Cognitive and Memory Processes in Obsessive-Compulsive Checking

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Submitted in partial requirement for the degree of Master of Psychology (Clinical) at the University of Tasmania.

I declare that this thesis is my own work and that, to the best of my knowledge and belief, does not contain material from unpublished sources without proper acknowledgement, nor does it contain material which has been accepted for the award of any other higher degree or graduate diploma in any university.

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Literature Review

Models of Obsessive-Compulsive Checking: A Review of the Literature

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Abstract

A wide array of neurobiological, neuropsychological and cognitive models have been formulated in an attempt to explain the development and persistence of obsessive-compulsive checking. Memory processes, including impaired memory for actions and confidence in memory, and cognitive variables such as exaggerated threat appraisal, inflated personal responsibility and intolerance to uncertainty, have received much attention in recent years. Although researchers generally agree that multiple factors are likely to be involved in this disorder, a coherent model articulating the contribution and relative importance and contributions of each has not been forthcoming. This review provides an overview of obsessive-compulsive checking and research efforts in the fields of memory and cognitive psychology with regard to this disorder. Limitations of the existing research are discussed to highlight barriers to the development of a more complete understanding of checking behaviour.

Obsessive-Compulsive Disorder (OCD) is characterised by the presence of obsessions or compulsions that are a significant source of distress, are time-consuming, and cause significant impairment in daily functioning (American Psychiatric Association (APA), 1994). Typically, OCD is further classified according to the theme of the obsession or associated compulsion. Checking rituals, cleaning rituals, counting, ordering and obsessional slowness are among the most common forms of the disorder (Jenike, 1995).

Despite being one of the most common psychiatric conditions with a worldwide prevalence of approximately 2% of the general population (Sasson, Zohar, Chopra, Lustig, Iancu & Hendler, 1997), the aetiology of OCD has proven difficult to determine. Moreover, although there is growing evidence suggesting distinct aetiological pathways for the various OCD subtypes (Matsunaga, Kiriike, Matsui, Iwasaki, Koshimune, Ohya et al., 2001), relatively few researchers have investigated such differences until recently.

With regard to obsessive-compulsive checking, neurobiological, neuropsychological, cognitive appraisal and memory impairment models currently compete in the literature. However, although it is widely agreed that multiple factors are likely to be aetiologically important in the development of compulsive checking, agreement about the specific factors involved, relative contributions of each and interactions between the factors has not been reached. A more complete understanding of the underlying mechanisms of obsessive-compulsive checking, and other forms of the disorder, should therefore be an important priority for psychological research.

This review critically examines several of the potential cognitive mediators and memory processes hypothesised to underlie the development of obsessive-compulsive checking. Commencing with a description of the disorder and its epidemiology and natural course, the review then presents an historical account of OCD theories. A brief summary of the neurobiological and neuropsychological research is provided, followed by a more extensive critique of the extensive literature concerning memory phenomena implicated in obsessive-compulsive checking. Research investigating deficits in memory for actions and memory confidence is critically examined. The literature review then explores the burgeoning cognitive literature. Aetiological models proposing a central role of exaggerated threat appraisal, inflated personal responsibility and intolerance for uncertainty are reviewed. Finally, a summary of the key findings is presented, along with a discussion concerning the methodological impediments of the existing research and suggestions for future investigations.

Obsessive-Compulsive Checking: an Overview

Description and Diagnostic Features

Obsessive-Compulsive Disorder (OCD) is characterised by obsessions and/or compulsions that are time-consuming, cause clinically significant distress and impairment in daily functioning (APA, 1994). O*bsessions* are recurrent or persistent thoughts, impulses or images that are experienced at some time during the course of the disturbance as intrusive and distressing and, with the exception of children, are irrational and the product of the individual's own mind (APA, 1994).

Compulsions are repetitive behaviours or mental acts that the individual feels driven to perform in response to an obsession or according to rules that must be rigidly followed. Generally, compulsions are aimed at reducing distress associated with having the obsession, or preventing some dreaded event or situation from occurring. However, compulsions are usually not realistically connected with the situation or are clearly excessive (APA, 1994). The obsessions or compulsions must not be restricted to another Axis I disorder (e.g., a preoccupation with food in the presence of an eating disorder) or be related to the direct physiological effects of a general medical condition or a substance (APA, 1994).

Clinical obsessions and compulsions are typically limited and stereotyped, generally falling into four main categories: contamination fears, pathological doubt, intrusive sexual, blasphemous, or aggressive thoughts, and obsessional slowness (Kolada, Bland & Newman, 1994; Sasson et al., 1997). Contamination fears are one of the most common obsessions, reported by up to 55% of all OCD patients (Kolada et al., 1994). Intrusive urges or thoughts of a sexual, blasphemous, or aggressive nature are reported in approximately 25% of patients (Kolada et al., 1994) and are often associated with covert mental strategies such as counting, praying, or ordering (Sasson et al., 1997). Obsessional slowness, characterised by a need to have things "just right" (Sasson et al., 1997), is less commonly observed in clinical settings (Rachman & Shafran, 1998).

Pathological doubt or "checking" is commonly reported among individuals with OCD (Kolada et al., 1994). Typically, obsessions concern doubt about whether a

particular action has been performed (e.g., turning off the stove, locking the door), or the repeated concern that one has harmed someone through an action (e.g., the possibility of having hurt someone while driving) (Sasson et al., 1997). Checking compulsions presumably develop because they serve to lower the likelihood of the feared outcome (e.g., fire as a result of the stove being left on) (Rachman & Shafran, 1998). Alternatively, "undoing" rituals, such as counting, praying, or ordering, are sometimes also performed (Sasson et al., 1997).

Age of Onset, Course and Prevalence

The onset of OCD symptoms tends to be gradual rather than acute (Jenike, 1995), generally occurring during the early to mid-20s (Bebbington, 1998), although children as young as ten years of age have been reported to show compulsive behaviours (Thomsen, 1993). In light of this, several researchers have proposed a bimodal age of onset pattern, with peaks occurring between 10-14 years and 20-22 years of age (e.g., Henin, Savage, Rauch, Deckersbach, Wilhelm, Baer et al., 2001; Kolada et al., 1994). Individuals with checking compulsions or mixed rituals tend to have an earlier age of onset than individuals with washing concerns (Minichiello, Baer, Jenike & Holland, 1990). Additionally, men generally have an earlier age of symptom onset compared with women (Jenike, 1995; Minichiello et al., 1990).

OCD is typically a chronic disorder with a fluctuating course (Jenike, 1995), with different symptoms predominating at particular points over the course of the individual's life (Sasson et al., 1997). Most individuals present with a combination of obsessive symptoms (Marks, 1987) and a high number of

comorbid disorders including depression, other anxiety disorders, eating disorders, substance abuse, schizophrenia and personality disorders (APA, 1994; Sasson et al., 1997). Although several effective treatments exist, complete remission of symptoms is unfortunately rare (Jenike, 1995).

Research from large scale studies (e.g., Kolada et al., 1994; Samuels & Nestadt, 1997; Zohar, Apter, King, Pauls, Leckman & Cohen, 1999) and cross-national epidemiological research (e.g., Horwath & Weissman, 2000; Weissman, Bland, Canino, Greenwald, Hwu, Lee, et al., 1994) have consistently shown relatively high prevalence rates of between 1.9% and 5% worldwide for OCD, that are similar for males and females (Bebbington, 1998). Currently, the worldwide prevalence of the disorder is generally accepted to be around 2% of the population (Sasson et al., 1997), placing OCD as the fourth most common psychiatric disorder (Rasmussen & Eisen, 1994) affecting an estimated 50 million people world-wide (Sasson et al., 1997).

Normal and Abnormal Obsessions

Most individuals exhibit thoughts or behaviours that are remarkably similar to the obsessions and compulsions characterising OCD (e.g., Muris, Merckelbach & Clavan, 1997; Rachman & de Silva, 1978; Salkovskis & Harrison, 1984), and differ only in frequency, intensity, and discomfort (Burns, Keortge, Formea & Sternberger, 1996; Rassin, Muris, Schmidt & Merckelbach, 2000). Mataix-Cols, Vallejo and Sànchez-Turet (2000) concluded that obsessive-compulsive phenomena are dimensionally distributed in the general population. Additionally, several studies have shown that obsessive-compulsive symptoms are relatively

stable in nonclinical groups (e.g., Burns et al., 1996; Morris, Forbes, Bradley & Goodman, 2000). Consequently, it has been possible to use subclinical samples in research investigating the aetiology of OCD.

OCD Subtypes: Evidence for Distinctive Aetiologies

Recent investigations indicate that OCD may not be an homogenous disorder; the various subtypes described may actually represent distinct disorders. As previously discussed, the various OCD subtypes are generally characterised by different ages of symptom onset (Minichiello et al., 1990). There is also evidence for differences in the types of cognitions or beliefs associated with washing and checking subtypes (e.g., Overton & Menzies, 2002).

Several researchers have further hypothesised that the various subtypes are differentially mediated, at least in part, by different neuroanatomical circuits: *"...it is possible that distinct OCD patient subgroups manifest different impairments within the circuit connecting the orbitofrontal cortex, the basal ganglia, and thalamus"* (Wilson, 1998, p. 168). Compelling experimental evidence is emerging in support of this hypothesis. For example, Phillips, Marks, Senior, Lythgoe, O'Dwyer, Meehan, et al. (2000) found evidence of a differential neural response between OCD washers and checkers when presented with pictures designed to elicit disgust.

Despite the emerging evidence in favour of distinct neuroanatomical structures, developmental pathways and cognitive features among the OCD subtypes, contemporary research into memory and cognitive features of the disorder is

largely derived from studies using mixed symptom profiles. The extent to which the findings of such studies are specific to obsessive-compulsive checking is therefore unclear. However, due to the relative paucity of studies employing "pure" checking samples, the inclusion of studies examining mixed profile groups in the present literature review is unavoidable.

In the subsequent sections of this literature review, efforts have been made to distinguish clearly between those studies investigating solely obsessive-compulsive checking and those that have included heterogenous samples. Similarly, clinical and nonclinical populations are explicitly defined wherever possible in the following review of the literature.

Theories of OCD: Historical Explanations

There is some evidence that the first descriptions of obsessive-compulsive symptoms were documented in Mesopotamia over 4000 years ago (Frazier & Goldstein, 1987, as cited in Kolada et al., 1994). However, it was not until the Middle Ages that the first theoretical accounts of OCD emerged. These models were strongly influenced by the dominant religious beliefs of the time. For example, the *Malleus Maleficarum* (Witch's Hammer), an Inquisition treatise on psychopathology and witchcraft, contained a description of what would now be considered a compulsion (Kraemer & Sprenger, 1486 as cited in Sasson et al., 1997). As evident in this text, blasphemous or sexual thoughts were presumed to be signs of being "possessed". Accordingly, the treatment of choice during this period was exorcism to expel the unfortunate soul of evil (Jenike, 1995).

Although surprisingly effective for some individuals, many more were not "cured" of their affliction and not all survived the "treatment".

Fortunately, over time the religious explanation of OCD was abandoned in favour of a medical aetiology. Jean Etienne Dominique Esquirol is credited with providing the first account of OCD in the psychiatric literature in 1838 (Jenike, 1995). By the end of the 19th century, the medical view considered that the symptoms of OCD were a manifestation of melancholia or depression (Jenike, 1995). This model predominated until well into the 20th century when theories of OCD started to focus on the psychological aspects of the disorder.

Sigmund Freud's influential psychoanalytical view became the prevailing aetiological theory of OCD in the early part of the 20th Century (Kolada et al., 1994). According to Freud, the obsessive state was a manifestation of psychological defenses against repressed memories of sexual guilt (Carr, 1974); a view famously recorded in Freud's description of the 'Rat Man' in 1909 (Freud, 1909 as cited in Esman, 2001).

Psychoanalytical models predominated until the 1950s when researchers began applying learning theories to obsessive-compulsive symptoms. Wolpe (1958) regarded obsessions and compulsions as conditioned avoidance responses arising from traumatic experiences. Specifically, the behavioural model of OCD proposed that obsessions were internal stimuli that had become the focus of anxiety. Compulsions were viewed as conditioned avoidance responses that served to provide immediate anxiety reduction, and therefore prevent habituation,

resulting in a perpetuation of the compulsive behaviours (Salkovskis, Forrester & Richards, 1998).

Despite the popularity of behavioural models and the effective treatment techniques they have spawned (Marks, 1987), researchers have long recognised that they do not sufficiently account for all OCD phenomenology (Jenike, 1995). Consequently, several researchers have focussed on exploring a neurobiological basis of OCD. Further, there has been a growing appreciation that the symptoms of obsessive-compulsive checking may be at least partly attributable to memory dysfunction. Finally, "*obsessions are, by definition, a cognitive phenomena and play a crucial role in triggering compulsions*" (Ladoucer, Léger, Rhéaume & Dubé, 1996, p. 767). Hence, there is also growing interest in the role of cognition in the development and maintenance of OCD.

Neurobiological Factors

Using research exploiting advances in neuroimaging techniques and gene technologies, substantial progress in delineating some of the potential genes and neurological structures involved in the development of OCD has been made.

Genetic Factors

Reviews of the genetic literature and meta-analyses have indicated that OCD is far more common in first-degree relatives than in the general population, with heritability reported to be around 30-40% (Heteema, Neale & Kendle, 2001; Thomsen, 1997). Evidence for a moderate genetic influence has also been found

using twin studies, however findings of discordant monozygotic twins rule out a completely penetrant hereditary transmission of OCD (Kolada et al., 1994). Individual environmental factors are therefore very influential in the development of the disorder (Heteema et al., 2001).

Pato, Pato and Pauls (2002) believe that progress in determining the genetic mechanisms involved in the expression of OCD have been hindered by two factors: the heterogeneity of clinical presentations and a lack of understanding at the molecular level. A lack of well-controlled twin studies represents another limitation of the existing research (Heteema et al., 2001; Thomsen, 1997). Studies addressing these issues would assist in identifying the specific locus of the genes involved and, in doing so, provide an opportunity to determine the environmental factors critical in the development of the full-blown condition.

Neurotransmitter Abnormalities

Based on findings of symptom improvement in response to serotonergic antidepressants (SSRIs), several researchers have hypothesised that individuals with OCD have low levels of the neurotransmitter, serotonin (Baumgarten & Grozdanovic, 1998). There are several lines of converging evidence for this hypothesis. Firstly, abnormal levels of a cerebrospinal fluid (CSF) serotonin metabolite, CSF-5-HIAA, have been reported in untreated individuals with OCD (Jenike, 1995; Micallef & Blin, 2001). Secondly, studies in both laboratory animals and humans in controlled clinical trials have shown that these levels return to normal after treatment with serotonergic antidepressants but not with norepinephrine reuptake inhibitors or dopamine antagonists, providing further

evidence for a serotonin specific effect (Blier & Abbott, 2001; Micallef & Blin, 2001).

The serotonergic hypothesis however, does not account for the finding that serotonin depletion does not exacerbate OCD symptoms (Delgado & Moreno, 1998). Further, not all patients with OCD respond to SSRI medications and elevated levels of CSF serotonergic metabolites do not correlate with OCD symptom ratings (Baumgarten & Grozdanovic, 1998). Finally, low baseline levels of CSF-5-HIAA have not been found to be reliably different in OCD (Baumgarten & Grozdanovic, 1998) and genetic research to determine the transmission of variants of genes coding for serotonergic structures has produced conflicting results (e.g., Di Bella, Cristina & Bell, 2002).

Therefore, while serotonin may be involved in OCD, there is little evidence for a causative role. Jenike (1995) also suggests that several studies indicate the involvement of other neurotransmitter systems.

Neurological Anomalies

Reviews of functional neuroimaging studies reveal that hypermetabolism in the orbitofrontal cortex, caudate nucleus, thalamus and anterior cingulate gyrus have consistently been found (e.g., Micallef & Blin, 2001; Saxena, Brody, Schwartz & Baxter, 1998). Imaging studies have generally shown hypermetabolism in the orbitofrontal regions at rest, and hyperactivity in the striatum and limbic areas during symptom provocation (Hoehn-Saric & Greenberg, 1997). Studies of neurological electrical activity have confirmed this pattern of increased frontal

activation during symptom provocation (e.g., Blair-Simpson, Tenke, Towey, Liebowitz & Bruder, 2000). Further, volumetric computed tomographic research has demonstrated bilaterally decreased caudate volumes in OCD patients compared with nonclinical controls (Jenike, 1995).

Veale, Sahakian, Owen and Marks (1996) concluded that the findings appear to implicate dysfunction in the neural networks connecting the basal ganglia and frontal lobes. However, other researchers have suggested a more global disruption to normal brain development or in the myelination process due to findings of significantly reduced total white matter associated with increased total cortex and opercular volumes (Jenike, Breiter, Baer, Kennedy, Savage, Olivares, et al., 1996).

Summary

Research has shown that a genetic contribution is evident in OCD, but does not account for all cases, implying that environmental factors are also necessary for the development of the disorder. The specific genes involved have not been consistently identified however, and therefore the transmission of the disorder remains unknown. Similarly, although serotonin appears to play a role in OCD, it does not appear to be causative and other neurotransmitter systems are likely to be involved. Finally, although the neurological and neuroimaging research has reported reasonably consistent abnormalities, the specific biological processes involved and the functional significance of such anomalies is not yet understood (Gehring, Himle & Nisenson, 2000).

Savage, Deckersbach, Wilhelm, Rauch, Baer, Reid et al. (2000) point out that the underlying neuropathology of OCD is likely to be attributable to subtle morphological abnormalities and disrupted function in widely distributed neural systems rather than a gross lesion. Therefore, specific conclusions regarding the underlying neuropathology of the disorder might be better made on the basis of functional imaging studies employing cognitive activation paradigms. Finally, as it has not been conclusively established that the abnormalities identified are an underlying cause in contrast to a consequence of OCD, such research should be interpreted with caution.

Neuropsychological Research

Neuropsychological research has allowed the gaps between the neurological structures and processes identified in OCD and their psychological functions to be bridged to some extent. Deficits in several areas have been reported on the basis of neuropsychological assessments, including exaggerated startle reflex, saccadic eye movement programming and motor difficulties (Greisberg & McKay, 2003; Wilson, 1998). However, the most consistent findings have been obtained in the areas of visuospatial performance, attentional impairments, executive functioning and memory (Wilson, 1998). As memory abnormalities, including visual memory deficits have been among the most extensively studied in the neuropsychological research (Savage et al., 2000), the literature on memory functions will be examined separately.

Visuospatial Deficits

One of the most consistent findings of neuropsychological testing in heterogenous OCD samples is lowered scores on a range of visuospatial tasks. In a review of neuropsychological research into OCD, Schultz, Evans and Wolff (1999) found that studies generally show a consistent pattern of deficits in response inhibition, visual memory and visuoperceptual functioning. Poor performance on visuospatial tasks is believed to implicate frontostriatal dysfunction (Tallis, 1997) lending support to the findings of neurobiological research. Veale et al. (1996) further proposed that basal ganglia dysfunction is also indicated, as lesions within these structures are associated with visuospatial defects. However, Cox (1997) reported that the literature shows inconsistent difficulties with visual perceptual discrimination, visual and working memory, and visuomotor tasks in OCD. Therefore, further research to address the inconsistencies in the literature on visuospatial deficits is required.

Attention and Response Inhibition

In general, inconsistent findings with regard to performance on attention tasks have been obtained, perhaps reflecting the diverse methodologies employed across studies. Conversely, relatively consistent results revealing differences in allocation of attention, regardless of whether measured by evoked potentials, eye movements or reaction time methods, have been found (Cox, 1997).

For example, Martin, Wiggs, Altemus, Rubenstein and Murphy (1995) found no evidence of deficits in working memory (an index of attentional functioning) in OCD participants, although significantly slower performance on a self-ordered

pointing task relative to controls, implicating attention allocation deficits. Similarly, although Papageorgiou, Rabavilas, Liappas and Stefanis (2003) found significantly reduced P300 amplitudes at right prefrontal areas and a longer P300 latency at central prefrontal sites in participants with OCD, indicating abnormalities in working memory and attentional processing, there was no deficit with regard to overt working memory performance. Finally, Gehring et al. (2000) reported electrophyisological data suggesting dysfunction in action monitoring (a measure of attention allocation) but no differences in accuracy or error measures on a Stroop task.

Deficits in Executive Functioning

Due to the inconsistent findings with regard to attentional processes, Greisberg and McKay (2003) proposed that a more general deficit in executive functions, particularly organisational strategies, might underlie OCD. In line with this hypothesis, Veale et al. (1996) reported that 40 participants with OCD were as accurate as controls on various neuropsychological tests, but slower in generating alternative solutions when a mistake occurred, and had difficulties in shifting between sets. Similarly, a study by Savage et al. (2000) assessing strategic processing and memory performance in OCD reported that deficits on free recall of verbal and nonverbal information were attributable to executive function impairments.

These findings were interpreted as implicating a range of executive function deficits including increased distractibility to competing stimuli, excessive monitoring and checking of responses, and perseveration when an error is made.

Further, both researchers concluded that a primary deficit in strategic processing is consistent with neurobiological models hypothesising frontostriatal dysfunction.

Summary

Wilson (1998) reported that although deficits in set-shifting, hyperattention and visuospatial construction have been found, these findings have not been replicated consistently. Also, despite the strong neurological evidence implicating the prefrontal cortex and basal ganglia in OCD, Cox (1997) found that traditional neuropsychological measures of these neural substrates were reduced only in participants with comorbid depression, obsessional slowness, many neurological soft signs, Tourette's syndrome and/or lower intellectual ability.

Methodological problems associated with small sample sizes, the use of heterogenous OCD samples and failure to control for medication status or comorbid disorders, in addition to the diverse experimental paradigms and stimuli used, are likely to have contributed to the confusing pattern of results. Therefore, replication of existing experimental procedures employing more stringent exclusion criteria may clarify the nature and extent of the neuropsychological impairments implicated in obsessive-compulsive checking. Additionally, several researchers have suggested that combining neuropsychological assessment with neuroimaging methods promises to delineate the pathobiology of OCD, and its subtypes, more precisely (e.g., Schultz et al., 1999; Wilson, 1998).

Impaired Memory Processes

Individuals who check excessively frequently report doubting their ability to recall accurately whether they have carried out a task adequately, if at all (Rachman & Shafran, 1998), even in the presence of decisive and normally doubt-reducing information (Tallis, 1997). Accordingly, several researchers have proposed that impairments in memory processes may be important in obsessive-compulsive checking.

Although a substantial body of research has examined verbal and implicit memory processes in OCD, inconsistent results have been found (Greisberg & McKay, 2003). In contrast, the neuropsychological literature has produced more robust findings with regard to visual memory deficits, namely impairments on a range of visual free recall and recognition tasks (e.g., Dirson, Bouvard, Cottraux & Martin, 1995; Tallis, Pratt & Jamani, 1999). Nevertheless, there are also several conflicting results in the literature (for reviews see Tallis, 1997; Woods, Vevea, Chambless & Bayen, 2002) as discussed previously. Consequently, several researchers have hypothesised that the observed memory deficits may be a manifestation of other higher order memory processes including memory for actions and reduced memory confidence. This research is critically examined in the following sections.

