement of in service care. One notable primary care source is Increasing Access to Psychological Therapies (IAPT) services that operate throughout England. IAPT services work solely with people that suffer from symptoms of anxiety or depression and local teams could have been approached about being involved in the research project. Although, as mentioned previously, due to the nature of anxiety disorders individuals may have declined involvement in the project but nonetheless primary care services will increase the number of potential participants and thus power and effect size. Therefore, primary care provides the ideal setting for potential recruits to a research study. In retrospect a primary care venue would offer a wider scope of potential suitable participants. Secondly, the development of the conditioned inhibition retardation task. In the current thesis the original design was very broad perhaps incorporating too many aspects (various valences, transfer, stimuli) meaning the task design went through many changes and stages. One way around this would be to start

simpler and expand out; to get the task working at a basic level and then after to incorporate various aspects and levels to the design. Both of these issues could straightforwardly be addressed in future work or if any aspect of the thesis was to be repeated. A future adaptation could be to make the tasks idiosyncratic for the participants and therefore when they are completing them are only exposed to individual anxieties. This would require identifying each participant's anxiety, fear or symptoms subtype prior to completing the tasks. Each task could then easily be altered to incorporate these and be specific and representative of each participant's fears or anxieties. For example, if the participant reported washing was their OCD symptoms subtype then the stimuli used would be representative of this subtype, washing stimuli. This would make the task more sensitive and perhaps highlight and identify the underlying mechanisms behind any differences in conditioned inhibition or response inhibition.

7.8 Conclusions

The aim of this thesis was to investigate inhibitory processes in relation to anxiety and anxiety disorders, specifically conditioned inhibition and response inhibition. Avoidance is often the behaviour that is carried out to escape and provide relief from an anxiety provoking situation causing them to be negatively reinforced. As a result of acting out the behaviours, through associative learning mechanisms, safety signals (CIs) that are generated and accompany them may also inadvertently sustain the behaviours and become secondarily rewarding (Cándido et al., 1991; Cook et al., 1987; Dinsmoor, 2001; Gray, 1987). To examine this hypothesis, computer-based tasks to demonstrate conditioned inhibition as measured by both retardation and summation tests (Hearst, 1972; Kantini et al., 2011a; Kantini et al., 2011b; Migo et al., 2006; Rescorla, 1969) were devised. Two novel tasks were created and an established task was used. The two novel tasks incorporated negative stimuli as previous studies have reported a link between this and anxiety (Lavy et al., 1994). Further to this it has also been argued that individuals that suffer

from anxiety and anxiety disorders display a response inhibition deficit to certain anxiety related emotional stimuli (Aycicegi et al., 2003; Foa et al., 1993; Lavy et al., 1994; Rosenberg et al., 1997; Watkins et al., 2004). Attention is focused on stimuli that are related or perceived to be threatening. To examine this computer tasks examining response inhibition were devised and included an emotional component: Emotional Stroop Task, Go/No-Go Words Task, Go/No-Go Border Images Task, and Go/No-Go Colour Images Task.

The results in a healthy sample showed conditioned inhibition and performance on the task was not related to individual differences in anxiety. This was displayed via both the retardation test method and the summation test method. The results from the response inhibition tasks demonstrated a classic Stroop effect: participants were overall slower and less accurate to correctly categorise colour incongruent words compared to colour congruent words. There was some difference in relation to emotional words too: participants were overall faster for OCD words compared to negative and congruent words and more accurate for negative words. However, there was no difference in performance on any of the Go/No-Go Tasks. Participants did not respond differently to the pre-potent Go signals as compared to the No-Go signals. There was no relationship between performance across all of the response inhibition tasks and individual differences. Overall the results demonstrate no relationship between anxiety in a healthy sample and performance in the tasks detailed in this thesis.