Impaired Memory for Actions

Sher, Frost and Otto (1983) proposed that compulsive checking might arise, in part, from poorer memory for actions. Other researchers have noted that this

hypothesis compliments clinical observations showing that checkers commonly express doubts about their memory of previous actions (Woods et al., 2002).

In a study designed to test whether memory disturbances were associated with compulsive checking, Sher et al. (1983) reported that high-checking students had poorer memory for actions compared with noncheckers and underestimated their performance on a reality-monitoring task. These impairments were not observed in nonclinical cleaners, indicating they were specific to checking behaviour. In a subsequent study, Sher, Mann and Frost (1984) found that more frequent checking behaviour in a student sample was related to poorer overall memory performance and there was a tendency for checkers to have poorer memory for actions. State anxiety or depression did not account for the lower memory performance. It should be noted however, that despite the finding of a lower memory performance in checkers, all experimental groups fell within the normal range. Thus, the conclusion of impaired memory performance in checkers in this study is tenuous.

In a final study Sher, Frost, Kushner, Crews & Alexander (1989), using a psychiatric outpatient sample, found that checkers again had an overall memory deficit in addition to impaired recall, but not recognition, for actions. Further the frequency of checking behaviour was negatively related to memory functioning, greater levels of general psychopathology and neuroticism.

Rubenstein, Peynircioglu, Chambless and Pigott (1993) obtained similar findings in a series of experiments involving the performance of actions in different modalities, and recall and recognition of cartoons and word-pair lists in 20

subclinical checking students compared with 20 healthy students. Overall, the results showed that high checking students remembered fewer actions and confused whether they had performed, observed or written a given action, making more errors of commission than the normal sample. The deficit appeared to be specific to the performance of the high checking students' own actions, with no impairments found on recall of cartoons or words.

Expanding on this research, Ecker and Engelkamp (1995) proposed that memory for actions impairments in OCD might be more specifically related to weaker motor or kinesthetic components than visual or verbal memory deficits. A study comparing memory for actions across four modalities, motor-encoding, motor-imaginal encoding, visual-imaginal encoding and sub-vocal encoding in 24 OCD checkers, 24 high checking controls and 48 low checking controls supported this hypothesis. Obsessive-compulsive checkers showed poorer free recall of self-performed actions that was not related to depression, state-anxiety, or measures of doubting, conscientiousness or washing, greater confusion regarding whether an item had been motorically or motoric-imaginally encoded and lower motor imagery ratings relative to the other groups. Performance on all other memory tests was essentially normal. Ecker and Engelkamp (1995) suggested that this pattern of results indicated a specific motor memory deficit relating to the performance of an individual's own actions in obsessive-compulsive checking.

Reduced Confidence in Memory

The finding of impaired memory for actions has been the most consistently demonstrated memory deficit in the OCD literature (Tallis, 1997). However,

clinical observations have indicated that individuals with checking concerns are prone to pathological doubt even in situations where memory ability is irrelevant (Tallis, 1997). Concurrently, a growing body of research has found evidence that reduced memory confidence, rather than memory deficits *per se,* characterises obsessive-compulsive checking.

McNally and Kohlbeck (1993) found evidence for this proposal in a study comparing reality monitoring, recognition and confidence in recognition, and imagery ability between 12 OCD checkers, 12 OCD noncheckers and 12 normal controls. The experiment required the participants to trace, imagine tracing or look at 60 items comprised of words or simple line drawings. No significant differences were found between the groups with regard to reality monitoring, recognition of items, errors of commission or perceived imagery ratings. Both OCD groups however, expressed significantly less confidence in their memories for the activities performed compared with the controls.

In a more recent study, Merckelbach and Wessel (2000) found further evidence for reduced confidence in memory in obsessive-compulsive checking. Nineteen OCD patients and 16 matched nonpatient controls were required to either imagine performing or actually perform an action they had read from a printed card. Regardless of their symptom profile, participants with OCD had slightly superior reality-monitoring ability but were far less confident about their correct identifications of actions compared with the control group (Merckelbach & Wessel, 2000).

Similarly, Zitterl, Urban, Linzmayer, Aigner, Demal, Semler, et al. (2001) found poorer nonverbal intermediate memory, reduced memory for visual sequences and significantly lower confidence in memory, despite similar memory vividness, desire for vividness and satisfaction of recall in 27 non-depressed OCD (predominantly checking) patients compared with 27 normal controls.

Reduced memory confidence has also been demonstrated using verbal stimuli. MacDonald, Antony, MacLeod and Richter (1997) assessed memory functioning in a group of 10 OCD checkers, 10 OCD noncheckers and 10 clinical controls using a word-list paradigm. In line with the findings of Zitterl et al. (2001) and Merckelbach and Wessel (2000), the OCD group generally underestimated their memory abilities despite the absence of any memory impairments.

Dar, Rish, Hermesh, Taub and Fux (2000) demonstrated that reduced confidence in OCD might not be restricted to memory judgements in a study comparing 20 OCD checkers, 29 Panic Disorder noncheckers and 23 matched healthy controls on a 100-item, two-alternative, general knowledge questionnaire. Obsessive-compulsive checkers reported significantly lower confidence in their answers than the control group, in spite of normal memory performance, and confidence was inversely related to the severity of their obsessions.

In an attempt to integrate the findings of increased desire for memory vividness and reduced memory confidence, van den Hout and Kindt (2003) proposed that repeated checking might decrease memory vividness, and consequently, reduce confidence due to increased stimulus familiarity. To test this theory, 20 trials of a

computer animated checking sequence with either gas rings or light bulbs were presented to healthy participants in a series of three experiments. Ratings of checking accuracy and memory vividness, detail, confidence and confidence in the outcome of checking were obtained. As predicted, manipulating healthy participants to engage in OCD-like checking behaviour was found to reduce memory vividness and detail but did not change memory accuracy (van den Hout & Kindt, 2003).

Tolin, Abramowitz, Brigidi, Amir, Street and Foa (2001) also demonstrated a decrease in memory confidence associated with repeated exposure. Fourteen OCD participants were compared with 14 anxious controls and 14 non-anxious controls over six trials involving exposure to 78 items deemed safe, unsafe or neutral by the OCD group. The participants were required to recall as many objects as possible and rate their confidence in each memory for each trial. The results replicated the findings of van den Hout and Kindt (2003) showing no deficit in memory accuracy but a progressive decline in memory confidence over the trials in the OCD group.

Not all studies are in agreement with the reduced memory confidence hypothesis however. Constans, Foa, Franklin and Mathews (1995) found no difference in memory confidence ratings between 12 OCD checkers and seven controls in a task that assessed memory for actions by asking participants to either imagine or perform a sequence of actions with 20 anxiety provoking or neutral objects. Further, the checking group had superior recall of their last actions that appeared to be enhanced by higher anxiety levels. However, the checking group reported

higher levels of desired memory vividness compared to the control group. Constans et al. (1995) concluded that this factor, in combination with cognitive variables, such as anticipated disaster and an exaggerated sense of responsibility precipitates repeated checking.

Summary

A number of different memory phenomena have been studied in recent years in OCD, including various visual memory deficits, memory for actions and memory confidence. Tallis (1997) in a review of the literature concluded that there was a growing body of evidence in support of memory impairments in obsessive-compulsive checking. In general, a convergence of research suggests that obsessive-compulsive checking may be mediated, at least in part, by deficits in immediate and delayed visual recall and recognition, impaired visual and motoric memory for actions, increased desire for memory vividness and reduced confidence in memory. It should be noted however, that these conclusions are made on the basis of the results from studies generally employing mixed OCD symptom groups.

Nevertheless, support for these phenomena in relation to obsessive-compulsive checking has been found. Woods et al. (2002), in a meta-analysis of 22 studies incorporating 794 participants (341 with primary checking concerns), found that checkers had poorer performance than non-checkers on explicit memory tasks presumed to assess short-term memory. Impairments in episodic long-term memory tasks including free recall, cued recall and recognition were also found.

The largest effect sizes were obtained for recall of actions (0.71) and confidence in recognition (0.92).

However, the small to medium effect sizes found overall prompted Woods et al. (2002) to suggest that although a memory impairment might be moderately related to checking, it does not completely account for it. That is, the memory impairment in OCD may be secondary to higher meta-cognitive functions. Tallis et al. (1999), whilst also advising caution in attributing causality, state that the failure to establish significant correlations may instead be due to other methodological limitations. These limitations will be examined following a review of the cognitive research.

The Role of Cognitive Appraisals in OCD

Although memory impairments are likely to play a role in obsessive-compulsive checking, only modest correlations between memory deficits and OCD symptoms have been found (e.g., Woods et al., 2002). Further, these impairments do not sufficiently account for the restricted range of obsessions and compulsions observed in OCD (Tallis, 1997). Consequently, several researchers have suggested that cognitive processes are also likely to be involved in the emergence and maintenance of checking behaviour.

A convergence of findings suggests that cognitions regarding inflated personal responsibility, over-estimation of threat, intolerance to uncertainty, excessive thought control or over-importance of thoughts and thought-action fusion are

important in the maintenance of OCD (Obsessive-Compulsive Cognitions Working Group, (OCCWG) 1997; Rachman & Shafran, 1998; Steketee, Frost & Cohen, 1998). However, relatively little research has been conducted with regard to the role of thought control in obsessive-compulsive checking and the literature on thought-action fusion suggests that this variable may be more important in cases of obsessional impulses (Rassin et al., 2000; Shafran, Thordarson & Rachman, 1996). Accordingly, this review provides a critique of the research investigating over-estimation of threat, inflated personal responsibility and intolerance to uncertainty.

Exaggerated Threat Appraisal

Based on Lazarus' (1966 as cited in Carr, 1974) concept of 'threat appraisal' Carr (1974) proposed that the development of highly circumscribed compulsions in OCD is the result of an interaction between high subjective probability estimates and situation-specific cost estimates of the perceived outcome. That is, individuals with OCD are believed to exaggerate both the likelihood of an aversive outcome (e.g., fire) and the cost of the possible outcome (e.g., loss of home) relative to other individuals.

McFall and Wollersheim (1979) expanded this theory by integrating cognitive-behavioural concepts, such as Beck's cognitive model of anxiety (e.g., Beck, Laude & Bohnert, 1974) and identifying a role for irrational beliefs. The researchers proposed that a primary appraisal process, characterised by several irrational beliefs (i.e., the need to be perfect, mistakes should be punished, certain thoughts and feelings are unacceptable and individuals can initiate or prevent the

occurrence of disastrous outcomes) produces increased anxiety. A secondary underestimation of available coping resources then occurs. Feelings of loss of control, uncertainty and further anxiety result, and lead to the obsessions and compulsions that distinguish the disorder (McFall & Wollersheim, 1979).

Indirect support for overestimation of threat models has been derived from studies showing that compared with controls, individuals with OCD have a history of parental overprotection (Frost, Steketee, Cohn & Griess, 1994), engage in less risk-taking behaviour (e.g., Steiner, 1972) and readily identify themes of danger in everyday situations (Menzies, Harris, Cumming & Einstein, 2000). Despite the strong theoretical support for the model, few empirical studies have examined the role of exaggerated threat estimations in OCD (Steketee et al., 1998), and fewer still have investigated these beliefs in obsessive-compulsive checking.

Nevertheless, a study by Overton and Menzies (2002) provided support for a primary role of danger expectancies in a sample of OCD checkers. Ratings of perceived probability and cost of danger, thought-action fusion, confidence in memory, intolerance to uncertainty and need to control thoughts in relation to their most prominent individual checking concerns were compared between 21 OCD checkers and 21 control participants. While there were no significant differences between the groups with regard to perceived personal responsibility, thought-action fusion and confidence in memory, OCD checking participants endorsed significantly higher ratings of probability and cost of danger, intolerance of uncertainty and need to control thoughts compared to controls.

Despite these positive findings, models emphasising a crucial role of exaggerated threat appraisal in OCD have been criticised on the basis that they may not adequately distinguish the disorder from other anxiety conditions (e.g., Rhéaume, Ladouceur, Freeston & Letarte, 1995). As a consequence, several researchers have proposed that beliefs relating to perceived responsibility may have a more pivotal role in obsessive-compulsive checking.

Inflated Personal Responsibility

Rachman (1976) observed that most checking rituals occur predominantly in the individual's home, are carried out when the person is alone and intensify when the person is depressed or feels responsible for the act concerned. On the basis of these observations, Rachman (1976) suggested that the intensity of obsessive-compulsive behaviours might be reduced if responsibility for aversive outcomes was lessened.

Subsequently, Salkovskis (1985, 1989) inspired by Beck's cognitive model of depression (Beck, Epstein & Harrison, 1983), proposed that obsessions are intrusive cognitions that elicit '*negative automatic thoughts*' about personal responsibility. The negative automatic thoughts in turn are believed to trigger compulsions or rituals to neutralise the associated discomfort and perceived harmful consequences that result from the negative appraisal process. As a result of this neutralising, intrusive cognitions become more salient and frequent and elicit greater discomfort, thereby increasing the likelihood of further neutralising attempts or compulsions (Salkovskis, 1985, 1989).

Numerous researchers have provided support for the mediating role of responsibility in obsessive-compulsive checking. For example, Rachman (1993) reported that compulsive checkers do not display obsessive-compulsive symptoms when first admitted to hospital, presumably due to not feeling responsible for the foreign environment. Additionally, pilot cognitive treatments targeting the correction of inflated responsibility beliefs have been successful in producing significant symptom relief in OCD checking (e.g., Ladouceur et al., 1996).

Experimental research has also supported a role for inflated personal responsibility in obsessive-compulsive checking. Lopakta and Rachman (1995) compared ratings of perceived responsibility, discomfort, urge to check, probability and severity of anticipated harm, estimated length of time to complete checking, perceived panic, and likelihood, timing and severity of perceived criticism in 30 OCD checkers across four individually tailored behavioural avoidance tests: high responsibility, low responsibility, control check and control clean. Relative to the control groups, the high and low groups reported significantly higher and lower ratings of responsibility respectively, indicating the manipulation was successful. Additionally, the low responsibility group reported significantly lower discomfort, urge to check, length of time needed to check and probability of harm than the control group.

Lopakta and Rachman (1995) concluded that experimentally decreasing perceived responsibility leads to significant reductions in discomfort and urges to carry out compulsive checking. However, it should be noted that increasing responsibility did not alter these ratings in the high group.

Foa, Sacks, Tolin, Prezworski and Amir (2002) compared ratings of urge to rectify situations, anticipated relief and perceived responsibility from the *Obsessive Compulsive Responsibility Scale* (OCRS) (Foa, Amir, Bogert, Molnar & Przeworski, 2001) among 22 OCD checkers, 24 OCD noncheckers and 25 non-anxious controls. The OCD checkers reported significantly greater urges to rectify situations, relief upon rectifying situations and perceived responsibility for low and moderate risk scenarios compared to the control group. Additionally, OCD checkers, but not noncheckers, rated their urge to rectify and relief significantly higher than controls for the low and moderate risk items, and responsibility significantly higher for the moderate risk category. Foa et al. (2002) believed these results supported Rachman's (1993) proposal that responsibility concerns are more strongly associated with checking compared with other compulsions.

Not all research supports the inflated personal responsibility hypothesis of OCD however. Emmelkamp and Aardema (1999) reported that inflated responsibility did not account for the variance in obsessive-compulsive behaviour in many of the Padua Inventory-Revised (van Oppen, Hoekstra & Emmelkamp, 1995) subscales. Additionally, Wells (1997) suggested that responsibility appraisal is an emergent property of meta-cognitive processing and a marker for dysfunctional beliefs about the danger and influences of thought that are more central to OCD.

A similar conclusion was reached by Menzies et al. (2000) in a study that manipulated responsibility on a questionnaire requiring participants to rate the likelihood and severity of potential outcomes of checking and washing situations

on 100-point visual analogue scales. Increasing perceptions of personal responsibility in healthy participants led to an increase in subjective cost and severity of danger ratings. Menzies et al. (2000) concluded that, while responsibility concerns do play a role in OCD, they operate through an indirect effect on danger estimates.

Intolerance for Uncertainty

In contrast to models proposing exaggerated threat appraisal or inflated personal responsibility, several researchers have observed that intolerance for uncertainty and indecision are the defining cognitive features of OCD (Steketee et al., 1998). Beech and Liddell (1974; as cited in Steketee et al., 1998) proposed that ritualistic behaviours, such as checking, are maintained to address the need for certainty before terminating an activity, in addition to reducing immediate discomfort.

Initial support for the intolerance for uncertainty hypothesis came from studies indicating that individuals with OCD are more cautious, take longer to categorise objects, and more frequently request information to be repeated than nonclinical groups (e.g., Frost, Lahart, Dugas & Sher, 1988). Empirical studies have subsequently provided further support for the intolerance to uncertainty hypothesis.

Steketee et al. (1998) compared 62 mixed OCD individuals, 45 other anxiety disorder patients and 34 matched controls on the 90-item *Obsessive Compulsive Beliefs Questionnaire* that measures the strength of beliefs of responsibility for harm, need to control thoughts, intolerance for uncertainty, overestimation of

threat, discomfort/anxiety and coping. The OCD group had significantly higher scores on all belief domains compared with the other groups. The anxiety disorder group also reported significantly higher ratings than controls for intolerance for uncertainty, intolerance for anxiety and beliefs about coping suggesting that these features are not specific to OCD, but characterize anxiety disorders in general. However, regression analyses on the collapsed data of both clinical groups found that when anxiety belief items were held constant, only intolerance for uncertainty explained the variance among OCD symptom scores.

In contrast, Mancini, D'Olimpio, Del Genio, Didonna and Prunetti (2002) reported that intolerance for uncertainty could not be considered a strong predictor of obsessive-compulsive symptoms. Intolerance for uncertainty (defined as "need for cognitive closure") was investigated in a principal components analysis of Depression, Anxiety, OCD symptoms and Need for Cognitive Closure subscales in a sample of 144 community volunteers. Although a three-factor solution emerged, interpreted as representing "general distress", "need for closure", and "obsessions and compulsions", a series of hierarchical multiple regression analyses showed that the need for cognitive closure was not a strong predictor of obsessions or compulsions as measured by the Padua Inventory – Revised (van Oppen et al., 1995). Mancini et al. (2002) concluded that intolerance for uncertainty therefore does not have a central role in OCD but appears to subserve other specific meta-cognitive beliefs.

Summary

A large number of cognitive variables have been suggested as being important in the development and maintenance of OCD. Exaggerated threat appraisal, inflated personal responsibility and intolerance for uncertainty appear to be among the more robust findings obtained to date. However, considerable disagreement exists in the literature as to the relative importance of these cognitive factors in the maintenance of obsessive-compulsive symptoms (Purdon & Clark, 1994). Further, the theoretical and experimental literature, whilst consistently identifying these cognitive variables, has not been able to integrate them into a meaningful model of checking behaviour. This may be largely due to the absence of well-controlled empirical studies.

Additionally, despite the strong evidence in favour of at least partially distinct aetiologies between the various OCD subtypes (e.g., Matsunaga et al., 2001; Overton & Menzies, 2002; Phillips et al., 2000; Wilson, 1998), few studies have directly examined these cognitive variables solely in relation to obsessive-compulsive checking. Therefore, while it seems likely that inflated personal responsibility, exaggerated threat appraisal and intolerance for uncertainty all play a significant role in obsessive-compulsive checking, only tentative conclusions can be made at this time with regard to whether these variables distinguish checking from other OCD subtypes.

Conclusions and Suggestions for Future Research

Substantial progress regarding the likely causes of obsessive-compulsive checking has been made over the last few decades. In particular, there is growing evidence suggesting that cognitive and memory factors play a critical role in the aetiology of OCD.

With regard to memory processes, although visual deficits have been reported reasonably consistently, recent findings suggest impairments in memory for actions or reality monitoring and reduced confidence in memory may be more important in obsessive-compulsive checking. Such findings are in line with neurobiological accounts of OCD, proposing a role of dysfunctional frontostriatal and basal ganglia networks (Tallis, 1997).

However, memory deficit theories predict impairment across a broad range of memory functions, whereas the checking behaviours evident in OCD are highly circumscribed (Summerfeldt & Endler, 1998). Further, few studies have found correlations between the observed memory impairments and OCD symptom severity. A causal relationship cannot therefore be implied. Additionally, whilst checkers have been shown to be impaired relative to non-checking controls on standardised memory batteries, the memory impairments have rarely fallen outside the 'normal' range (e.g. Sher et al., 1984).

Metacognitive factors are therefore also likely to be important in obsessive-compulsive checking (Tallis, 1997). In particular, there is increasing support for a role for exaggerated threat appraisal, inflated personal responsibility and

intolerance for uncertainty in the literature. However, the exact mechanisms by which these cognitive variables exert their effects on memory processes, and ultimately checking behaviour, are far from clear.

Therefore, despite the insights research into cognitive and memory processes has afforded in recent years, a successful integration of the findings has not yet been accomplished (Wilson, 1998). An inability to consistently replicate findings across studies has been cited as the major impediment to a more complete understanding of OCD. Methodological flaws associated with the various investigations into obsessive-compulsive checking are partially to blame.

The OCCWG (1997) concluded that heterogeneity in the content of obsessional concerns (i.e., mixed symptom profiles) has been the chief impediment in research into the cognitive biases of OCD. Similar concerns have plagued the neurobiological and neuropsychological research. As previously discussed, there is an emerging literature suggesting that the different subtypes of OCD may have at least partially distinct aetiologies (e.g., Minichiello et al., 1990; Overton & Menzies, 2002; Phillips et al., 2000; Wilson, 1998). Investigations carefully examining differences between the OCD subtypes would therefore be beneficial in elucidating the common and subtype-specific developmental factors, neural circuits and cognitive and memory dysfunctions involved in OCD.

Methodological constraints associated with studying a clinical population have also contributed to the lack of understanding regarding the cognitive factors and memory phenomena underlying obsessive-compulsive checking (Salkovskis &

Harrison, 1984). In addition to small sample sizes, many studies failed to screen for, or assess the impact of, anxiety, depression and other comorbid disorders, and medication or treatment status among their samples of OCD checkers. Further, very few studies included psychiatric controls, making interpretations regarding the specificity of findings to obsessive-compulsive checking tenuous.

It is conceivable that the memory deficits and cognitive variables observed in obsessive-compulsive checking are merely a function of anxiety or depression and may therefore be common to a number of disorders. The inclusion of individuals with anxiety disorders other than OCD who have similarly high levels of anxiety and depression, is a potential solution to this problem (Dar et al., 2000). Alternatively, statistical methods may assist in determining whether memory impairments and cognitive biases remain once the influence of anxiety and depression are eliminated.

The use of both clinical and nonclinical checking samples has been frequently cited in the literature as limiting progress in understanding the development of checking behaviours. Several researchers have questioned the generalisability of results obtained from arbitrarily assigned subclinical analogues with varying levels of symptom severity to the psychopathology underlying OCD (e.g., Simonds & Elliot, 2001; Tallis et al., 1999). The stability of symptoms in subclinical samples has also been questioned. However, similar clinical and personality profiles have been found among participants with a wide range of scores above the mean on OCD symptom inventories (e.g., Mataix-Cols et al., 2000). Support for long-term symptom stability has also been reported (e.g.,

Burns et al., 1995; Morris et al., 2000). Nevertheless, it would be prudent for future investigations using subclinical and clinical samples to consistently employ the same stringent selection criteria, with discrete and narrowly defined symptom levels that assess for the presence of OCD and examine the duration of symptoms.

Finally, providing standardised, ecologically valid stimuli has proven to be a barrier to developing a more complete understanding of obsessive-compulsive checking. Research investigating memory processes in OCD has generally relied on extrapolating the results obtained from highly structured memory batteries, simple laboratory performance tasks, or recall of verbal stimuli that are not directly related to checking (Woods et al., 2002). Similar criticisms can be applied to the stimuli used in the cognitive biases research. As previously discussed, checking behaviours are most likely to be elicited when an individual feels personally responsible (or perhaps some other cognitive variable) and presumes that a poor outcome may result from an incompetent performance (Sher et al., 1984; McNally & Kohlbeck, 1993).

It is therefore highly possible that the emotionally neutral and non-specific experimental materials used in many of the investigations examined in this review may not have been sufficiently realistic to induce the necessary anxiety needed to elicit the cognitive distortions or memory dysfunctions maintaining OCD (Woods et al., 2002). Individuals with OCD may show greater impairments in more realistic situations compared with the simple performance tasks in the laboratory (McNally & Kohlbeck, 1993). A suitable experimental paradigm for eliciting

checking behaviour in the laboratory is therefore a worthwhile goal for future research.

In conclusion, despite the methodological flaws of many of the studies in this field, there appears to be a convergence of findings suggesting both cognitive and memory dysfunction may be important in obsessive-compulsive checking. More specifically, poorer memory for self-performed actions and reduced confidence in memory, in addition to dysfunctional appraisals concerning personal responsibility and threat estimation are likely to be involved. However, further replication of the results is clearly needed. Additionally, research examining both cognitive and memory factors in obsessive-compulsive checking with ecologically valid stimuli is required as such findings have important implications for the revision of current models of OCD.

The development of a theoretical framework of obsessive-compulsive checking that accounts for these variables and explains the relationships between them would allow for the development of more effective treatment techniques. For example, cognitive techniques designed to enhance visual memory or memory for actions through the use of more efficient encoding and retrieval strategies or to correct dysfunctional appraisal processes may be effective in the treatment of the disorder (Dirson et al., 1995; McFall & Wollersheim, 1979; Savage et al., 2000; Woods et al., 2002; Zitterl et al., 2001). Pilot treatments along these lines have already shown some promise (e.g., Jones & Menzies, 1997).

Finally, future research investigating the cognitive and memory factors underlying obsessive-compulsive checking may provide further evidence for aetiological differences between subtypes. Clearly, this would have important implications for the present DSM-IV (APA, 1994) classification that considers the heterogenous subtypes of OCD to be variants of a single, Axis I Anxiety Disorder.

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Empirical Study

Cognitive and Memory Processes in Non-clinical Checking

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Table of Contents

Abstract

Few studies have examined the cognitive and memory deficits proposed to underlie obsessive-compulsive checking using ecologically valid stimuli. This issue was addressed by obtaining ratings of perceived responsibility, likelihood and cost of danger, intolerance for uncertainty and memory accuracy, confidence and certainty in relation to video clips depicting typical checking activities from 25 Low and 24 High non-clinical checking participants. Despite equivalent auditory and spatial working memory performance, High checkers were significantly less accurate on the checking task. This was not attributable to higher levels of anxiety or depression. High checkers also rated the cost of danger as being significantly greater despite identifying similar aversive outcomes and probability ratings and reported significantly higher levels of personal responsibility and intolerance for uncertainty. However, anxiety and depression moderated these differences. These findings have important implications for models of obsessive-compulsive checking. It is suggested that cognitive appraisals, such as high severity of danger estimates, may interfere with the processing of threat information, resulting in the observed memory for actions deficit in obsessive-compulsive checking. The use of salient checking stimuli in future research will provide a more valid method for examining such processes.

Despite being first recognised as a disorder in the psychiatric literature as early as 1838 (Jenike, 1995), and extensively researched since that time, the aetiological determinants of Obsessive-Compulsive Disorder (OCD) are not fully understood. Diverse areas of research including neurobiological (for reviews see Micallef & Blin, 2001; Saxena, Brody, Schwarzt & Baxter, 1998), genetic (e.g., Heteema, Neale & Kendle, 2001; Pato, Pato & Pauls, 2002; Thomsen, 1997) and neuropsychological studies (for reviews see Cox, 1997; Greisberg & McKay, 2003; Tallis, 1997; Wilson, 1998), have made significant contributions in furthering our understanding of the disorder. However, models exploring cognitive factors and impaired memory functioning have perhaps shown the most promise in explaining the development and maintenance of obsessive-compulsive checking to date.

Carr (1974) is credited with developing the first cognitive model of OCD, postulating that individuals make abnormally high subjective estimates of both the probability and "cost" of aversive outcomes related to having an obsession. Compulsive behaviours were proposed to develop as threat-reducing activities that acted to lower the probability and/or cost of the unfavourable outcome. McFall and Wollersheim (1979) extended on this model suggesting that the overestimation of threat arose from a combination of irrational beliefs and underestimation of available coping resources. They proposed that this appraisal process led to feelings of loss of control, uncertainty and anxiety that in turn triggered the obsessions and compulsions that distinguish the disorder (McFall & Wollersheim, 1979). More recently, the cognitive model of obsessional thinking has been conceptualised as an equation, specifying that anxiety arises due to the

multiplicative effects of perceived probability and cost of threat, divided by perceived ability to cope and perceived 'rescue' factors (Beck, Emery & Greenberg, 1985; Salkovskis, Forrester & Richards, 1998).

Investigations in both clinical and non-clinical samples conducted by Menzies and colleagues have provided support for the mediating role of expectations of potential threat in the aetiology of OCD. For example, Jones and Menzies (1997) found large and significant relationships between danger expectancies and obsessive-compulsive symptoms but not for other cognitive mediators in obsessive-compulsive washers. Similarly, a study comparing the role of potential cognitive mediators in a sample of obsessive-compulsive checkers and matched non-clinical controls provided further evidence for the role of beliefs concerning the probability and severity of harm in OCD (Overton & Menzies, 2002).

However, cognitive models emphasising dysfunctional danger appraisal processes in OCD have been criticised for being unable to adequately distinguish individuals with OCD from other clinical groups (Obsessive-Compulsive Cognitions Working Group (OCCWG), 1997). That is, overestimation of the likelihood and severity of harm appears to be common to many anxiety disorders (Salkovskis, 1985). Consequently, some researchers have suggested that beliefs concerning personal responsibility may play a more central role in the aetiology and maintenance of OCD.

Salkovskis' (1985, 1989) influential model proposed that obsessions elicit '*negative automatic thoughts*' concerning personal responsibility that in turn

trigger compulsions or rituals to neutralise the associated discomfort and perceived harmful consequences. Numerous researchers have provided support for this model. Rachman (1993) reported that compulsive checkers do not display symptoms when first admitted to hospital, presumably due to the foreign environment not providing salient triggers for responsibility concerns. Further, experimentally manipulating perceived responsibility has produced corresponding changes in discomfort and urge to carry out compulsive checking in several studies (e.g., Foa, Sacks, Tolin, Prezworski & Amir, 2002; Lopakta & Rachman, 1995; Rhéume, Ladoucer, Freeston & Letarte, 1995). Finally, clinically significant reductions in obsessive-compulsive checking symptoms and perceived responsibility that were maintained at 6- and 12-month follow-up have been reported following a treatment specifically targeting inflated responsibility (Ladoucer, Léger, Rhéaume, & Dubé, 1996).

Although a role for inflated personal responsibility in OCD is well supported in the literature, not all research is in favour of it being the central cognitive mediator underlying OCD. For example, Emmelkamp and Aardema (1999) found that ratings of inflated personal responsibility did not account for variance in scores of obsessive-compulsive symptoms. Additionally, some researchers have found evidence to suggest that inflated personal responsibility operates indirectly through danger expectancies (Menzies, Harris, Cumming & Einstein, 2000; Wells, 1997).

In addition to cognitions concerning exaggerated threat appraisal and inflated personal responsibility, some support is emerging in favour of a role for

intolerance for uncertainty in OCD. Steketee, Frost and Cohen (1998) reported that of several cognitive variables, including threat estimation, intolerance for uncertainty alone explained the variance among OCD symptom scores once anxiety beliefs were held constant. However, Mancini, D'Olimpio, Del Genio, Didonna and Prunetti (2002) reported conflicting results. In a series of hierarchical multiple regression analyses, which incorporated depression and anxiety level, the researchers did not find strong evidence for a significant relationship between measures of intolerance for uncertainty and checking symptoms. It was concluded that intolerance for uncertainty appears to subserve more specific meta-cognitions, rather than having a central role in OCD.

A number of diverse memory phenomena have been suggested as being aetiologically important in both the development and maintenance of obsessive-compulsive behaviours and may explain some of the anomalies reported in the cognitive literature. Sher, Frost and Otto (1983) hypothesised that compulsive checkers are characterised by poorer memory for actions and deficits in '*reality monitoring*', the ability to determine real from imagined events, compared with their peers.

Sher, Mann and Frost (1984) found evidence for impaired memory for actions and reality monitoring in non-clinical checkers in an experiment involving the participants' recollection of cognitive tasks performed. A number of researchers have replicated these findings in both clinical and non-clinical samples (e.g., Ecker & Engelkamp, 1995; Rubenstein, Peynircioglu, Chambless, & Pigott, 1993; Tallis, Pratt & Jamani, 1999; Zitterl, Urban, Linzmayer, Aigner, Demal, Semler,

et al., 2001). Additionally Sher, Frost, Kushner, Crews and Alexander (1989) reported that the frequency of checking behaviour was negatively related to memory functioning in a clinical sample. However, although impaired memory for actions appears to be the most consistently demonstrated deficit in the literature (see Tallis, 1997 for a review), several studies have failed to support these findings.

McNally and Kohlbeck (1993) found no evidence of deficits in memory or reality monitoring ability, but reduced confidence in memory for actions, in a sample of obsessive-compulsive checkers compared with control participants. As a result of these findings, it was proposed that the memory dysfunction in OCD might arise from poorer confidence in memory rather than an actual memory deficit. This hypothesis has received support from a number of researchers (e.g., Constans, Foa, Franklin & Mathews, 1995; Dar, Rish, Hermesh, Taub & Fux, 2000; MacDonald, Antony, MacLeod & Richter, 1997; Merckelbach & Wessel, 2000; Tolin, Abramowitz, Brigidi, Amir, Street & Foa, 2001; van den Hout & Kindt, 2003; Zitterl et al., 2001).

Clearly, a diverse array of cognitive and memory factors have been proposed to underlie OCD. However it is also apparent that researchers are yet to reach agreement as to the relative contributions of each of the proposed factors, or the mechanisms by which they interact. The lack of understanding concerning the processes contributing to OCD may be partly attributable to methodological constraints associated with providing salient stimuli in a laboratory setting (Woods, Vevea, Chambless & Bayen, 2002).

Previous research has also been criticised for failing to control for, or assess the influence of, anxiety, depression and other psychological conditions on the performance of memory tasks or in relation to cognitive appraisals for obsessive-compulsive checking. It is possible then, that the poorer memory performance and confidence documented for individuals with OCD, or differences in cognitive appraisal processes, may be attributable to more general effects of emotional state.

Many studies investigating cognitive and memory processes in OCD have used self-report or belief measures, recall of verbally presented material, or general neuropsychological batteries in the absence of ecologically valid checking stimuli. It is likely that such measures may not be sufficient to engage the cognitive and memory processes thought to underlie OCD (Woods et al., 2002). Frost, Sher and Geen (1986) suggest that attempts to construct laboratory simulations of checking behaviour should draw on predominant life activities that involve some important personal consequence.

This study aims to further the research into cognitive and memory processes among individuals engaging in high levels of checking behaviour. Methodological issues associated with inappropriate stimuli used in other studies will be addressed by providing video footage of an individual engaging with salient obsessive-compulsive checking stimuli such as electrical appliances, door and car locks and taps. The potential influence of anxiety and depression will also be addressed through statistical analyses.

In order to measure accuracy of recall, High and Low checking undergraduate participants will be required to indicate whether the stimulus presented in each of the scenarios was either OFF (the stimulus is clearly shown to be turned off or locked), ON (the stimulus is clearly left on or unlocked) or UNSEEN (it is not clear whether the stimulus is turned off/locked or on/unlocked). This last condition is designed to differentiate between false reporting or guessing and inaccurate recall and to determine the extent to which ambiguity (intolerance for uncertainty) affects memory. For each stimulus, the participants will also be required to rate the probability and likelihood of aversive outcomes, personal responsibility and desire to check and discomfort associated with not checking (intolerance for uncertainty) in relation to each of the scenarios. Additionally, participants will be asked to provide ratings of memory certainty and confidence for each of the scenes and complete assessments of their general intellectual ability and working and spatial memory.

In line with research suggesting a central role of threat appraisal in OCD, it is predicted that High checking participants will report greater overall likelihood and cost of danger ratings relative to low checking participants. High checking participants are also expected to report greater overall personal responsibility and intolerance for uncertainty compared with low checking participants. With regard to memory processes, it is hypothesised that high checking participants will have poorer memory for actions and report lower confidence and certainty in memory compared with low checking students.

Method

Participants

Participants were recruited from a pool of undergraduate *Psychology 1* students from the *University of Tasmania* who were screened for subclinical obsessive-compulsive checking symptoms as measured by the *Padua Inventory – Revised* (PI-R) (Burns, Keortge, Formea & Sternberger, 1996). From this sample, 334 questionnaires were returned, of which 315 were correctly completed. Students scoring the highest and lowest *Checking* subscale scores were invited to participate in the study.

Following exclusion of participants reporting current, untreated psychological conditions, 24 High (mean score = 17.67, SD = 4.59; range = 13-29) and 25 Low (mean = 1.00, SD = 1.08; range = 0-2) scoring students completed the study. The High checking group consisted of six males and 18 females with a mean age of 20.00 years (SD=2.93) and the Low group was comprised of six males and 19 females with a mean age of 22.52 years (SD=6.27). A one-way between groups ANOVA indicated the groups did not differ in terms of age.

Materials

Participants were assessed with the following measures:

Padua Inventory-Revised (PI-R) (Burns et al., 1996). This 39-item self-report measure of obsessive and compulsive symptoms provides scores on five main factors: impulses, washing, checking, rumination and precision. Items are

rated on a five-point scale from 0 (not at all) to 4 (very much). The *Checking* subscale is comprised of ten items, with a maximum possible score of 40. The inventory is reported to have adequate reliability and validity and distinguishes between obsessions and worry (Burns et al., 1996).

Beck Depression Inventory - II (BDI -II) (Beck, Steer & Brown, 1996). This 21-item self-report inventory measures the severity of cognitive, affective, somatic and motoric symptoms of depression. The items are rated on a four-point scale from 0 (symptom-free) to 3 (high symptom level) over the past two weeks with a maximum total score of 63. A score of 26 or above indicates severe depression (Beck et al., 1996). The BDI is the most widely used assessment instrument for depression in clinical and normal populations and has been shown to have good psychometric properties (e.g., Dozois, Dobson & Ahnberg, 1998; Steer & Clark, 1997; Whisman, Perez & Ramel, 2000).

Beck Anxiety Inventory (BAI) (Beck & Steer, 1990). This 21-item self-report inventory measures the degree and level of discomfort of common physiological and cognitive symptoms of anxiety. Items are rated on a four-point scale from 0 ("not at all") to 3 ("severely") over the past week with a total maximum score of 63. A score of 30 or above indicates severe anxiety. The BAI has been established as being a reliable and valid measure of anxiety that has good psychometric properties (Creamer, Foran & Bell, 1995; Fydrich, Dowdall & Chambless, 1992).

National Adult Reading Test (NART) (Nelson, 1982). This test comprises a list of 50 irregular increasingly difficult words that the participant is required to read aloud. Since verbal ability correlates highly with intellectual ability, the NART is widely used as a screening measure of pre-morbid intellectual functioning (Lezak, 1995). Numerous studies have provided support for the factor-structure and predictive ability of this measure (e.g., Bright, Jaldow & Kopelman, 2002; Crawford, Deary, Starr & Whalley, 2001).

Weschler Adult Intelligence Scale –III (WAIS-III) (Weschler, 1997a) – *Digit Span* subtest. The Digit Span subtest of the WAIS-III is designed to provide an indication of short-term auditory memory, including working memory and attention. Psychometric research supports the reliability and validity of this subtest (The Psychological Corporation, 1997).

Weschler Memory Scale – Third Edition (WMS-III) (Weschler, 1997b) – *Spatial Span* subtest. This subtest is designed to assess immediate visual memory for spatial sequences and has been used in psychological research to provide a measure of memory for actions. The reliability and validity of this subtest is well-supported (The Psychological Corporation, 1997).

Checking Program (Appendix A). A series of video clips of between 5-12 seconds duration relating to common obsessive-compulsive checking stimuli such as doors, appliances and taps were presented individually to participants on a PC, with questions relating to the proposed cognitive and memory factors following each stimulus presentation. Two sets of 15 video clips were created in order to

control for potential differences among the stimuli. Set 1 consisted of scenes depicting a person closing a car door, closing a front door, and turning off a kitchen tap, heater and stove. The stimuli in Set 2 were matched to those of Set 1 and consisted of scenes showing a person closing a car boot, closing a back door, and turning off a bathroom tap, iron and oven.

There were three conditions for each scene: 1) OFF: the stimulus was clearly turned off or locked, 2) UNSEEN: an ambiguous condition that did not indicate whether the stimulus had been turned off or locked, and 3) ON: the stimulus was clearly left on or unlocked. The sequence of presentations for each stimulus condition within each set was randomised to control for ordering effects. Participants within the High and Low Checking groups were randomly allocated to either Set 1 or 2.

Cognitive Mediators and Memory Questions consisted of nine questions designed to elicit some of the cognitive and memory factors proposed to underlie checking behaviour. These questions were presented in random order after each stimulus presentation.

The participants were instructed to watch each video scene carefully and then answer the questions that followed as accurately as possible. For the cognitive mediators questions, participants were instructed to imagine that they were the person in the film clip and to rate their responses accordingly. The responses to each question were automatically recorded in an individual data file (Appendix A).

Table 1 presents these questions and the range of participant response allowed.

Table 1. Proposed cognitive mediators and memory phenomena in obsessive-compulsive checking and the corresponding checking program questions.

Cognitive Mediators and Memory Questions	
Memory Accuracy	**1.** Was the (stimulus) Off, On, Unsure?
Discomfort (Intolerance for Uncertainty)	**2.** How uncomfortable would you feel if you were not sure the (stimulus) was off/locked? (0 "fine" – 100 "completely uncomfortable")?
Cost and Probability of Danger	**3a.** What is the worst thing that could happen as a result of not checking? (Open Question)
	3b. How bad would that be? (0 "not bad" – 100 "unbearable")?
	3c. What is the probability of that happening? (%)
Personal Responsibility	**3d.** How personally responsible would you feel if (worst event) happened? (0 "not at all"-100 "totally")
Memory Certainty	**4.** How certain are you that the (stimulus) was locked/off? (0 "not at all"-100 "totally")
Confidence in memory	**5.** How confident are you that your memory is correct? (0 "not at all"-100 "totally")
Desire to check (Intolerance for Uncertainty)	**6.** How much would you like to be able to check? (0 "not at all" – 100 "totally")

Procedure

This research was conducted in the *School of Psychology, University of Tasmania* following ethical approval from the *University of Tasmania Human Ethics Committee.* Participants selected for inclusion in the study were provided with an information sheet outlining the nature and aims of the research (Appendix B1). Informed consent (Appendix B2) and demographic data (Appendix B3) were then

obtained. Participants then completed the NART, WAIS-III *Digit Span* subtest, BDI-II and BAI.

Following these assessments, participants completed the computerised checking task. Finally, participants completed the WMS – III *Spatial Span* subtest and were debriefed (see Appendix C for screening data).

Design and Data Analysis

This investigation employed two designs. The first, a 2(Checking level: High, Low) x 3(Condition: ON, OFF, UNSEEN) mixed design, investigated differences between the High and Low checking groups with regard to the memory processes examined (Memory Accuracy, Memory Certainty and Memory Confidence ratings). The between groups variable was checking level (Low, High), the within groups variable was Condition (ON, OFF, UNSEEN) and the dependent variables were the mean number of stimuli correctly recalled (memory accuracy), memory certainty and confidence ratings.

The second 2(Checking level) x 3(Condition) mixed design investigated differences between the two groups with regard to each of the five cognitive mediators (Discomfort, Probability of Danger, Cost of Danger, Personal Responsibility, Desire to Check). The between group variable was again checking level (Low, High), the within groups variable was Condition (ON, OFF, UNSEEN), and the dependent variables were the mean scores on the cognitive mediators questions.

A significance level of $p<.05$ was used for all analyses. One-way between groups ANOVAs were used to examine differences between the groups with regard to the NART, Digit Span, Spatial Span, BAI, BDI-II, PI-R Total and PI-R Checking scores. To assess comparability between set 1 and set 2 of the checking program for each cognitive and memory variable, separate 2(Set) x 3(Condition) mixed ANOVAs were employed. Differences between the two groups for each cognitive and memory factor were assessed by separate 2(Group) x 3(Condition) mixed ANOVAs. Newman-Keuls post hoc tests were used to further examine significant differences where appropriate. Where significant group differences were found, ANCOVAs with BDI-II and BAI scores as covariates were performed in order to control for the potential influence of mood state on the cognitive and memory measures (see Appendix D1 for all analyses).

Results

Demographic Data

The results of the screening measures for each group are presented in Table 2.

Table 2. Means and standard deviations (in parentheses) for participant screening measures.

	N	PI-R Total	PI-R Checking	NART	DS	SS	BAI	BDI
Low	25	6.92 (4.92)	1.00 (1.08)	33.68 (5.59)	10.64 (2.33)	10.72 (2.51)	4.12 (5.19)	4.96 (4.65)
High	24	42.63 (13.39)	17.67 (4.59)	33.46 (5.11)	10.75 (2.91)	11.08 (2.73)	7.96 (4.49)	10.08 (6.83)

It is clear that the groups were very similar in terms of estimated intellectual ability, working memory and memory for actions, but differed on the measures of anxiety, depression, and as selected, checking behaviour. A manipulation check by means of a one-way between groups ANOVA, confirmed that the High group reported significantly higher levels of checking behaviour, as assessed by the PI-R Checking subscale, compared with the Low checking group, $F(1, 47) = 311.42$, $p<.01$. Burns et al. (1996) reported means of 7.48 and 19.87 for a normative sample and OCD group respectively. The High checking group in this study are clearly just below the threshold for the OCD group in the Burns et al. (1996) study and therefore engage in considerably more checking behaviour than their peers.