Further to this the same tasks were administered to a clinical sample taken from an anxiety disorder and substance abuse population to understand the relationship between performance and a clinically diagnosed sample. The results showed no difference in performance on any of the tasks. There was a marginal classic Stroop effect, individuals were less accurate for colour incongruent words compared to other word-types) although this result was not replicated with reaction time. There was also a difference in accuracy that was also replicated in the healthy sample; individuals were more accurate for

negative words. Some relationships were apparent between individual differences and performance on the Go/No-Go Words Task but overall responses on this task did not differ. Overall there was no difference in performance dependent on diagnosis or individual differences (apart from the limited correlations on the Go/No-Go Words Task) on any of the tasks. However, the sample size that was successfully recruited for the study was comparatively small and therefore the study did not have large statistical power. Other studies that have examined conditioned inhibition in a clinical sample have shown a medication effect (Kantini et al., 2011a; Kantini et al., 2011b) and in a healthy sample a positive correlation with BAS reward responsiveness and negative correlation with schizotypy (Migo et al., 2006); both with larger sample sizes. The results reported in this thesis, Chapter 2 – successfully demonstrated conditioned inhibition as tested by retardation, Chapter 3 – successfully demonstrated conditioned inhibition as tested by summation, Chapter 4 – response inhibition as tested by the Emotional Stroop Task, have also had large sample sizes. Therefore, in order to conclusively demonstrate whether there is a difference, dependent on diagnosis, in performance on the tasks a larger sample size would be increase the power of the study.

As mentioned above, one of the main limitations of this thesis is the small sample size from the clinical population. Due to unexpectedly low compliance, as well as ethical and time restraints, only a small number of participants were recruited and to fully investigate the effects of diagnosis, ideally in relation to medication status, a larger sample would be needed. However, conditioned inhibition and a Stroop effect (a classic Stroop effect – slower and less accurate for colour incongruent words compared to other word-types and an emotional Stroop effect, more accurate for negative words and faster for negative and OCD words) was shown in a healthy sample and the accuracy effect on the Emotional Stroop Task found in the clinical sample. There were no correlations between performance on the tasks and anxiety as measured by the questionnaires (HADS, MOCI, BIS/BAS and EPQR-S). Anxiety is something that most individuals feel at some point so this result demonstrates there was

no evidence for a relationship between performance on the mentioned tasks (Negative Images CI Task: Retardation Test, Negative Images CI Task: Summation Test, 'Mission to Mars' CI Task: Summation Test, Emotional Stroop Task and Go/No-Go Words, Border Images and Colour Tasks and individual differences in anxiety (HADS, MOCI, BIS/BAS and EPQR-S). To further develop the tasks and understand what the underlying mechanisms are the tasks could be adapted to be idiosyncratic for each individual. People perceive different stimuli to be fearful; this is displayed in both formally diagnosed individuals and healthy individuals. Each task could be adapted to be personal for the individual tested using stimuli that are pertinent to their difficulty.

Overall, the main aim of the thesis was to investigate inhibitory processes in relation to anxiety based on the theory that individuals that are prone to anxiety act out behaviours that generate safety signals which reinforce and maintain it. Further to this that they may show response inhibition deficits towards anxiety related stimuli. The results from a healthy sample demonstrate conditioned inhibition shown by both retardation and summation and this was not related to individual differences in HADS, MOCI, BIS/BAS and EPQR-S. The results also demonstrate response inhibition deficits on the Emotional Stroop Task, the classic Stroop effect, and further to this quicker and more accurate response latencies to negative and OCD emotionally related words. There were no performance effects on any of the 3 Go/No-Go Tasks (Go/No-Go Words Task, Go/No-Go Border Images Task, Go/No-Go Colour Images Task). Response inhibition differences in the aforementioned tasks were not related to HADS, MOCI, BIS/BAS and the EPQR-S. The preliminary results from the clinical population sample did not show any evidence for conditioned inhibition or response inhibition deficits. Further to this clinical diagnosis, sex or individual differences (HADS, MOCI, BIS/BAS and the EPQR-S) did not impact on performance. Within the scope of the thesis the purpose to examine inhibitory processes, both conditioned inhibition and response inhibition has been investigated. Overall the data show initial evidence for a no apparent link between inhibitory learning and anxiety. A larger clinical sample size and

individualising the tasks to fully investigate the mechanisms is required to examine conditioned inhibition and response inhibition and provide any conclusive results. This would also allow medication and psychological treatment effects to be considered.

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