A one-way between groups ANOVA revealed that the High group also reported significantly higher levels of overall obsessive-compulsive symptoms compared with the Low group, $F(1, 47) = 155.86$, $p<.01$. Reference to the normative data indicates that a mean of 21.78 is typical for the normal population compared to 54.93 for an OCD group. This finding suggests then, that the High checking group also experience relatively high levels of other obsessive-compulsive symptoms such as contamination concerns and ordering rituals compared with their peers. However, it should be noted that the Low group in the present study reported far lower overall obsessive-compulsive symptoms compared with the normative sample, thereby magnifying the difference between the Low and High groups.

As predicted, one-way between group ANOVAs indicated there were no significant differences between the Low and High Checking groups with regard to

estimated intellectual ability (NART score), working memory (Digit Span) or memory for actions (Spatial Span). Participants fell within the average range on the measures of working memory and memory for actions, whilst the mean NART scores predicted a 'High Average' intelligence level (WAIS-III *Full Scale IQ* = 114) for both groups (see Nelson, 1982).

However, as can be seen in Table 2, the High group reported significantly higher levels of anxiety (BAI score), $F(1, 47) = 7.64$, $p<.01$ and depression (BDI-II score), $F(1,47) = 9.48$, $p<.01$ than the Low group. Reference to the normative data for these instruments indicated the Low group fell within the "normal" range for both anxiety and depression. The High group was also placed in the "normal" range for anxiety but fell within the "mild" range for depression. This finding was not unexpected given the common finding of greater levels of depression among individuals with OCD (Sasson, Zohar, Chopra, Lustig, Iancu & Hendler, 1997).

Manipulation Check for Set

In order to ascertain the comparability of Set 1 and Set 2 of the Checking Program, 2(Set) x 3(Condition) mixed ANOVAs were conducted on the data for all memory and cognitive mediator questions. The analyses revealed that there were no significant differences between the sets or significant Set by Condition interactions for the measures of Cost and Probability of Danger, Desire to Check, Personal Responsibility, Memory Certainty and Memory Confidence. Hence, the

data from each set were collapsed for the analyses of group differences for these measures.

Analyses of the mean Number of Correct Responses (memory accuracy) data found a significant Set by Condition interaction, $F(2,94) = 3.81$, $p<.05$, a significant main effect of Condition, $F(2,94) = 62.66$, $p<.01$, and a trend for a significant main effect of Set, $F(1,47) = 3.79$, $p=.06$. As shown in Figure 1 and confirmed by post hoc analyses, both Set 1 and Set 2 had greater memory accuracy for the ON condition (means= 4.61 and 4.46 respectively) than the UNSEEN condition (means = 1.83 and 1.88 respectively) and did not differ from each other for these conditions.

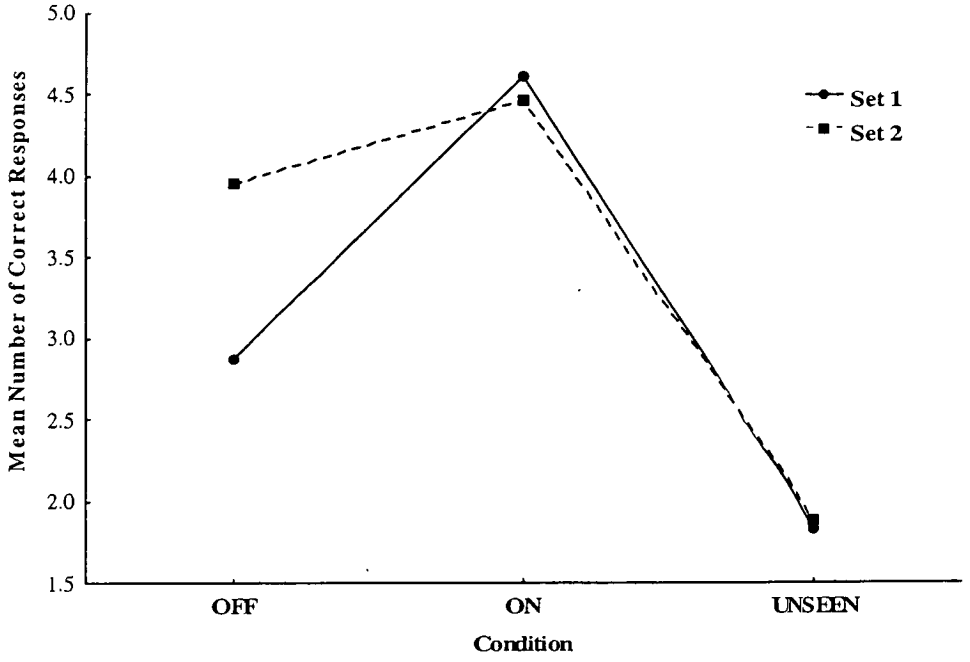

Figure 1. Mean number of correct responses (accuracy) for Set 1 and Set 2 across the three experimental conditions.

However, the difference in memory accuracy between the two sets for the OFF condition was significant ($p<.01$). Whereas Set 1 had significantly higher

memory accuracy ($p<.01$) for the ON condition (mean = 4.61) compared with the OFF condition (mean = 2.87), there was no significant difference between the means for these conditions for Set 2 (mean ON = 4.46 and OFF =3.96).

As the interaction involving Set was due solely to the difference in ratings for the OFF condition, the two sets were collapsed for the analyses of group differences for the memory accuracy data.

A significant main effect of Set emerged for the Discomfort ratings, $F(1,47) = 4.25$, $p<.05$, with mean ratings being significantly higher across the experimental conditions for Set 2 (64.13) than Set 1 (48.10). Set was therefore included as a between subjects factor in the analyses of group differences for this measure.

Memory Measures

Mean Number of Correct Responses

The mean number of correct responses regarding the status of the stimuli (OFF, ON, UNSEEN) provided a measure of overall memory accuracy. As shown in Figure 2, the Low checking group was slightly more accurate overall compared with the High group in terms of their recall of the condition of the stimulus (OFF, ON, UNSEEN). A 2(Group) X 3(Condition) mixed ANOVA revealed that the difference between the groups was significant, $F(1,47) = 7.95$, $p<.01$.

It can also be seen from Figure 2 that both groups had a similar pattern of results across the three conditions. Overall, memory accuracy was higher for the ON condition compared with the OFF and UNSEEN conditions, with the UNSEEN condition having the lowest number of correct responses.

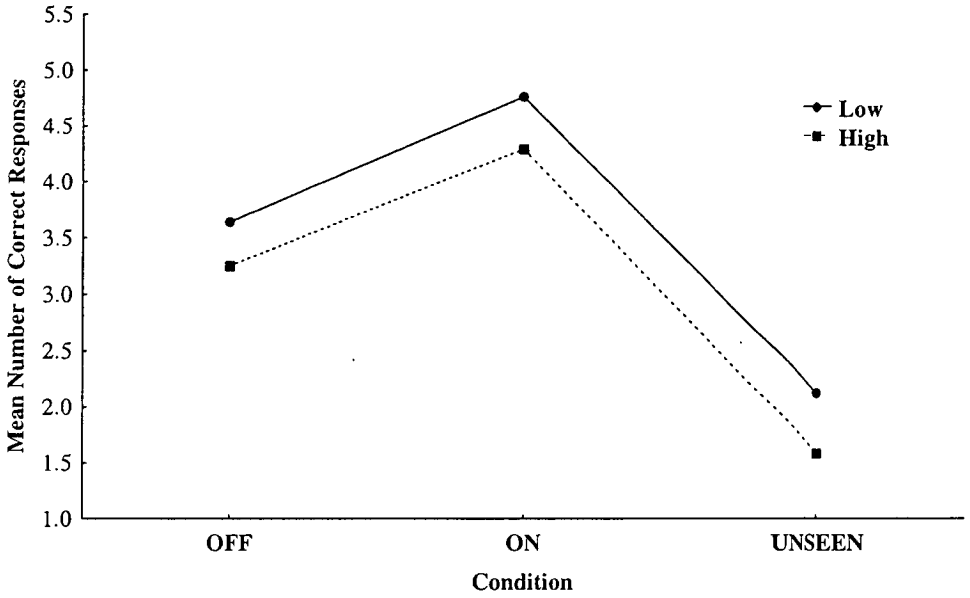

Figure 2. Mean Number of Correct Responses (accuracy) for the Low and High checking groups across the three experimental conditions.

The 2(Group) x 3(Condition) repeated measures ANOVA confirmed that the main effect of Condition was significant, $F(2,94) = 58.15$, $p<.01$. The interaction between Group and Condition was not significant.

Due to the significant group differences with regard to ratings of depression and anxiety, the analyses were re-performed using ANCOVAs with BDI-II and BAI scores used as the covariates. The Group main effect remained significant for both analyses, $F(3,44) = 3.73$, $p<.05$ and $F(3,44) = 3.42$, $p<.05$ respectively.

Memory Certainty Ratings

A 2(Group) x 3(Condition) mixed ANOVA conducted on the mean memory certainty ratings revealed a significant main effect of Condition, $F(2,94) = 81.10$, $p<.01$. As shown in Figure 3, memory certainty ratings were higher overall for the ON condition than the UNSEEN and OFF conditions with the lowest ratings reported for the OFF condition. It is also clear from Figure 3 that the Low checking group had slightly higher memory certainty scores than the High group across the three experimental conditions.

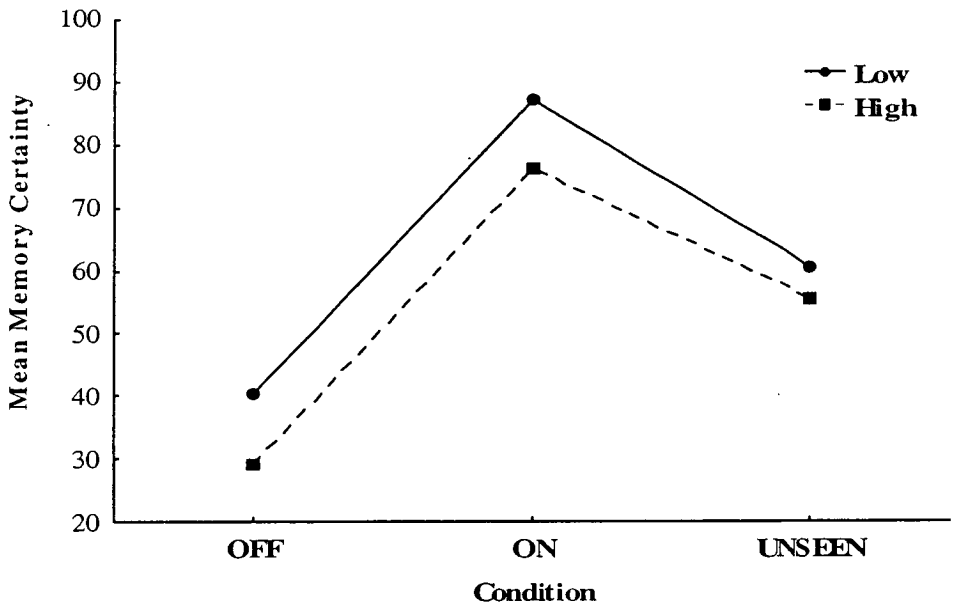

Figure 3. Mean Memory Certainty (%) ratings for the High and Low checking groups across each experimental condition.

The 2(Group) x 3(Condition) mixed ANOVA showed that there was a trend for a significant main effect of Group, $F(1,47) = 3.75$, $p=.06$. The Group by Condition interaction was not significant.

ANCOVA performed on the data revealed that the Group main effect reached significance when BAI scores were included as a covariate, $F(3,44) = 3.01$, $p<.05$

but was non-significant when BDI-II scores were included, $F(3,44) = 1.68$, $p = .19$.

Memory Confidence Ratings

Inspection of the mean memory confidence ratings presented below in Figure 4 reveals that participants in both groups generally had greater confidence in their memories for the ON condition compared with the OFF and UNSEEN conditions, which had similar confidence ratings.

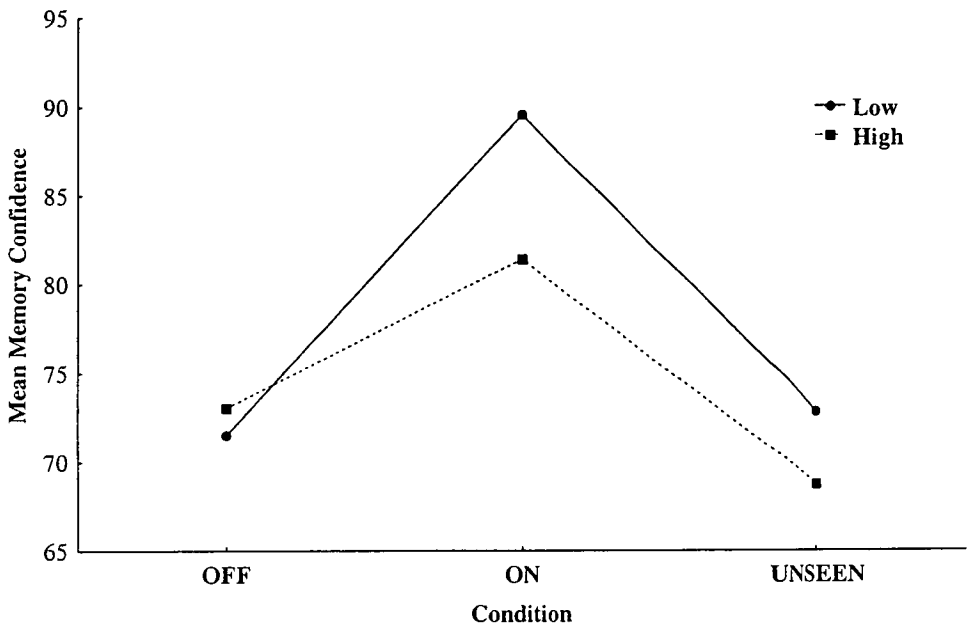

Figure 4. Mean Memory Confidence ratings for the Low and High checking groups across each experimental condition.

A 2(Group) x 3(Condition) mixed ANOVA confirmed that the main effect of Condition was significant, $F(2,94) = 18.17$, $p<.01$. However, although the Low group reported higher overall memory confidence ratings compared to the High checking group, the main effect of Group was not significant. The Group by Condition interaction was also non-significant.

Cognitive Measures

Perceived Outcomes associated with not Checking

In order to determine whether the Low and High checking groups differed in relation to the perceived consequences of not checking, the responses for both groups to the question (3b): *"what is the worst thing that could happen?"* were analysed for common themes. As there were no major differences between Set 1 and Set 2 with regard to the common themes identified for each of the matched stimuli (e.g., heater/iron, car door/boot etc.) (see Appendix D2), the data from both sets were pooled. A frequency table comparing the responses, coded according to major theme (e.g., break-in/theft, overflow/flood, etc.), for the Low and High checking groups across the three experimental conditions (OFF, ON, UNSEEN) was constructed (Appendix D2) and the percentage of participants in each group recording each common theme identified was calculated.

As can be seen in Table 3, the majority of participants in both groups reported "break-in or theft" as the worst possible outcome across the three experimental conditions for the Car door/boot stimuli. It is evident however, that a minority of Low checking participants (20%) recorded an alternative response for the OFF condition, including "nothing", or "it was off".

Table 3. Number of participants and percentage (in parentheses) in the High and Low checking groups reporting "break-in/theft" as the worst outcome across experimental conditions for the Car door/boot stimuli.

	ON	**OFF**	**UNSEEN**
High (N=24)	24 (100%)	22 (91.7%)	23 (95.8%)
Low (N=25)	24 (96%)	20 (80%)	22 (88%)

Similarly, Table 4 shows that there were no major differences between the High and Low checkers with regard to the Front/Back door stimuli for the ON and UNSEEN conditions, with the majority of participants in both groups again reporting break-in/theft as the worst outcome.

Table 4. Number of participants and percentage (in parentheses) in the High and Low checking groups reporting "break-in/theft" as the worst outcome across experimental conditions for the Front/back door stimuli.

	ON	**OFF**	**UNSEEN**
High (N=24)	24 (100%)	24 (100%)	24 (100%)
Low (N=25)	21 (84%)	18 (72%)	21 (84%)

As can be seen in Table 4, a minority of Low checking students (28%) again reported "nothing" or "it was off" for the OFF condition.

As shown in Tables 5 and 6, a similar pattern emerged for the stimuli involving electrical appliances (oven/hotplate, heater/iron), with the majority of participants in both groups reporting "fire/burns" as the worst outcome.

Table 5. Number of participants and percentage (in parentheses) in the High and Low groups reporting "fire/burns" as the worst outcome across experimental conditions for the Oven/Hotplate stimuli.

	ON	**OFF**	**UNSEEN**
High (N=24)	24 (100%)	24 (100%)	24 (100%)
Low (N=25)	19 (76%)	17 (68%)	19 (76%)

Again, a minority of Low checking participants reported other outcomes for both stimuli, including "nothing", "waste of electricity", "high electricity bill", "overheating" and "I'd feel guilty". However, this was evident across all three

conditions, in contrast to only being evident for the OFF condition for the Car door/boot and Front/back door stimuli.

Table 6. Number of participants and percentage (in parentheses) in the High and Low groups reporting "fire/burns" as the worst outcome across experimental conditions for the Iron/Heater stimuli.

	ON	**OFF**	**UNSEEN**
High (N=24)	24 (100%)	24 (100%)	24 (100%)
Low (N=25)	19 (76%)	17 (68%)	19 (76%)

In contrast to the pattern observed for the other stimuli, a trend emerged for participants in the High group to also report other outcomes for the tap stimuli (sink/bathroom tap). As can be seen in Table 7, although the majority of participants in both groups reported "flood" as the worst possible outcome, a minority in both the Low and High groups reported other outcomes, including "waste of water" or "running out of water", "high electricity bills" or "nothing".

Table 7. Number of participants and percentage (in parentheses) in the High and Low groups reporting "flood" as the worst outcome across experimental conditions for the sink/bathroom tap stimuli.

	ON	**OFF**	**UNSEEN**
High (N=24)	18 (75%)	15 (62.5%)	19 (79.17%)
Low (N=25)	16 (64%)	16 (64%)	18 (72%)

In summary, the same themes generally emerged between the High and Low checking groups across the experimental conditions for each of the individual (paired) stimuli, indicating there were no major differences in the perceived outcome between the groups. However, a minority of Low checking participants reported other outcomes, including "nothing" and "it was off" across conditions

for all of the stimuli with the exception of the Car door/boot stimuli where this only occurred for the OFF condition. This may suggest a tendency of low checking individuals to downplay potentially adverse consequences. Finally, there was a trend for a minority (20-25%) of participants in both groups to report "other" outcomes for the tap stimuli. This might indicate that the outcomes arising from these stimuli were not regarded as being as great a threat compared with the possible outcomes associated with the other stimuli.

Cost and Probability of Danger Ratings

In addition to listing the worst possible outcome that might result as a consequence of not checking, participants were required to rate the "cost" associated with the outcome and the likelihood ("probability") of it occurring.

As illustrated in Figure 5, the High checking group reported greater Cost of Danger ratings across all three experimental conditions compared with the Low checking group. A 2(Group) x 3(Condition) mixed ANOVA confirmed that the main effect of Group was significant, $F(1,47) = 6.26$, $p<.05$. That is, High checking participants regarded the perceived aversive outcomes as being far more severe than Low checking individuals. However, ANCOVA revealed that although this difference remained significant when BAI scores were covaried, $F(3,44) = 2.94$, $p<.05$, the difference between the groups fell below the significance level when BDI-II scores were included, $F(3,44) = 2.39$, $p=.08$.

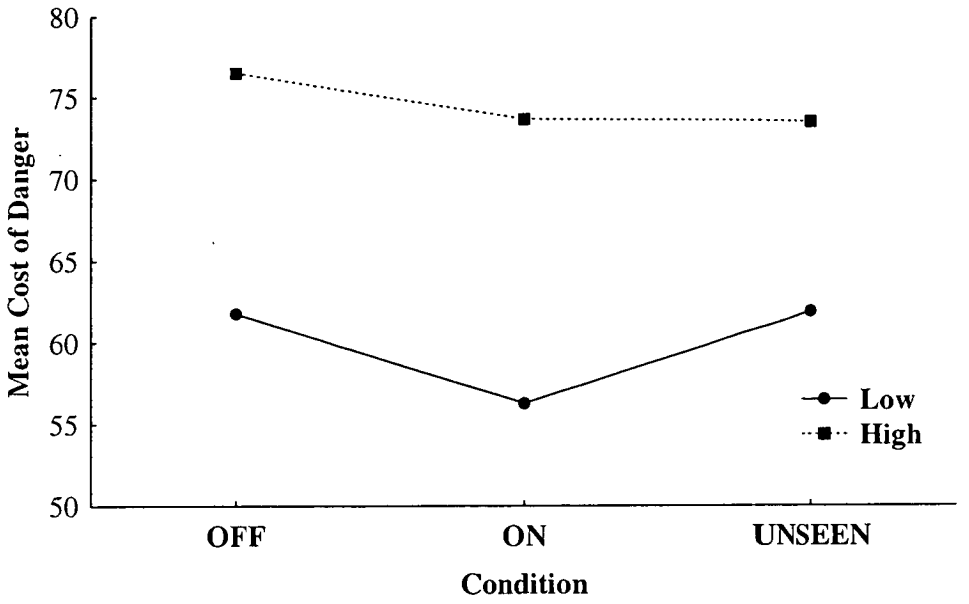

Figure 5. Mean Cost of Danger ratings for the Low and High checking groups across each experimental condition.

As indicated in Figure 5, the 2(Group) x 3(Condition) mixed ANOVA showed that neither the main effect of Condition, nor the Group by Condition interaction were significant.

A 2(Group) x 3(Condition) mixed ANOVA revealed that the High and Low checking groups did not differ significantly with regard to mean Probability of Danger ratings. As shown in Figure 6, both groups reported roughly similar and relatively low (<40%) ratings for the likelihood of the aversive outcome occurring. However, a significant main effect of Condition was found, $F(2,94) = 9.66$, $p<.01$. Overall, participants reported higher Probability of Danger ratings for the OFF condition compared to the UNSEEN condition and the ON condition that had relatively low ratings. The Group by Condition interaction was not significant.

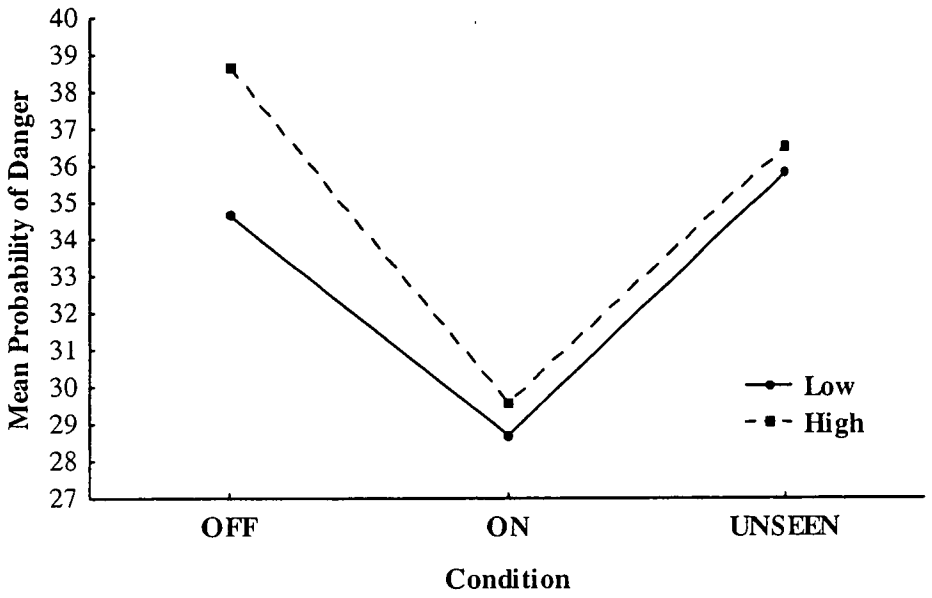

Figure 6. Mean Probability of Danger ratings for the Low and High checking groups across each experimental condition.

Personal Responsibility Ratings

High and Low checking participants were also required to provide ratings of how personally responsible they would feel in relation to the worst possible outcome occurring. As illustrated in Figure 7, High checking participants reported overall significantly higher ratings of personal responsibility compared to the Low checking participants across the three experimental conditions. For both groups, personal responsibility was greater for the OFF condition compared to the UNSEEN condition or the ON condition that had the lowest ratings.

A mixed 2(Group) x 3(Condition) ANOVA conducted on the mean Personal Responsibility data revealed significant main effects of Group, $F(1,47) = 5.34$, $p<.05$ and Condition, $F(2,94) = 8.76$, $p<.01$. The Group by Condition interaction was not significant.

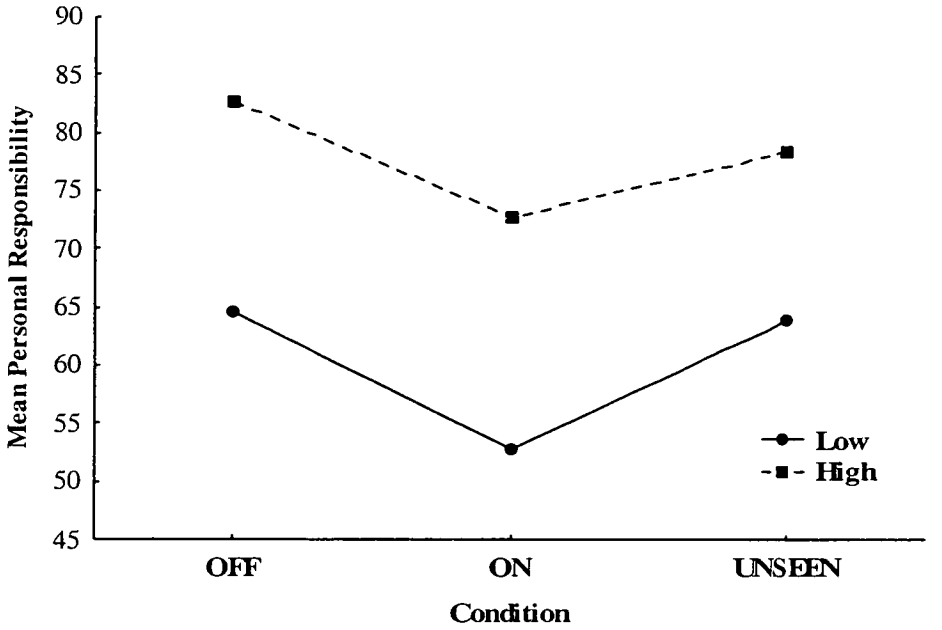

Figure 7. Mean Personal Responsibility ratings for the High and Low checking groups across the experimental conditions.

However, when the influence of BAI and BDI-II scores was accounted for in ANCOVA, the significant difference between the High and Low checking groups disappeared, $F(3,44) = 2.14$, $p = .11$ and $F(3,44) = 1.39$, $p=.26$ respectively.

Intolerance for Uncertainty

In order to determine the level of intolerance for uncertainty among high and low checking individuals, participants were required to provide ratings of their desire to check and discomfort associated with not checking.

It is clear from Figure 8 that the High checking group reported overall greater Desire to Check ratings compared to the Low checking group across the experimental conditions.

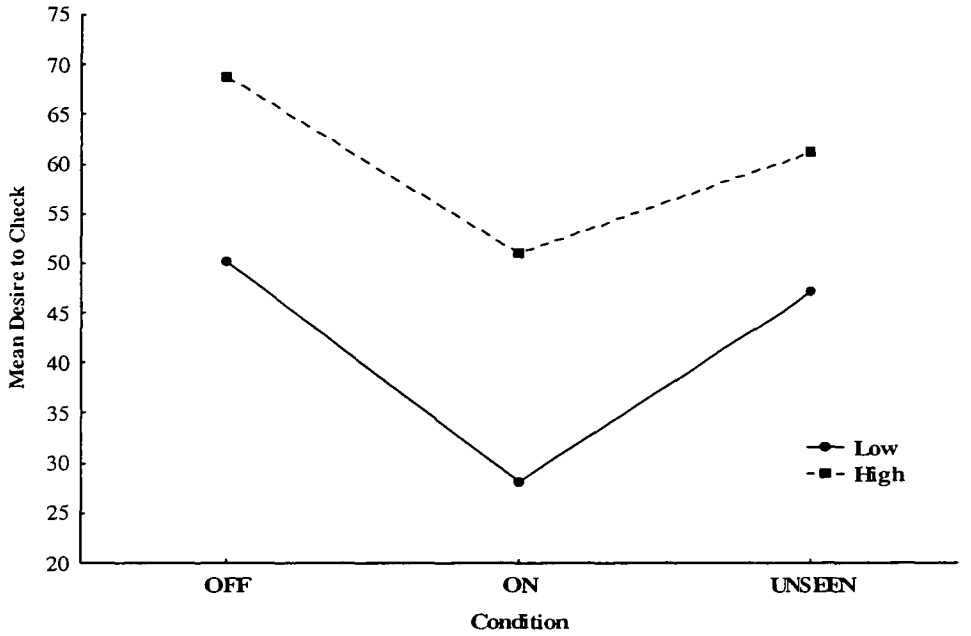

Figure 8. Mean Desire to Check ratings for the High and Low checking groups across the three experimental conditions.

A 2(Group) x 3(Condition) mixed ANOVA confirmed that the difference in ratings between the two groups was significant, $F(1,47) = 5.48$, $p<.05$. However, ANCOVA showed that the group difference fell below the significance level when BDI-II, $F(3,44) = 2.36$, $p = .08$ and BAI, $F(3,44) = 2.53$, $p = .07$ scores were included as covariates.

As shown in Figure 8, mean Desire to Check ratings were highest for the OFF condition, followed by the UNSEEN condition and the ON condition that had relatively low ratings. The analysis found that the main effect of Condition was significant, $F(2,94) = 21.61$, $p<.01$. The Group by Condition interaction did not reach significance.

Due to the finding of a significant difference between the sets for the Discomfort associated with Checking measure, the mean ratings were subjected to a 2(Group)

x 2(Set) x 3(Condition) mixed ANOVA. The analysis confirmed that the Group main effect, $F(1,45) = 8.54$, $p<.01$, and Set main effect, $F(1,45) = 4.73$, $p<.05$ were significant. Overall, the High group reported greater discomfort associated with not checking than the Low group, and Set 2 had higher discomfort ratings compared with Set 1. However, as shown in Figure 9, a significant Group by Set interaction, $F(1, 45) = 5.08$, $p<.05$ modified this interpretation. None of the main effects or interactions involving Condition reached significance.

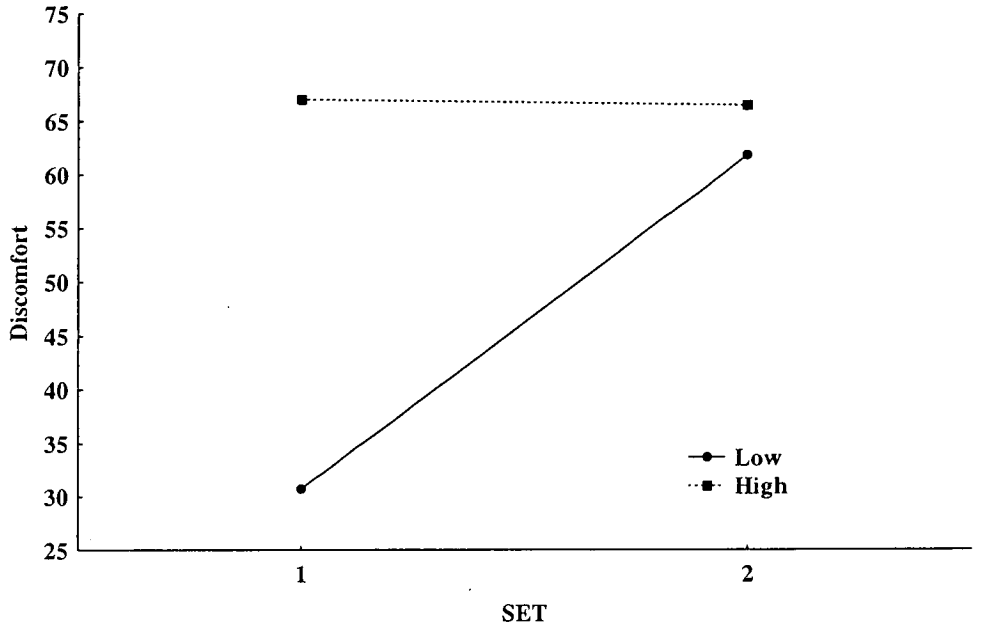

Figure 9. Mean Discomfort associated with not Checking ratings for the High and Low checking groups across the two stimulus sets.

Post hoc tests confirmed that whereas the High checking group had similarly high ratings of discomfort for both sets, there was a significant ($p<.01$) increase in discomfort ratings for the Low group from Set 1 to Set 2. As suggested in Figure 9, there was a significant difference between the groups for Set 1 ($p<.01$) but not for Set 2. It is worth noting however, that when Set was collapsed, the Group difference remained significant, $F(1,47) = 6.87$, $p<.05$. Therefore the finding of a significant Set main effect may simply be an experimental anomaly. The fact that

the sets were comparable for all of the other cognitive or memory measures, with the exception of memory accuracy, supports this interpretation.

However, ANCOVA with BDI-II and BAI scores as covariates performed on the Discomfort data revealed that the significant difference between the groups disappeared when the influence of depression, $F(3,44) = 2.21$, $p = .10$ and anxiety, $F(3,44) = 2.28$, $p = .09$ were accounted for.

Summary of Results

In addition to significantly higher levels of checking behaviour, High checking students also reported greater overall levels of obsessive-compulsive symptoms compared with Low checking individuals. Further, High checking participants reported significantly higher levels of anxiety and depression, although within the 'normal' to 'mild' range, than their Low checking counterparts. There were no significant differences between High and Low checking students in terms of their estimated intellectual ability or auditory or spatial (memory for actions) working memory.

With regard to the memory measures, memory accuracy and memory certainty and confidence were higher overall for the ON condition compared to the UNSEEN condition, with the OFF condition having the lowest ratings. Across the conditions, High checking participants were significantly less accurate in their recall of the stimuli than Low checking students. This difference remained significant when depression and anxiety level were taken into account. Although

there was a trend for High checkers to have lower certainty about their memories, this difference disappeared when depression scores were included as a covariate in the analyses. Conversely, the group difference reached significance when the influence of anxiety was accounted for.

In contrast to the memory measures, ratings for most of the cognitive measures (personal responsibility, probability of danger and desire to check) were significantly higher overall for the OFF condition compared with the UNSEEN condition or ON condition that had the lowest ratings. Although both groups generally reported similar aversive outcomes resulting from not checking, High checking participants recorded significantly higher ratings of cost of danger, in addition to personal responsibility, discomfort associated with not checking and desire to check. However, these differences generally did not remain significant when BDI-II and BAI scores were covaried in the analyses. Nevertheless, there was evidence for a trend for High checkers to report significantly greater cost of danger and desire to check ratings irrespective of anxiety or depression level.

Discussion

This study aimed to investigate the cognitive and memory phenomena proposed to underlie obsessive-compulsive checking in a non-clinical student sample using ecologically valid stimuli. In line with previous research, it was hypothesised that participants engaging in high levels of checking would report greater levels of personal responsibility, intolerance for uncertainty and higher probability and cost

of danger estimates. Consistent with the memory research, it was also hypothesised that High checking participants would have poorer memory for actions and report lower confidence and certainty in memory compared with Low checking students. These hypotheses were partially supported.

Contrary to the hypotheses, there were no significant differences in memory confidence ratings between the High and Low checkers. Additionally, theme analysis of the data concerning perceived aversive outcomes resulting from not checking indicated there were no major differences between High and Low checking students. More specifically, the majority of students in both groups reported break-in or theft as the 'worst possible outcome' resulting from not checking the house or car doors, flood as arising from not checking taps and fire or burns in relation to the electrical appliances. Further, the two experimental groups both reported similarly low to moderate probability of danger ratings in relation to these outcomes.

Although high checking participants were characterised by significantly greater perceived responsibility, desire to check and discomfort associated with not checking ratings compared to Low checkers, analyses indicated that the group differences disappeared once the influence of anxiety and depression level were taken into account. Similarly, a trend emerged for High checkers to report lower memory certainty, but this disappeared when the higher levels of depression in this group were accounted for. Finally, the expected interaction for the UNSEEN condition, which was expected to differentially provoke intolerance for uncertainty concerns in High checking participants relative to their peers and

result in the endorsement of higher ratings on the other cognitive measures was not found.

However, in line with the hypotheses, High checking participants were found to rate the "cost" of the aversive outcomes as significantly greater compared to the Low checking group. That is, although High checkers perceived the likelihood of harm to be reasonably low, they believed the severity of the outcome to be far greater than their Low checking peers. The higher general anxiety levels of the High checking group did not influence this tendency. Further, although the higher depression levels of the High checking group were found to moderate this difference, a clear non-significant trend remained for High checkers to "catastrophise" about the cost of danger resulting from not checking. Similarly, a trend for High checking participants to report greater desire to check compared to their Low checking peers remained after the influence of depression and anxiety was analysed.

Also in line with the hypotheses, High checking participants were significantly less accurate than Low checkers for memory for actions on the checking task despite the finding that the two experimental groups were comparable with regard to their overall estimated intelligence, auditory working memory ability and working memory for actions. Consistent with the findings of Sher et al. (1984), Ecker and Engelkamp (1995) and Rubensteing et al. (1993), this difference could not be explained by the influence of anxiety or depression.

This finding has important implications for the specific nature and location of the memory deficit involved in obsessive-compulsive checking. Information processing investigations of anxiety disorders have consistently found a selective attention bias favouring the enhanced processing of threatening information (Mathews & MacLeod, 1985; Summerfeldt & Endler, 1998; Tata, Leibowitz, Prunty, Cameron & Pickering, 1996). Given these findings, it would seem logical to assume that memory for threat would be enhanced in obsessive-compulsive checking due to the increased processing. However, clinical observations note that individuals with obsessive-compulsive checking frequently report being unable to clearly recall performing a checking-related action such as turning off the stove, even when the action was performed moments previously (Rachman & Shafran, 1998). As previously discussed, there is a growing body of evidence suggesting a deficit in memory for actions underlies this behaviour (e.g., Ecker & Engelkamp, 1995; Rubenstein et al., 1993; Tallis et al., 1999; Zitterl et al., 2001).

It is possible that the memory deficit may arise from the competing demands of hypervigilance for threat and cognitive appraisal processes. That is, although obsessive-compulsive checkers may attend more vigorously to the threat-related stimuli than low checking individuals, appraisal processes interfere with the encoding or storage of the memory. In support of this theory, Woods et al. (2002) have suggested that the poorer memory performance observed in obsessive-compulsive checking might be secondary to higher order meta-cognitive processes such as exaggerated cost appraisals. Memory impairment would therefore not be observed in threat-irrelevant situations.

Studies that have failed to find a memory for actions deficit in checking behaviour may therefore not have used appropriately threatening materials. This issue clearly requires further exploration. A relationship between memory impairment and checking symptoms also remains to be demonstrated.

Although the results of the present study support models proposing that poorer memory for actions and, to a lesser extent, higher cost of danger and desire to check beliefs, mediate checking behaviour, they challenge a number of existing models of obsessive-compulsive checking. There was no support for heightened probability of danger estimations and reduced confidence or certainty in memory. Additionally, the results of the present study challenge the proposal that inflated personal responsibility beliefs or intolerance for uncertainty concerns have a central role in mediating checking behaviour, with group differences being moderated by anxiety and depression. Several explanations are possible to explain the discrepancies between the findings of the present study and previous research.

Cognitive models proposing exaggerated threat appraisal have emphasised that both probability and cost of danger ratings are inflated in obsessive-compulsive checking (e.g. Carr, 1974; McFall & Wollersheim, 1979). However, the results of this investigation indicated that heightened cost of danger estimates alone, are sufficient to drive checking behaviour. A similar conclusion was made by Menzies et al. (2000) who reported that experimentally manipulating personal responsibility led to increased severity of danger (cost) ratings but no difference in likelihood (probability) of danger ratings.

Both Beck et al. (1985) and Salkovskis et al. (1998) have suggested that checking behaviour arises due to the interplay of beliefs concerning the probability and "awfulness" of the likely outcome, perceptions of coping capacity and external "rescue" factors:

$$\frac{\textbf{Probability} * \textbf{Cost}}{\textbf{Coping} + \textbf{Rescue}}$$

According to this model then, it is not necessary for probability estimations to be high, provided cost of danger ratings are elevated and perceptions of coping and rescue factors are relatively low. Therefore, it may be that High checking individuals, whilst identifying similar consequences of not checking and comparable probabilities, catastrophise about the "awfulness" of the predicted outcome and their capacity to cope with an aversive threat. This explanation is consistent with clinical observations indicating that many individuals with obsessional concerns recognise the irrationality of their fears, but report that they would not be able to cope if the unlikely event did occur (Salkovskis et al., 1998). The inclusion of a measure of perceived ability to cope with the predicted aversive outcome resulting from not checking in future studies would allow this possibility to be more fully explored.

With regard to the lack of significant group differences for personal responsibility beyond anxiety and depression, it should be noted that not all studies have found evidence in support of this cognitive mediator (e.g., Emmelkamp & Aardema, 1999; Menzies et al., 2000). Further, previous research favouring a role of inflated responsibility beliefs has generally not controlled for the influence of mood (e.g., Ladouceur et al., 1996; Lopakta & Rachman, 1995). An exception is

the research of Foa et al. (2002), in which depression and anxiety scores were included as covariates in their analyses.

As previously reported, Steketee et al. (1998) found that only the "Tolerance for Uncertainty" subscale explained significant variance among OCD symptom scores beyond depression, anxiety and worry. That is, responsibility beliefs did not distinguish between controls, individuals with OCD and those with other anxiety disorders beyond mood state. Further, although Foa et al. (2002) concluded that obsessive-compulsive checkers have an inflated perception of responsibility for harm, once depression and anxiety were accounted for, responsibility ratings were significantly higher for obsessive-compulsive checkers compared to non-anxious controls for only one of the three scenario types used in their experiment.

Given these findings and the results of the current study, it may be that inflated personal responsibility beliefs are not specific to obsessive-compulsive checking, but rather a function of more general mood disturbances. That is, inflated personal responsibility, although being prominent in checking behaviour, may not be a unique feature of the disorder.

The lack of support for intolerance for uncertainty in checking behaviour is harder to reconcile. The OCCWG (1997) stated that intolerance of uncertainty involves beliefs concerning the necessity of being certain, inability to cope with unpredictable change and difficulty functioning in ambiguous environments. It

was therefore hypothesised that the UNSEEN condition would provoke intolerance for uncertainty concerns due to the ambiguity involved.

Contrary to expectations, High checking students did not show greater distress, as assessed by their ratings on the cognitive measures, for the UNSEEN condition compared to the Low checkers. Further, High checking participants did not report higher ratings of desire to check and discomfort associated with not checking compared with Low checkers, once anxiety and depression levels were controlled for, although there was a trend for higher desire to check ratings in the High group. However, it could be argued that this measure tapped a more general "urge to check" schema as opposed to specific intolerance for uncertainty beliefs.

The results therefore contradict the findings of Steketee et al. (1998) but support the assertion of Mancini et al. (2002) who believed intolerance for uncertainty beliefs may subserve higher order cognitive appraisals in OCD. It should be noted however, that whereas a mixed sample of individuals with OCD was compared with controls and individuals with other anxiety disorders in the Steketee et al. (1998) study, Mancini et al. (2002) based their findings on results obtained from a normal population.

The lack of significant intolerance for uncertainty differences, beyond anxiety and depression, in the present study could therefore be attributable to the use of a nonclinical sample. The inclusion of an obsessive-compulsive checking group in future research would assist in clarifying this issue. Nevertheless, the concept of intolerance for uncertainty is a relatively recent development in the OCD

literature. Empirical support is not robust and is based largely on results obtained from beliefs inventories. The results of the present study, which used checking relevant stimuli to assess potential cognitive mediators suggest that while intolerance for uncertainty beliefs may be endorsed on paper, they play only a secondary role under more realistic checking conditions.

In contrast to the findings of several recent investigations, the present study also failed to support a role for reduced confidence or certainty in memory. However, it is worth examining the experimental procedures used in the research supporting these phenomenona. The majority of studies have used stimuli that are not directly related to checking behaviour. For example, tracing or imaginal tracing (e.g., McNally & Kohlbeck, 1993), imagined or actual performance of verbally presented simple actions (e.g., Merckelbach & Wessel, 2000), word lists (e.g., MacDonald et al., 1997; McNally & Kohlbeck, 1993), general knowledge questionnaires (Dar et al., 2000) and neuropsychological batteries (Zitterl et al., 2001) have all been employed to assess memory confidence.

It could be argued that the findings of research using these paradigms have little bearing on the processes underlying actual checking behaviour. In support of this interpretation, studies using more ecologically valid stimuli have found evidence to suggest that a reduction in memory confidence only emerges after repeated exposure to the stimuli in both clinical (e.g., Tolin et al., 2001) and non-clinical participants (e.g., van den Hout & Kindt, 2003). As the participants in the present study were not given the opportunity to conduct repeated checks, a reduction in memory confidence and certainty may not have emerged. It would therefore be

worthwhile modifying the existing checking program to allow participants to re-check the scenes and re-rate the cognitive and memory measures. This would also have the advantage of providing an objective measure of the amount of checking behaviour, compared to the reliance on self-report data in the current investigation.

An alternative explanation for the lack of significant group differences in relation to the cognitive and memory measures is that the experimental procedure was not sufficiently threat-inducing to engage these processes beyond mood state. Although the participants were instructed to respond to the questions according to how they would feel in the situation, they were not required to actually engage with the stimuli. Hence, the checking situations were of a vicarious nature.

Previous research has consistently observed that compulsive checkers experience more discomfort and difficulty when they carry out the relevant checking activity in their own environments (Rachman, 1976). Compulsive checkers typically experience little or no feelings of responsibility in the homes or workplaces of other people, including laboratories, implying that responsibility concerns only emerge within an individual's "psychological territory" (Rachman & Shafran, 1998). That is, when the individual has a vested interest in their environment. It is conceivable that similar conditions might be necessary to induce the intolerance for uncertainty and memory confidence impairments believed to be involved in checking behaviour.

In support of this explanation, Rubenstein et al. (1993) and Ecker and Engelkamp (1995) reported that deficits in memory for actions occurred only on tasks performed by the participants themselves. An *in vivo* procedure could be employed in future research, in which the participants are required to rate responsibility concerns, intolerance for uncertainty, memory confidence and other potential cognitive mediators after completing typical checking tasks such as locking a door. A procedure of this type might elicit the elevated responsibility or intolerance for uncertainty concerns, or produce reductions in memory confidence and certainty. However, several investigations using non-specific and impersonal stimuli have found these variables to differ between high and low checking individuals, thus challenging this explanation. Nevertheless, as mentioned earlier, few of these have controlled for the influence of mood state.

Although this research has addressed a methodological shortcoming of previous research relating to the use of inappropriate stimuli, and thereby provided a more valid picture of the cognitive and memory processes involved in obsessive-compulsive checking, several improvements could be made. The current investigation does not shed light on the relative contributions of the cognitive and memory factors to checking behaviour. Stepwise multiple regression or principal components analyses with the participants' checking symptom scores held constant would help to resolve this issue. However, a much larger sample size than the one used in the present study would be required in order to ensure adequate statistical power.

In addition to employing an *in vivo* procedure and an objective measure of checking behaviour as previously discussed, repeating the investigation with a more homogenous sample of high checking individuals would help to clarify the findings of the current research. The participants in the High checking group had a relatively wide range of *PI-R 'Checking'* subscale scores and also engaged in higher levels of other obsessive or compulsive symptoms, such as washing, ordering or magical thinking compared to the Low checking group. It is conceivable that the differences between the groups, or lack thereof, may be attributable to the poorly defined High checking group or more general compulsive behaviour.

Specifying a more restricted cut-off score for checking behaviour and obtaining symptom profiles from the *PI-R* would therefore improve the experimental design. The inclusion of a measure of the nature and level of the participants' daily checking activity would also be a useful modification to the experimental procedure. This would allow for a more complete profile of checking behaviour both during the experiment and in day-to-day functioning to be obtained. Further investigations could also compare the cognitive and memory processes involved in checking between correct and incorrect identifications of the stimuli (i.e., memory for actions comparisons). A larger sample size would allow for this analysis to be conducted.

Finally, it is recommended that future research consider the inclusion of a clinical OCD checking group. This would allow for comparisons between nonclinical and clinical checkers. Additionally, comparisons between these populations and non-

checking clinical anxiety groups and a non-checking clinical OCD group would be useful in determining the extent to which the various cognitive and memory features are specific to OCD as opposed to being present in the general population or among other anxiety disorders. It would also allow for comparisons between the different OCD subtypes, thus informing debate surrounding the existing conceptualisation of the disorder.

Conclusions

Although the cognitive and memory processes believed to underlie obsessive-compulsive checking have been well-researched, many studies have used stimuli unrelated to checking behaviour. The present research has therefore made a significant contribution to the literature by investigating these processes using more ecologically valid stimuli. In accordance with several previous investigations, High checking participants had reduced memory for checking-related actions. Checking behaviour was also found to be characterised by cognitions concerning inflated personal responsibility, intolerance for uncertainty and overestimation of the severity of potential harm. However, once the higher anxiety and depression levels of the High checking group were included in the analyses, these differences disappeared. Nevertheless, a trend for High checkers to report greater cost of danger and desire to check remained. A role for probability of danger estimations and memory certainty and confidence in checking behaviour previously reported in the literature was not supported by this study.

In order to obtain further clarification of the specific cognitive and memory processes involved in checking behaviour, it is recommended that future research investigate these processes *in vivo*, comparing control, high checking, anxious and obsessive-compulsive subtypes. Further, studies employing more sophisticated data analyses, such as principal components or regression analysis, would allow for the relative contributions of the cognitive and memory variables to be ascertained. A coherent model of obsessive-compulsive checking could then be articulated.

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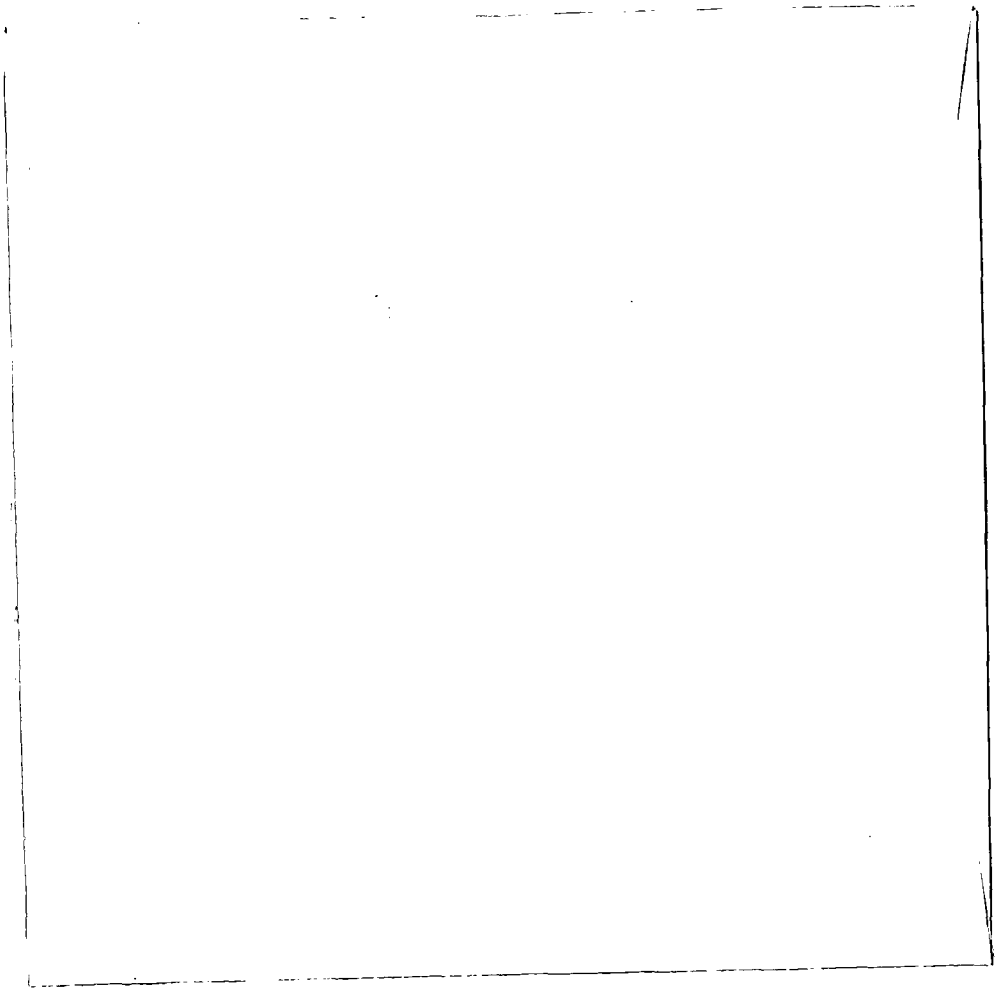
Table of Appendices

Appendix A: Individual Participant Data and Checking Program



The Checking Program relies on Microsoft Office software. If you experience any problems running the program, please contact the *School of Psychology, University of Tasmania*, on: +61 3 6226 2237 or Private Bag 30 Hobart Tas. 7001.

Appendix B1: Participant Information Sheet

Thought and Memory Processes in Checking Behaviour

Chief Investigators: Professor Kenneth C Kirkby and Dr Frances Martin
Researcher: Louise Dewis

Purpose of the Study: This Masters study aims to investigate some of the thought and memory processes that underlie checking behaviour.

To be included in this study you need to be able to use a standard computer, are of average intelligence, not currently on psychotropic medication, and don't have any anxiety or depressive disorder. To assess this, you will be asked to complete a series of pen and paper questionnaires and tests that will help assess your current level of checking behaviour, performance on memory tasks, general intellectual ability, and levels of anxiety and depression.

If you are selected to continue participation in the study, you will then be asked to complete a checking task that will be presented via a computer. The details and requirements of this task will be explained to you fully beforehand and you will have the opportunity to ask any questions. After completion of each video scenario, you will be presented with a series of questions relating to the task. At the end of these tasks, you will be asked to complete a memory test and answer some more questions relating to the checking tasks. The total time commitment for participation in the investigations will be between 1-2 hours.

Participation in this study is entirely *voluntary*. You may withdraw from the study at any time without penalty. There is *no payment* for the study, but you will receive course credit for participation.

The information you give us is confidential. The data will be kept in a locked filing cabinet in the Discipline of Psychiatry and only the principal researchers will have access to this. The results of the study may be published or presented, however the data will be coded to ensure individual participants cannot be identified. You may have access to any future publications if required.

This investigation has been approved by the University of Tasmania Human Research Ethics Committee. If you have any ethical concerns or complaints about the manner in which the investigation is conducted, you may contact: Ms Chris Hooper (Secretary) on (03) 6226 2763.

If you have any questions or worries about this study and what is required of you, please contact Louise Dewis via email: lmdewis@utas.edu.au, Professor Ken Kirkby during business hours on (03) 6226 4885 or Dr Frances Martin on (03) 6226 2262. You will be given copies of the information sheet and consent form to keep.

Thank you for your cooperation.

Appendix B2: Participant Consent Form

Thought and Memory Processes in Checking Behaviour

1. I have read and understood the information sheet for this study.
2. The nature and possible effects of the study have been explained to me.
3. I understand that the study involves the following procedures:
   - Completing screening questionnaires
   - Completing a computerised video checking task and then answering questions about the task
   - Completing memory tests and answering some other questions about the video
4. Any questions I currently have about the study have been answered to my satisfaction.
5. I agree that the research data gathered for the study may be published provided that I cannot be identified as a participant.
6. I give my permission to participate in this investigation and understand that I may withdraw from the study at any time without penalty.

Participant Section:

Name of Participant_____

Signature_____

Date_____

Researcher Section:

I have explained this study and the implications of involvement to the participant. I believe that the consent is informed and that he/she understands the implications of participation.

Name of Researcher_____

Signature_____

Date_____

Appendix B3: Participant Data Sheet

Thought and Memory Processes in Checking Behaviour

Date: _____/_____/_____ Participant ID:
02LD_____

Personal Details

Name:_____ Sex: Male/Female
Date of Birth: _____/_____/_____ Age:_____
Address:_____
Postcode_____
Phone: Home _____ Work _____ Mobile _____
Email:_____
University Course:_____
Occupation (if any):_____

Medical Details

Do you have a heart condition or any other serious physical condition? YES/NO

If YES, please specify your condition(s) _____

Do you have or have you ever been diagnosed with a psychological condition? YES/NO

If YES, please specify your condition(s) and any treatment you have received _____

Are you currently taking any medication for any conditions? YES/NO

If YES, what medication? _____

Do you drink alcohol? YES/NO

If YES, how many drinks on average would you drink in a week? _____

Do you smoke cigarettes? YES/NO
If YES, how many cigarettes on average do you smoke each day? _____

Participation Details

Please indicate the level of previous experience you have had with using a computer mouse by circling the appropriate number below:

1 2 3 4 5 6 7 8 9 10

|----------|----------|

None Moderate A Lot

Would you be interested in being contacted for any follow-up studies?

YES/NO

If YES, please provide the following information to assist in getting in touch with you:

Next of Kin: _____ Relationship to you: _____

Address: _____

Postcode: _____

Do you wish to be sent a summary of the results of this study?

YES/NO

Test Battery Results

BDI Total Score _____ BAI Total Score _____

NART Score _____ WMS-R Spatial Span _____

WAIS-III Digit Span _____

WAIS-III Digit Span

Digit Span Forward

I am going to say some numbers. Listen carefully, and when I am through, I want you to say them right after me. Just say what I say.

Digit Span Backward

Now I am going to say some more numbers. But this time when I stop, I want you to say them backward. For example, if I say 7-1-9, what would you say?

If correct:

That's right. (PROCEED)

If incorrect:

No, you would say 9-1-7. I said 7-1-9, so to say it backward, you would say 9-1-7. Now try these numbers. Remember, you are to say them backward: 3-4-8. (PROCEED)

Digits Forward	Trial Score	Item Score
1.1 1-7		
.2 6-3		
2.1 5-8-2		
.2 6-9-4		
3.1 6-4-3-9		
.2 7-2-8-6		
4.1 4-2-7-3-1		
.2 7-5-8-3-6		
5.1 6-1-9-4-7-3		
.2 3-9-2-4-8-7		
6.1 5-9-1-7-4-2-8		
.2 4-1-7-9-3-8-6		
7.1 5-8-1-9-2-6-4-7		
.2 3-8-2-9-5-1-7-4		
8.1 2-7-5-8-6-2-5-8-4		
.2 7-1-3-9-4-2-5-6-8		
Digits Forward Total Score (Maximum = 16)		

Digits Backward	Trial Score	Item Score
1.1 2-4		
.2 5-7		
2.1 6-2-9		
.2 4-1-5		
3.1 3-2-7-9		
.2 4-9-6-8		
4.1 1-5-2-8-6		
.2 6-1-8-4-3		
5.1 5-3-9-4-1-8		
.2 7-2-4-8-5-6		
6.1 8-1-2-9-3-6-5		
.2 4-7-3-9-1-2-8		
7.1 9-4-3-7-6-2-5-8		
.2 7-2-8-1-9-6-5-3		
Digits Backward Total Score (Maximum = 14)		

WMS-II Spatial Span

Spatial Span Forward

Now I want you to do exactly what I do. Touch the blocks I touch, in the same order.

Spatial Span Backward

Now I am going to touch some more blocks. This time when I stop, I want you to touch the blocks backwards, in reverse order of mine. For example, if I touch this block (3) then this one (5), what would you do?

If correct:

That's right. Here's the next one. Remember to touch them in reverse order. (PROCEED)

If incorrect:

No, I touched this one, then this one; so to do it in reverse, you would touch this one, then this one. Now let's try another one. If I touch this one (9), then this one (1), what would you do? (PROCEED)

SS Forward	Trial Score	Item Score	SS Backward	Trial Score	Item Score
1.1 3-10			1.1 7-4		
.2 7-4			.2 3-10		
2.1 1-9-3			2.1 8-2-7		
.2 8-2-7			.2 1-9-3		
3.1 4-9-1-6			3.1 10-6-2-7		
.2 10-6-2-7			.2 4-9-1-6		
4.1 6-5-1-4-8			4.1 5-7-9-8-2		
.2 5-7-9-8-2			.2 6-5-1-4-8		
5.1 4-1-9-3-8-10			5.1 9-2-6-7-3-5		
.2 9-2-6-7-3-5			.2 4-1-9-3-8-10		
6.1 10-1-6-4-8-5-7			6.1 2-6-3-8-2-10-1		
.2 2-6-3-8-2-10-1			.2 10-1-6-4-8-5-7		
7.1 7-3-10-5-7-8-4-9			7.1 6-9-3-2-1-7-10-5		
.2 6-9-3-2-1-7-10-5			.2 7-3-10-5-7-8-4-9		
8.1 5-8-4-10-7-3-1-9-6			8.1 8-2-6-1-10-7-3-4-9		
.2 8-2-6-1-10-3-7-4-9			.2 5-8-4-10-7-3-1-9-6		
Forward Total Score (Maximum = 16)			Backward Total Score (Maximum = 16)		

Appendix C: Data Spreadsheet

	1 AGE	2 SEX	3 GROUP	4 SET	5 PADTOT	6 PADCH	7 BDI	8 BAI	9 NART	10 DS	11 SS
02LD17	19	2	2	1	30	16	8	5	27	6	4
02LD26	21	2	2	2	41	13	12	12	28	10	12
03LD05	18	2	1	2	8	1	7	1	36	14	3
02LD04	20	1	2	1	58	25	17	12	34	12	12
02LD13	18	2	1	1	6	1	1	1	33	12	11
02LD23	19	2	2	1	49	17	24	8	32	13	10
02LD06	30	2	1	1	2	1	2	1	46	11	11
02LD27	37	2	1	1	9	1	4	2	41	12	15
02LD16	18	2	2	2	57	23	13	11	29	8	4
02LD41	23	1	1	1	8	2	4	1	29	12	7
02LD45	18	1	2	1	38	13	6	5	32	14	10
02LD36	19	2	2	1	37	16	10	3	26	6	10
02LD24	22	2	2	2	40	15	2	4	34	9	12
02LD12	18	2	2	2	33	17	9	12	31	11	9
02LD11	29	1	1	1	6	1	5	4	37	13	11
02LD25	21	2	1	1	1	0	9	7	36	15	11
02LD18	18	1	1	2	5	0	0	0	30	10	13
02LD07	18	2	2	2	45	15	7	9	42	13	14
02LD10	18	2	2	2	26	14	5	4	30	13	10
02LD35	19	2	1	2	4	1	1	0	25	8	8
02LD44	42	1	1	1	2	0	0	2	41	11	14
02LD15	19	2	1	1	17	5	15	26	30	11	11
02LD50	20	2	2	1	23	13	12	8	34	15	15
02LD46	19	1	1	2	8	1	1	2	32	10	10
02LD47	22	1	2	1	36	20	11	8	30	9	9
02LD39	18	2	1	2	3	0	3	2	34	8	11
02LD49	18	2	1	2	3	2	7	5	23	8	12
02LD42	20	2	1	1	1	0	12	6	33	12	11
02LD20	22	2	2	2	52	16	8	12	42	12	12
02LD28	20	2	2	2	43	13	14	12	28	9	12
02LD01	25	1	1	1	1	0	0	11	34	10	15
02LD37	18	1	2	1	77	20	6	3	38	13	13
02LD34	19	1	2	1	29	13	4	7	35	15	12
02LD09	19	2	1	1	3	1	1	4	28	10	10
02LD21	22	2	2	1	30	16	25	4	36	14	12
02LD08	18	2	1	2	19	0	1	3	40	11	11
02LD02	18	2	2	2	42	22	13	21	31	6	12
02LD22	31	1	2	2	62	24	3	7	32	11	9
02LD43	26	2	1	2	12	1	11	5	41	11	10
02LD40	21	2	1	2	9	2	7	2	35	8	8
02LD31	24	2	1	2	9	1	7	2	28	8	11
02LD03	18	2	2	2	25	14	8	4	29	10	13
02LD32	19	2	1	2	7	1	2	4	30	7	10
02LD19	25	2	1	1	5	0	0	2	39	16	11
02LD29	18	2	2	1	46	16	23	13	42	13	13
02LD14	24	2	2	2	60	29	0	5	38	10	14
02LD30	18	2	2	2	44	24	2	2	43	6	13
02LD38	18	2	1	2	15	2	12	5	32	8	10
02LD33	19	1	1	2	10	1	12	5	29	10	13

Appendix C: Data Spreadsheet

	1 Q1OFFC	2 Q1ONC	3 Q1USC	4 Q2OFF	5 Q2ON	6 Q2US	7 Q3BOFF	8 Q3BON	9 Q3BUS
02LD17	3.00	4.00	0.00	75.00	57.50	65.00	73.33	58.75	77.00
02LD26	4.00	4.00	0.00	46.25	48.75	80.00	73.75	43.13	69.00
03LD05	5.00	4.00	2.00	73.00	75.63	72.08	98.00	98.75	96.67
02LD04	2.00	3.00	3.00	62.50	55.00	69.17	80.83	83.33	83.33
02LD13	1.00	4.00	0.00	0.00	0.00	0.00	47.50	56.25	36.40
02LD23	2.00	5.00	1.00	62.50	43.00	53.13	72.58	65.80	78.13
02LD06	3.00	5.00	3.00	5.83	2.00	4.17	12.92	14.00	16.67
02LD27	3.00	5.00	4.00	0.00	0.00	0.00	9.58	16.00	18.13
02LD16	5.00	2.00	1.00	76.00	75.00	80.63	76.00	79.17	79.63
02LD41	5.00	4.00	0.00	75.60	55.00	78.00	82.00	68.75	79.80
02LD45	4.00	4.00	0.00	16.25	44.57	30.17	40.00	71.25	54.00
02LD36	3.00	5.00	0.00	85.42	81.00	86.00	91.25	92.00	93.00
02LD24	3.00	5.00	0.00	45.00	57.00	26.00	60.83	58.00	54.00
02LD12	4.00	5.00	0.00	63.75	50.00	58.00	67.50	54.00	54.00
02LD11	4.00	5.00	0.00	70.00	58.00	60.00	97.50	16.00	16.00
02LD25	4.00	5.00	0.00	41.25	54.00	22.00	52.50	47.00	44.00
02LD18	5.00	5.00	0.00	2.00	5.00	0.00	36.00	32.00	24.00
02LD07	5.00	5.00	0.00	64.20	62.00	54.00	88.00	82.00	86.00
02LD10	5.00	5.00	0.00	69.00	76.00	68.00	77.00	79.00	76.00
02LD35	4.00	5.00	2.00	92.25	76.40	57.67	66.50	65.00	69.67
02LD44	3.00	5.00	1.00	10.83	8.00	23.75	21.67	18.00	30.00
02LD15	2.00	5.00	1.00	58.33	25.00	36.25	82.50	44.00	86.25
02LD50	3.00	4.00	3.00	91.67	100.00	100.00	96.67	97.50	95.00
02LD46	3.00	4.00	4.00	41.67	37.50	75.00	66.67	50.00	87.50
02LD47	3.00	5.00	2.00	67.50	89.00	96.00	80.83	71.00	78.92
02LD39	4.00	4.00	2.00	68.75	73.75	61.67	91.13	92.25	85.42
02LD49	4.00	4.00	3.00	27.88	38.13	26.67	61.88	93.13	83.33
02LD42	4.00	5.00	4.00	64.38	34.00	18.75	30.00	50.00	85.00
02LD20	4.00	4.00	2.00	56.25	67.50	65.83	80.00	76.25	81.67
02LD28	3.00	4.00	2.00	69.17	35.00	68.33	77.50	51.25	66.67
02LD01	3.00	5.00	3.00	43.33	62.00	59.17	50.83	54.00	56.67
02LD37	0.00	5.00	3.00	16.00	8.20	9.25	46.00	54.00	40.00
02LD34	3.00	5.00	1.00	75.42	83.80	68.75	77.58	93.40	70.00
02LD09	4.00	5.00	2.00	15.00	16.00	15.00	48.75	60.00	59.17
02LD21	3.00	4.00	4.00	91.67	86.25	85.00	100.00	100.00	100.00
02LD08	3.00	5.00	1.00	80.00	64.18	91.25	71.67	80.00	77.50
02LD02	4.00	5.00	1.00	91.13	79.80	52.50	90.00	78.00	58.75
02LD22	4.00	5.00	1.00	97.50	100.00	93.75	75.00	68.00	52.50
02LD43	5.00	5.00	1.00	48.00	54.00	51.25	62.00	4.00	30.00
02LD40	3.00	5.00	2.00	100.00	100.00	100.00	95.00	96.00	100.00
02LD31	4.00	5.00	3.00	76.25	68.00	67.50	75.00	72.00	73.33
02LD03	2.00	4.00	2.00	28.33	11.88	17.50	62.50	72.50	57.08
02LD32	4.00	5.00	4.00	81.25	75.00	88.13	78.13	86.00	88.13
02LD19	2.00	5.00	2.00	28.67	28.00	34.50	42.50	42.00	41.67
02LD29	2.00	4.00	5.00	87.50	80.00	90.00	85.00	91.25	94.00
02LD14	5.00	4.00	4.00	84.00	93.75	100.00	70.00	87.50	82.50
02LD30	2.00	3.00	3.00	100.00	82.50	98.33	93.33	60.83	82.50
02LD38	4.00	5.00	4.00	100.00	80.00	50.00	100.00	100.00	100.00
02LD33	5.00	5.00	5.00	36.00	40.00	54.00	64.00	52.00	62.00

Appendix C: Data Spreadsheet

	1 Q3COFF	2 Q3CON	3 Q3CUS	4 Q3DOFF	5 Q3DON	6 Q3DUS	7 Q4OFF	8 Q4ON	9 Q4US
02LD17	33.33	19.38	23.00	80.00	50.00	78.00	43.33	66.25	62.00
02LD26	29.88	45.13	51.40	90.00	52.50	84.00	15.13	100.00	100.00
03LD05	78.00	80.00	80.00	98.00	97.50	100.00	14.00	64.38	46.67
02LD04	37.50	21.67	35.00	100.00	100.00	100.00	73.33	73.33	55.00
02LD13	50.00	50.00	60.00	0.00	0.00	0.00	73.13	100.00	100.00
02LD23	37.08	40.40	34.38	86.67	88.00	96.25	41.67	100.00	62.50
02LD06	10.83	0.00	25.83	22.08	7.00	30.83	18.33	100.00	25.00
02LD27	23.75	6.00	6.88	40.83	15.00	8.00	49.17	88.00	78.75
02LD16	46.00	51.67	52.50	87.00	88.33	89.38	26.60	59.17	41.25
02LD41	68.00	63.75	70.00	68.00	75.00	74.00	95.40	92.25	97.20
02LD45	68.00	22.50	27.00	100.00	100.00	100.00	65.00	85.00	85.53
02LD36	25.00	24.00	27.00	94.17	94.00	91.00	30.83	50.00	50.00
02LD24	4.33	1.20	2.60	80.83	37.00	62.00	3.33	89.00	80.00
02LD12	38.75	24.00	26.00	88.75	76.00	84.00	35.00	94.00	76.00
02LD11	38.75	40.00	60.00	97.50	20.00	40.00	50.00	100.00	100.00
02LD25	18.75	18.00	14.00	67.50	48.00	56.00	48.75	98.00	76.00
02LD18	10.00	40.00	42.00	30.00	32.00	16.00	20.00	100.00	100.00
02LD07	71.00	50.00	68.00	72.00	66.00	68.00	24.00	100.00	89.00
02LD10	8.00	8.40	8.40	81.00	73.00	72.00	16.00	100.00	82.00
02LD35	54.50	34.20	57.33	99.13	99.00	99.17	50.00	59.80	56.50
02LD44	33.33	14.00	26.25	24.17	42.00	26.25	26.67	100.00	77.50
02LD15	18.33	6.00	8.75	57.50	44.00	77.50	32.50	98.00	33.75
02LD50	70.83	66.25	77.50	100.00	98.75	96.67	53.33	71.25	33.33
02LD46	7.75	7.75	11.50	66.67	37.50	87.50	0.00	50.00	12.50
02LD47	12.67	16.00	38.33	66.67	47.00	72.92	44.17	97.40	31.67
02LD39	21.25	20.00	27.50	76.88	86.25	86.17	75.00	97.00	50.00
02LD49	30.63	34.38	43.33	55.50	40.63	38.33	50.63	53.75	50.00
02LD42	66.25	20.00	28.75	38.00	50.00	95.00	53.75	100.00	43.75
02LD20	59.38	78.13	66.67	100.00	100.00	100.00	37.50	75.00	49.17
02LD28	42.08	5.00	33.33	75.00	38.75	52.50	12.50	47.50	31.67
02LD01	13.33	16.00	15.83	46.67	44.00	46.67	28.33	100.00	50.00
02LD37	1.20	1.40	1.42	16.00	12.00	15.83	50.00	95.60	68.33
02LD34	30.83	15.00	47.50	89.50	55.00	86.25	12.50	94.00	50.00
02LD09	8.75	6.00	4.17	35.00	62.00	61.67	53.75	92.00	62.50
02LD21	86.67	68.75	65.00	100.00	100.00	100.00	5.00	40.00	55.00
02LD08	47.50	52.00	70.00	92.50	92.00	98.75	75.00	97.80	93.75
02LD02	25.63	23.40	35.00	93.75	78.00	57.50	25.00	95.80	43.63
02LD22	42.50	15.00	27.00	17.50	20.00	1.25	0.00	96.00	47.50
02LD43	9.40	1.00	25.00	80.00	10.00	50.00	10.00	100.00	50.00
02LD40	12.50	10.00	10.00	100.00	100.00	100.00	25.00	93.80	51.25
02LD31	38.75	48.00	56.67	82.50	80.00	81.67	25.00	84.00	44.17
02LD03	14.58	9.88	11.17	82.50	80.00	75.00	7.50	68.75	68.33
02LD32	42.50	40.00	37.50	100.00	86.00	99.38	35.00	96.00	72.50
02LD19	29.50	0.60	1.67	75.83	2.00	56.67	26.67	99.00	44.17
02LD29	66.67	60.00	62.00	100.00	92.50	100.00	25.00	45.00	0.00
02LD14	36.18	17.50	28.75	80.00	100.00	100.00	0.00	37.50	37.50
02LD30	40.00	25.00	27.50	100.00	100.00	100.00	50.00	50.00	29.17
02LD38	80.00	60.00	58.75	100.00	100.00	100.00	12.50	60.00	50.00
02LD33	54.00	50.00	54.00	62.00	49.60	68.00	58.00	54.00	44.00

Appendix C: Data Spreadsheet

	1 Q5OFF	2 Q5ON	3 Q5US	4 Q6OFF	5 Q6ON	6 Q6US
02LD17	66.67	63.75	66.00	72.50	68.75	69.00
02LD26	76.25	100.00	100.00	50.00	5.00	0.00
03LD05	55.50	60.00	54.17	89.00	75.00	78.33
02LD04	90.00	81.67	92.50	60.83	51.67	75.83
02LD13	77.67	99.38	100.00	50.00	0.00	0.00
02LD23	87.50	82.00	57.50	32.25	7.00	64.75
02LD06	55.83	100.00	50.00	6.67	0.00	7.92
02LD27	83.33	90.00	85.00	0.83	0.00	5.50
02LD16	29.00	66.67	51.25	73.00	64.17	80.63
02LD41	89.60	97.88	97.20	60.00	63.75	76.00
02LD45	68.75	85.00	87.69	22.50	41.25	34.12
02LD36	53.33	76.00	73.00	55.00	71.00	58.00
02LD24	73.33	94.00	91.00	70.00	11.00	39.00
02LD12	63.75	86.00	83.80	76.25	40.00	48.00
02LD11	100.00	100.00	100.00	47.50	0.00	0.00
02LD25	75.00	99.00	87.00	13.75	4.00	14.00
02LD18	100.00	100.00	100.00	12.00	1.00	0.00
02LD07	80.40	100.00	88.00	58.00	40.00	58.00
02LD10	96.00	100.00	86.00	64.00	38.00	56.00
02LD35	99.50	99.60	63.00	63.50	14.80	59.50
02LD44	73.33	100.00	100.00	10.00	5.00	25.00
02LD15	31.67	90.00	46.25	73.33	22.00	75.00
02LD50	60.83	71.25	66.67	100.00	100.00	100.00
02LD46	50.00	45.00	12.50	41.67	62.50	100.00
02LD47	70.83	95.80	49.83	70.00	27.00	69.33
02LD39	70.00	98.75	66.67	57.50	9.38	62.50
02LD49	69.75	81.25	50.00	14.38	25.00	12.08
02LD42	66.25	100.00	100.00	64.38	2.00	63.75
02LD20	75.00	75.00	61.67	70.63	47.50	45.83
02LD28	88.33	97.50	67.50	92.50	67.50	70.00
02LD01	75.00	100.00	50.00	86.67	82.00	81.67
02LD37	83.75	93.80	89.75	15.00	3.40	6.17
02LD34	100.00	98.00	71.25	100.00	73.00	76.25
02LD09	78.75	94.00	87.50	11.25	4.00	2.50
02LD21	51.67	40.00	55.00	100.00	85.00	81.25
02LD08	75.00	99.80	73.75	80.00	4.00	43.75
02LD02	57.38	94.00	27.50	92.50	28.00	51.25
02LD22	100.00	100.00	100.00	87.50	80.00	100.00
02LD43	80.00	100.00	100.00	56.00	0.00	30.00
02LD40	95.00	100.00	85.00	100.00	100.00	100.00
02LD31	75.00	85.00	52.50	68.75	70.00	64.58
02LD03	81.67	56.13	85.00	35.83	7.50	14.58
02LD32	54.38	96.00	72.50	60.00	20.00	79.38
02LD19	74.17	99.00	80.83	42.50	2.00	38.33
02LD29	25.00	32.50	0.00	65.83	77.50	82.00
02LD14	100.00	93.75	50.00	86.00	90.00	91.25
02LD30	73.33	70.83	48.33	100.00	100.00	100.00
02LD38	25.00	60.00	62.50	100.00	82.00	100.00
02LD33	58.00	44.00	44.00	43.00	54.00	58.00

Appendix D1: ANOVAS and Post Hoc Tests

DEMOGRAPHIC DATA

Age

Univariate Tests of Significance for AGE (NEWDATA1.STA)
Sigma-restricted parameterization
Effective hypothesis decomposition

Effect	SS	Degr. of Freedom	MS	F	p
Intercept	22138.17	1	22138.17	912.5218	0.000000
GROUP	77.76	1	77.76	3.2052	0.079846
Error	1140.24	47	24.26		

GROUP; Unweighted Means (NEWDATA1.STA)
Current effect: F(1, 47)=3.2052, p=.07985
Effective hypothesis decomposition

Cell No.	GROUP	AGE Mean	AGE Std.Err.	AGE -95.00%	AGE +95.00%	N
1	1	22.52000	0.985097	20.53824	24.50176	25
2	2	20.00000	1.005411	17.97737	22.02263	24

Descriptive Statistics (NEWDATA1.STA)

Effect	Level of Factor	N	AGE Mean	AGE Std.Dev.	AGE Std.Err
Total		49	21.28571	5.037360	0.719623
GROUP	1	25	22.52000	6.265780	1.253156
GROUP	2	24	20.00000	2.934058	0.598912

NART

Univariate Tests of Significance for NART (NEWDATA1.STA)
Sigma-restricted parameterization
Effective hypothesis decomposition

Effect	SS	Degr. of Freedom	MS	F	p
Intercept	55194.56	1	55194.56	1922.445	0.000000
GROUP	0.60	1	0.60	0.021	0.885517
Error	1349.40	47	28.71		

GROUP; LS Means (NEWDATA1.STA)
Current effect: F(1, 47)=.02096, p=.88552
Effective hypothesis decomposition

Cell No.	GROUP	NART Mean	NART Std.Err.	NART -95.00%	NART +95.00%	N
1	1	33.68000	1.071646	31.52413	35.83587	25
2	2	33.45833	1.093744	31.25800	35.65866	24

Descriptive Statistics (NEWDATA1.STA)

Effect	Level of Factor	N	NART Mean	NART Std.Dev.	NART Std.Err.	NART -95.00%	NART +95.00%
Total		49	33.57143	5.303301	0.757614	32.04814	35.09471
GROUP	1	25	33.68000	5.588083	1.117617	31.37335	35.98665
GROUP	2	24	33.45833	5.107362	1.042536	31.30168	35.61498

Digit Span

Effect	SS	Degr. of Freedom	MS	F	p
Intercept	5602.434	1	5602.434	812.0471	0.000000
GROUP	0.148	1	0.148	0.0215	0.884118
Error	324.260	47	6.899		

Univariate Tests of Significance for DS (NEWDATA1.STA)
Sigma-restricted parameterization
Effective hypothesis decomposition

Cell No.	GROUP	DS Mean	DS Std.Err.	DS -95.00%	DS +95.00%	N
1	1	10.64000	0.525325	9.583183	11.69682	25
2	2	10.75000	0.536157	9.671391	11.82861	24

GROUP; LS Means (NEWDATA1.STA)
Current effect: F(1, 47)=.02148, p=.88412
Effective hypothesis decomposition

Effect	Level of Factor	N	DS Mean	DS Std.Dev.	DS Std.Err	DS -95.00%	DS +95.00%
Total		49	10.69388	2.599712	0.371387	9.947153	11.44060
GROUP	1	25	10.64000	2.325224	0.465045	9.680195	11.59981
GROUP	2	24	10.75000	2.908010	0.593595	9.522055	11.97794

Descriptive Statistics (NEWDATA1.STA)

Spatial Span

Effect	SS	Degr. of Freedom	MS	F	p
Intercept	5821.045	1	5821.045	847.3574	0.000000
GROUP	1.616	1	1.616	0.2353	0.629871
Error	322.873	47	6.870		

Univariate Tests of Significance for SS (NEWDATA1.STA)
Sigma-restricted parameterization
Effective hypothesis decomposition

Cell No.	GROUP	SS Mean	SS Std.Err.	SS -95.00%	SS +95.00%	N
1	1	10.72000	0.524200	9.66545	11.77455	25
2	2	11.08333	0.535010	10.00703	12.15963	24

GROUP; LS Means (NEWDATA1.STA)
Current effect: F(1, 47)=.23531, p=.62987
Effective hypothesis decomposition

Effect	Level of Factor	N	SS Mean	SS Std.Dev.	SS Std.Err	SS -95.00%	SS +95.00%
Total		49	10.89796	2.600039	0.371434	10.15114	11.64478
GROUP	1	25	10.72000	2.508652	0.501730	9.68448	11.75552
GROUP	2	24	11.08333	2.733316	0.557936	9.92916	12.23751

Descriptive Statistics (NEWDATA1.STA)

BDI-II

Univariate Tests of Significance for BDI (NEWDATA1.STA) Sigma-restricted parameterization Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	2771.043	1	2771.043	81.76770	0.000000
GROUP	321.411	1	321.411	9.48416	0.003457
Error	1592.793	47	33.889		

GROUP; LS Means (NEWDATA1.STA) Current effect: F(1, 47)=9.4842, p=.00346 Effective hypothesis decomposition						
Cell No.	GROUP	BDI Mean	BDI Std.Err.	BDI -95.00%	BDI +95.00%	N
1	1	4.96000	1.164289	2.617753	7.30225	25
2	2	10.08333	1.188297	7.692787	12.47388	24

Descriptive Statistics (NEWDATA1.STA)							
Effect	Level of Factor	N	BDI Mean	BDI Std.Dev.	BDI Std.Err	BDI -95.00%	BDI +95.00%
Total		49	7.46939	6.315002	0.902143	5.655507	9.28327
GROUP	1	25	4.96000	4.650090	0.930018	3.040537	6.87946
GROUP	2	24	10.08333	6.832891	1.394758	7.198056	12.96861

BAI

Univariate Tests of Significance for BAI (NEWDATA1.STA) Sigma-restricted parameterization Effective hypothesis decomposition					
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	1786.361	1	1786.361	75.66608	0.000000
GROUP	180.402	1	180.402	7.64139	0.008122
Error	1109.598	47	23.608		

GROUP; LS Means (NEWDATA1.STA) Current effect: F(1, 47)=7.6414, p=.00812 Effective hypothesis decomposition						
Cell No.	GROUP	BAI Mean	BAI Std.Err.	BAI -95.00%	BAI +95.00%	N
1	1	4.120000	0.971771	2.165049	6.074951	25
2	2	7.958333	0.991810	5.963070	9.953597	24

Descriptive Statistics (NEWDATA1.STA)							
Effect	Level of Factor	N	BAI Mean	BAI Std.Dev.	BAI Std.Err.	BAI -95.00%	BAI +95.00%
Total		49	6.000000	5.184110	0.740587	4.510950	7.489050
GROUP	1	25	4.120000	5.190697	1.038139	1.977386	6.262614
GROUP	2	24	7.958333	4.486493	0.915802	6.063853	9.852813

Padua Total Score

Effect	Univariate Tests of Significance for PADTOT (NEWDATA1.STA) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	30057.64	1	30057.64	300.0997	0.000000
GROUP	15610.37	1	15610.37	155.8562	0.000000
Error	4707.47	47	100.16		

Cell No.	GROUP; LS Means (NEWDATA1.STA) Current effect: F(1, 47)=155.86, p=.00000 Effective hypothesis decomposition					
	GROUP	PADTOT Mean	PADTOT Std.Err.	PADTOT -95.00%	PADTOT +95.00%	N
1	1	6.92000	2.001588	2.89332	10.94668	25
2	2	42.62500	2.042862	38.51529	46.73471	24

Effect	Descriptive Statistics (NEWDATA1.STA)						
	Level of Factor	N	PADTOT Mean	PADTOT Std.Dev.	PADTOT Std.Err	PADTOT -95.00%	PADTOT +95.00%
Total		49	24.40816	20.57397	2.939139	18.49863	30.31770
GROUP	1	25	6.92000	4.92375	0.984750	4.88758	8.95242
GROUP	2	24	42.62500	13.39310	2.733854	36.96959	48.28041

Padua Checking Score

Effect	Univariate Tests of Significance for PADCH (NEWDATA1.STA) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	4266.667	1	4266.667	390.6494	0.00
GROUP	3401.361	1	3401.361	311.4233	0.00
Error	513.333	47	10.922		

Cell No.	GROUP; LS Means (NEWDATA1.STA) Current effect: F(1, 47)=311.42, p=0.0000 Effective hypothesis decomposition					
	GROUP	PADCH Mean	PADCH Std.Err.	PADCH -95.00%	PADCH +95.00%	N
1	1	1.00000	0.660969	-0.32970	2.32970	25
2	2	17.66667	0.674598	16.30955	19.02378	24

Effect	Descriptive Statistics (NEWDATA1.STA)						
	Level of Factor	N	PADCH Mean	PADCH Std.Dev.	PADCH Std.Err	PADCH -95.00%	PADCH +95.00%
Total		49	9.16327	9.030843	1.290120	6.56930	11.75723
GROUP	1	25	1.00000	1.080123	0.216025	0.55415	1.44585
GROUP	2	24	17.66667	4.593631	0.937671	15.72695	19.60639

MANIPULATION CHECK FOR SET

Q1. Mean No. Correct

Effect	Repeated Measures Analysis of Variance (NEWDATA Sigma-restricted parameterization Effective hypothesis decomposition SS	Degr. of Freedom	MS	F	p
Intercept	1564.694	1	1564.694	1447.574	0.000000
SET	4.095	1	4.095	3.789	0.057590
Error	50.803	47	1.081		
CON	176.858	2	88.429	62.656	0.000000
CON*SET	10.763	2	5.382	3.813	0.025572
Error	132.666	94	1.411		

Cell No.	CON; Unweighted Means (NEWDATA1.STA) Current effect: F(2, 94)=62.656, p=0.0000 Effective hypothesis decomposition CON	DV_1 Mean	N
1	Q1OFFC	3.415552	49
2	Q1ONC	4.535117	49
3	Q1USC	1.855351	49

Effect	Descriptive Statistics (NEWDATA1.STA) Level of Factor	N	Q1OFFC Mean	Q1OFFC Std.Dev.	Q1ONC Mean	Q1ONC Std.Dev.	Q1USC Mean	Q1USC Std.Dev.
Total		49	3.448980	1.137637	4.530612	0.680136	1.857143	1.541104
SET	1	23	2.869565	1.099766	4.608696	0.583027	1.826087	1.613922

Cell No.	CON*SET; Unweighted Means (NEWDATA1.STA) Current effect: F(2, 94)=3.8131, p=.02557 Effective hypothesis decomposition SET	CON	DV_1 Mean	N
1	1	Q1OFFC	2.869565	23
2	1	Q1ONC	4.608696	23
3	1	Q1USC	1.826087	23
4	2	Q1OFFC	3.961538	26
5	2	Q1ONC	4.461538	26
6	2	Q1USC	1.884615	26

Effect	Descriptive Statistics (NEWDATA1.STA) Level of Factor	N	Q1OFFC Mean	Q1OFFC Std.Dev.	Q1ONC Mean	Q1ONC Std.Dev.	Q1USC Mean	Q1USC Std.Dev.
Total		49	3.448980	1.137637	4.530612	0.680136	1.857143	1.541104
SET	1	23	2.869565	1.099766	4.608696	0.583027	1.826087	1.613922
SET	2	26	3.961538	0.915675	4.461538	0.760567	1.884615	1.505375

Q2. Mean Discomfort

Effect	Repeated Measures Analysis of Variance (NEWDATA Sigma-restricted parameterization Effective hypothesis decomposition SS	Degr. of Freedom	MS	F	p
Intercept	461198.4	1	461198.4	208.3850	0.000000
SET	9410.8	1	9410.8	4.2521	0.044754
Error	104020.6	47	2213.2		
CON	279.9	2	140.0	1.1610	0.317637
CON*SET	1.7	2	0.8	0.0070	0.993058
Error	11333.1	94	120.6		

Cell No.	SET; Unweighted Means (NEWDATA1.STA) Current effect: F(1, 47)=4.2521, p=.04475 Effective hypothesis decomposition SET	DV_1 Mean	N
1	1	48.10158	23
2	2	64.13404	26

Effect	Descriptive Statistics (NEWDATA1.STA) Level of Factor	N	Q2OFF Mean	Q2OFF Std.Dev.	Q2ON Mean	Q2ON Std.Dev.	Q2US Mean	Q2US Std.Dev.
Total		49	58.41344	29.47696	55.04239	28.71638	56.36997	30.09608
SET	1	23	49.76703	31.57507	46.53575	31.48407	48.00196	32.90850
SET	2	26	66.06218	25.71577	62.56750	24.19768	63.77244	25.78107

Q3. Cost of Danger

Effect	Repeated Measures Analysis of Variance (NEWDATA1.STA) Sigma-restricted parameterization Effective hypothesis decomposition SS	Degr. of Freedom	MS	F	p
Intercept	652900.1	1	652900.1	497.5830	0.000000
SET	4616.1	1	4616.1	3.5180	0.066926
Error	61670.7	47	1312.1		
CON	424.7	2	212.4	1.4032	0.250905
CON*SET	90.8	2	45.4	0.3000	0.741498
Error	14226.1	94	151.3		

Effect	Descriptive Statistics (NEWDATA1.STA) Level of Factor	N	Q3BOFF Mean	Q3BOFF Std.Dev.	Q3BON Mean	Q3BON Std.Dev.	Q3BUS Mean	Q3BUS Std.Dev.
Total		49	68.97364	22.45401	64.79660	24.84480	67.57041	23.61775
SET	1	23	61.84058	27.65979	59.31667	26.71607	62.30942	27.25086
SET	2	26	75.28365	14.37203	69.64423	22.47180	72.22436	19.22204

Q3c. Probability of Danger

Effect	Repeated Measures Analysis of Variance (NEWDATA1.STA) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	167865.2	1	167865.2	124.9493	0.000000
SET	526.0	1	526.0	0.3915	0.534537
Error	63142.9	47	1343.5		
CON	1778.3	2	889.2	10.2075	0.000097
CON*SET	349.9	2	174.9	2.0083	0.139931
Error	8188.3	94	87.1		

Cell No.	CON; Unweighted Means (NEWDATA1.STA) Current effect: F(2, 94)=10.207, p=.00010 Effective hypothesis decomposition		
	CON	DV_1 Mean	N
1	Q3COFF	36.63911	49
2	Q3CON	28.94245	49
3	Q3CUS	35.98679	49

Effect	Descriptive Statistics (NEWDATA1.STA)							
	Level of Factor	N	Q3COFF Mean	Q3COFF Std.Dev.	Q3CON Mean	Q3CON Std.Dev.	Q3CUS Mean	Q3CUS Std.Dev.
Total		49	36.62136	22.53452	29.12874	22.37672	36.16633	22.26637
SET	1	23	36.92899	23.81768	25.89964	22.13395	33.05435	23.29716
SET	2	26	36.34923	21.80855	31.98526	22.63133	38.91923	21.38928

Q3d. Personal Responsibility

Effect	Repeated Measures Analysis of Variance (NEWDATA1.STA) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	688959.8	1	688959.8	313.7641	0.000000
SET	6818.1	1	6818.1	3.1051	0.084552
Error	103202.1	47	2195.8		
CON	3213.0	2	1606.5	8.9313	0.000281
CON*SET	226.8	2	113.4	0.6305	0.534546
Error	16908.2	94	179.9		

Cell No.	CON; Unweighted Means (NEWDATA1.STA) Current effect: F(2, 94)=8.9313, p=.00028 Effective hypothesis decomposition		
	CON	DV_1 Mean	N
1	Q3DOFF	72.96210	49
2	Q3DON	62.09351	49
3	Q3DUS	70.71105	49

Effect	Descriptive Statistics (NEWDATA1.STA)							
	Level of Factor	N	Q3DOFF Mean	Q3DOFF Std.Dev.	Q3DON Mean	Q3DON Std.Dev.	Q3DUS Mean	Q3DUS Std.Dev.
Total		49	73.42007	27.31205	62.57772	31.91523	71.02211	29.74114
SET	1	23	65.48188	31.76424	54.18478	34.26171	65.63043	32.36836
SET	2	26	80.44231	20.85837	70.00224	28.29384	75.79167	26.94288

Q4. Memory Certainty

Effect	Repeated Measures Analysis of Variance (NEWDATA1.STA) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	499935.6	1	499935.6	619.7312	0.000000
SET	2698.8	1	2698.8	3.3455	0.073736
Error	37914.8	47	806.7		
CON	53469.3	2	26734.6	83.1941	0.000000
CON*SET	1502.5	2	751.2	2.3378	0.102133
Error	30207.1	94	321.4		

Cell No.	CON; Unweighted Means (NEWDATA1.STA) Current effect: F(2, 94)=83.194, p=0.0000 Effective hypothesis decomposition		
	CON	DV_1 Mean	N
1	Q4OFF	35.26550	49
2	Q4ON	82.06248	49
3	Q4US	57.95313	49

Effect	Descriptive Statistics (NEWDATA1.STA)							
	Level of Factor	N	Q4OFF Mean	Q4OFF Std.Dev.	Q4ON Mean	Q4ON Std.Dev.	Q4US Mean	Q4US Std.Dev.
Total		49	34.76105	22.79926	81.80255	20.57825	57.92901	23.73739
SET	1	23	43.50471	21.18684	86.30797	19.13359	58.34696	25.28496
SET	2	26	27.02628	21.69001	77.81699	21.34699	57.55929	22.78021

Q5. Memory Confidence

Effect	Repeated Measures Analysis of Variance (NEWDATA1.STA) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	851668.5	1	851668.5	898.3167	0.000000
SET	107.2	1	107.2	0.1131	0.738145
Error	44559.4	47	948.1		
CON	6439.6	2	3219.8	17.9527	0.000000
CON*SET	312.4	2	156.2	0.8709	0.421943
Error	16858.8	94	179.3		

Cell No.	CON	DV_1 Mean	N
1	Q5OFF	72.19758	49
2	Q5ON	85.61017	49
3	Q5US	70.96979	49

CON; Unweighted Means (NEWDATA1.STA)
Current effect: F(2, 94)=17.953, p=.00000
Effective hypothesis decomposition

Effect	Level of Factor	N	Q5OFF Mean	Q5OFF Std.Dev.	Q5ON Mean	Q5ON Std.Dev.	Q5US Mean	Q5US Std.Dev.
Total		49	72.25510	19.48995	85.55697	18.60778	70.80830	23.71033
SET	1	23	71.25797	18.89583	86.47899	18.89704	73.60754	24.56628
SET	2	26	73.13718	20.33218	84.74135	18.68365	68.33205	23.12395

Descriptive Statistics (NEWDATA1.STA)

Q6. Desire to Check

Effect	SS	Degr. of Freedom	MS	F	p
Intercept	373414.0	1	373414.0	150.0813	0.000000
SET	5600.8	1	5600.8	2.2510	0.140213
Error	116939.7	47	2488.1		
CON	10234.1	2	5117.1	21.1448	0.000000
CON*SET	338.9	2	169.4	0.7002	0.499062
Error	22748.0	94	242.0		

Repeated Measures Analysis of Variance (NEWDATA1.STA)
Sigma-restricted parameterization
Effective hypothesis decomposition

Cell No.	CON	DV_1 Mean	N
1	Q6OFF	58.73460	49
2	Q6ON	39.03352	49
3	Q6US	53.71819	49

CON; Unweighted Means (NEWDATA1.STA)
Current effect: F(2, 94)=21.145, p=.00000
Effective hypothesis decomposition

Effect	Level of Factor	N	Q6OFF Mean	Q6OFF Std.Dev	Q6ON Mean	Q6ON Std.Dev	Q6US Mean	Q6US Std.Dev	Q6US Std.Err	Q6US +95.00%
Total		49	59.2406	28.9316	39.3195	34.0191	54.0619	32.2422	4.60604	63.3230
SET	1	23	50.4692	31.6654	34.3615	35.4637	48.1030	33.3858	6.96143	62.5401
SET	2	26	67.0000	24.3175	43.7054	32.7511	59.3333	30.8793	6.05594	71.8057

Descriptive Statistics (NEWDATA1.STA)

GROUP COMPARISONS

Q1. Mean No. Correct

Effect	Repeated Measures Analysis of Variance (NEWDATA1.STA) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	1575.208	1	1575.208	1576.718	0.000000
GROUP	7.943	1	7.943	7.951	0.007016
Error	46.955	47	0.999		
CON	177.275	2	88.637	58.145	0.000000
CON*GROUP	0.132	2	0.066	0.043	0.957678
Error	143.297	94	1.524		

Cell No.	GROUP; Unweighted Means (NEWDATA1.STA) Current effect: F(1, 47)=7.9506, p=.00702 Effective hypothesis decomposition		
	GROUP	DV_1 Mean	N
1	1	3.506667	25
2	2	3.041667	24

Cell No.	CON; Unweighted Means (NEWDATA1.STA) Current effect: F(2, 94)=58.145, p=0.0000 Effective hypothesis decomposition		
	CON	DV_1 Mean	N
1	Q1OFFC	3.445000	49
2	Q1ONC	4.525833	49
3	Q1USC	1.851667	49

Cell No.	CON*GROUP; Unweighted Means (NEWDATA1.STA) Current effect: F(2, 94)=.04326, p=.95768 Effective hypothesis decomposition			
	GROUP	CON	DV_1 Mean	N
1	1	Q1OFFC	3.640000	25
2	1	Q1ONC	4.760000	25
3	1	Q1USC	2.120000	25
4	2	Q1OFFC	3.250000	24
5	2	Q1ONC	4.291667	24
6	2	Q1USC	1.583333	24

Effect	Descriptive Statistics (NEWDATA1.STA)							
	Level of Factor	N	Q1OFFC Mean	Q1OFFC Std.Dev.	Q1ONC Mean	Q1ONC Std.Dev.	Q1USC Mean	Q1USC Std.Dev.
Total		49	3.448980	1.137637	4.530612	0.680136	1.857143	1.541104
GROUP	1	25	3.640000	1.036018	4.760000	0.435890	2.120000	1.536229
GROUP	2	24	3.250000	1.224745	4.291667	0.806450	1.583333	1.529895

BDI-II ANCOVA

Effect	Multivariate Tests of Significance (NEWDATA1.STA) Sigma-restricted parameterization Effective hypothesis decomposition					
	Test	Value	F	Effect df	Error df	p
Intercept	Wilks	0.036102	391.5909	3	44	0.000000
BDI	Wilks	0.922066	1.2396	3	44	0.306772
GROUP	Wilks	0.797332	3.7280	3	44	0.017937

BAI ANCOVA

Effect	Multivariate Tests of Significance (NEWDATA1.STA) Sigma-restricted parameterization Effective hypothesis decomposition					
	Test	Value	F	Effect df	Error df	p
Intercept	Wilks	0.034832	406.4030	3	44	0.000000
BAI	Wilks	0.997703	0.0338	3	44	0.991556
GROUP	Wilks	0.810763	3.4233	3	44	0.025183

Q2. Discomfort

Effect	Repeated Measures Analysis of Variance (NEWDATA1.STA) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	467235.5	1	467235.5	259.8468	0.000000
GROUP	15354.9	1	15354.9	8.5394	0.005419
SET	8498.8	1	8498.8	4.7265	0.035000
GROUP*SET	9133.4	1	9133.4	5.0794	0.029130
Error	80915.4	45	1798.1		
CON	268.7	2	134.4	1.0827	0.343034
CON*GROUP	85.0	2	42.5	0.3424	0.710972
CON*SET	2.8	2	1.4	0.0114	0.988703
CON*GROUP*SET	90.0	2	45.0	0.3625	0.696959
Error	11167.8	90	124.1		

Cell No.	GROUP; Unweighted Means (NEWDATA1.STA) Current effect: F(1, 45)=8.5394, p=.00542 Effective hypothesis decomposition		
	GROUP	DV_1 Mean	N
1	1	46.26759	25
2	2	66.75697	24

Cell No.	SET; Unweighted Means (NEWDATA1.STA) Current effect: F(1, 45)=4.7265, p=.03500 Effective hypothesis decomposition		
	SET	DV_1 Mean	N
1	1	48.89053	23
2	2	64.13404	26

Cell No.	GROUP	SET	DV_1 Mean	N
	GROUP*SET; Unweighted Means (NEWDATA1.STA) Current effect: F(1, 45)=5.0794, p=.02913 Effective hypothesis decomposition			
1	1	1	30.74468	12
2	1	2	61.79051	13
3	2	1	67.03638	11
4	2	2	66.47756	13

Effect	Level of Factor	Level of Factor	N	Q2OFF Mean	Q2OFF Std.Dev.	Q2ON Mean	Q2ON Std.Dev.	Q2US Mean	Q2US Std.Dev.
	Descriptive Statistics (NEWDATA1.STA)								
Total			49	58.41344	29.47696	55.04239	28.71638	56.36997	30.09608
GROUP	1		25	49.61067	32.21523	45.18320	28.98560	45.87167	30.32977
GROUP	2		24	67.58299	23.63114	65.31239	25.07109	67.30569	26.18842
SET	1		23	49.76703	31.57507	46.53575	31.48407	48.00196	32.90850
SET	2		26	66.06218	25.71577	62.56750	24.19768	63.77244	25.78107
GROUP*SET	1	1	12	34.43542	28.13960	28.50000	23.91462	29.29861	25.28041
GROUP*SET	1	2	13	63.61859	30.11527	60.58308	24.91650	61.16987	26.93965
GROUP*SET	2	1	11	66.49242	27.06590	66.21111	27.11946	68.40561	28.31616
GROUP*SET	2	2	13	68.50577	21.39728	64.55192	24.29990	66.37500	25.38297

Cell No.	GROUP	SET	{1} 30.745	{2} 61.791	{3} 67.036	{4} 66.478
	Newman-Keuls test; variable DV_1 (NEWDATA1.STA) Approximate Probabilities for Post Hoc Tests Error: Between MS = 1798.1, df = 45.000					
1	1	1		0.003208	0.003679	0.00231
2	1	2	0.003208		0.857606	0.638842
3	2	1	0.003679	0.857606		0.955414
4	2	2	0.002311	0.638842	0.955414	

BDI-II ANCOVA

Effect	Test	Value	F	Effect df	Error df	p
	Multivariate Tests of Significance (NEWDATA1.STA Sigma-restricted parameterization Effective hypothesis decomposition					
Intercept	Wilks	0.398175	22.16809	3	44	0.000000
BDI	Wilks	0.859415	2.39921	3	44	0.080654
GROUP	Wilks	0.869270	2.20572	3	44	0.100807

BAI ANCOVA

Effect	Test	Value	F	Effect df	Error df	p
	Multivariate Tests of Significance (NEWDATA1.STA Sigma-restricted parameterization Effective hypothesis decomposition					
Intercept	Wilks	0.364144	25.61039	3	44	0.000000
BAI	Wilks	0.941780	0.90669	3	44	0.445545
GROUP	Wilks	0.865362	2.28192	3	44	0.092324

Q3b. Cost of Danger

Effect	Repeated Measures Analysis of Variance (NEWDATA1.STA) Sigma-restricted parameterization Effective hypothesis decomposition SS	Degr. of Freedom	MS	F	p
Intercept	664779.6	1	664779.6	534.1144	0.000000
GROUP	7788.8	1	7788.8	6.2578	0.015905
Error	58498.0	47	1244.6		
CON	435.1	2	217.6	1.4492	0.239965
CON*GROUP	205.2	2	102.6	0.6833	0.507424
Error	14111.8	94	150.1		

Cell No.	GROUP; Unweighted Means (NEWDATA1.STA) Current effect: F(1, 47)=6.2578, p=.01590 Effective hypothesis decomposition GROUP	DV_1 Mean	DV_1 Std.Err.	DV_1 -95.00%	DV_1 +95.00%	N
1	1	59.98156	4.073719	51.78629	68.17682	25
2	2	74.54271	4.157722	66.17845	82.90697	24

Effect	Descriptive Statistics (NEWDATA1.STA) Level of Factor	N	Q3BOFF Mean	Q3BOFF Std.Dev.	Q3BON Mean	Q3BON Std.Dev.	Q3BUS Mean	Q3BUS Std.Dev.
Total		49	68.97364	22.45401	64.79660	24.84480	67.57041	23.61775
GROUP	1	25	61.76833	26.44916	56.28500	29.04485	61.89133	28.36112
GROUP	2	24	76.47917	14.38819	73.66285	15.72089	73.48611	15.91232

Cell No.	CON*GROUP; Unweighted Means (NEWDATA1.STA) Current effect: F(2, 94)=.68333, p=.50742 Effective hypothesis decomposition GROUP	CON	DV_1 Mean	N
1	1	Q3BOFF	61.76833	25
2	1	Q3BON	56.28500	25
3	1	Q3BUS	61.89133	25
4	2	Q3BOFF	76.47917	24
5	2	Q3BON	73.66285	24
6	2	Q3BUS	73.48611	24

BDI-II ANCOVA

Effect	Multivariate Tests of Significance (NEWDATA1.STA) Sigma-restricted parameterization Effective hypothesis decomposition Test	Value	F	Effect df	Error df	p
Intercept	Wilks	0.208986	55.51334	3	44	0.000000
BDI	Wilks	0.798591	3.69902	3	44	0.018522
GROUP	Wilks	0.859938	2.38883	3	44	0.081624

BAI ANCOVA

Effect	Multivariate Tests of Significance (NEWDATA1.STA) Sigma-restricted parameterization Effective hypothesis decomposition					
	Test	Value	F	Effect df	Error df	p
Intercept	Wilks	0.188849	62.99664	3	44	0.000000
BAI	Wilks	0.876962	2.05773	3	44	0.119600
GROUP	Wilks	0.833220	2.93573	3	44	0.043652

Q3c. Probability of Danger

Effect	Repeated Measures Analysis of Variance (NEWDATA1.STA) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	169772.1	1	169772.1	125.5742	0.000000
GROUP	126.5	1	126.5	0.0936	0.761039
Error	63542.4	47	1352.0		
CON	1736.6	2	868.3	9.6564	0.000153
CON*GROUP	85.9	2	42.9	0.4776	0.621739
Error	8452.3	94	89.9		

Cell No.	CON; Unweighted Means (NEWDATA1.STA) Current effect: F(2, 94)=9.6564, p=.00015 Effective hypothesis decomposition		
	CON	DV_1 Mean	N
1	Q3COFF	36.66234	49
2	Q3CON	29.13753	49
3	Q3CUS	36.17337	49

Cell No.	CON*GROUP; Unweighted Means (NEWDATA1.STA) Current effect: F(2, 94)=.47765, p=.62174 Effective hypothesis decomposition			
	GROUP	CON	DV_1 Mean	N
1	1	Q3COFF	34.65433	25
2	1	Q3CON	28.70700	25
3	1	Q3CUS	35.82833	25
4	2	Q3COFF	38.67035	24
5	2	Q3CON	29.56806	24
6	2	Q3CUS	36.51840	24

Effect	Descriptive Statistics (NEWDATA1.STA)							
	Level of Factor	N	Q3COFF Mean	Q3COFF Std.Dev.	Q3CON Mean	Q3CON Std.Dev.	Q3CUS Mean	Q3CUS Std.Dev.
Total		49	36.62136	22.53452	29.12874	22.37672	36.16633	22.26637
GROUP	1	25	34.65433	22.66127	28.70700	22.79114	35.82833	23.81283
GROUP	2	24	38.67035	22.70064	29.56806	22.41787	36.51840	21.04130

Q3d. Responsibility

Effect	Repeated Measures Analysis of Variance (NEWDATA1.STA) Sigma-restricted parameterization Effective hypothesis decomposition SS	Degr. of Freedom	MS	F	p
Intercept	703332.5	1	703332.5	334.6082	0.000000
GROUP	11228.1	1	11228.1	5.3417	0.025255
Error	98792.0	47	2102.0		
CON	3157.2	2	1578.6	8.7551	0.000326
CON*GROUP	186.3	2	93.2	0.5168	0.598139
Error	16948.7	94	180.3		

Cell No.	GROUP; Unweighted Means (NEWDATA1.STA) Current effect: F(1, 47)=5.3417, p=.02525 Effective hypothesis decomposition GROUP	DV_1 Mean	N
1	1	60.44356	25
2	2	77.92650	24

Cell No.	CON; Unweighted Means (NEWDATA1.STA) Current effect: F(2, 94)=8.7551, p=.00033 Effective hypothesis decomposition CON	DV_1 Mean	N
1	Q3DOFF	73.60278	49
2	Q3DON	62.78186	49
3	Q3DUS	71.17045	49

Cell No.	CON*GROUP; Unweighted Means (NEWDATA1.STA) Current effect: F(2, 94)=.51675, p=.59814 Effective hypothesis decomposition GROUP	CON	DV_1 Mean	N
1	1	Q3DOFF	64.65000	25
2	1	Q3DON	52.77900	25
3	1	Q3DUS	63.90167	25
4	2	Q3DOFF	82.55556	24
5	2	Q3DON	72.78472	24
6	2	Q3DUS	78.43924	24

Effect	Descriptive Statistics (NEWDATA1.STA) Level of Factor	N	Q3DOFF Mean	Q3DOFF Std.Dev.	Q3DON Mean	Q3DON Std.Dev.	Q3DUS Mean	Q3DUS Std.Dev.
Total		49	73.42007	27.31205	62.57772	31.91523	71.02211	29.74114
GROUP	1	25	64.65000	29.01828	52.77900	33.28760	63.90167	31.69773
GROUP	2	24	82.55556	22.52558	72.78472	27.50306	78.43924	26.17327

BDI-II ANCOVA

Effect	Multivariate Tests of Significance (NEWDATA1.STA) Sigma-restricted parameterization Effective hypothesis decomposition					
	Test	Value	F	Effect df	Error df	p
Intercept	Wilks	0.283781	37.01643	3	44	0.000000
BDI	Wilks	0.899722	1.63466	3	44	0.195022
GROUP	Wilks	0.913225	1.39364	3	44	0.257322

BAI ANCOVA

Effect	Multivariate Tests of Significance (NEWDATA1.STA) Sigma-restricted parameterization Effective hypothesis decomposition					
	Test	Value	F	Effect df	Error df	p
Intercept	Wilks	0.247413	44.61340	3	44	0.000000
BAI	Wilks	0.979225	0.31117	3	44	0.817187
GROUP	Wilks	0.872780	2.13787	3	44	0.109023

Q4. Memory Certainty

Effect	Repeated Measures Analysis of Variance (NEWDATA1.STA) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	495529.9	1	495529.9	619.1900	0.000000
GROUP	3000.1	1	3000.1	3.7488	0.058872
Error	37613.5	47	800.3		
CON	54205.6	2	27102.8	81.0961	0.000000
CON*GROUP	294.3	2	147.1	0.4403	0.645181
Error	31415.3	94	334.2		

Cell No.	CON; Unweighted Means (NEWDATA1.STA) Current effect: F(2, 94)=81.096, p=0.0000 Effective hypothesis decomposition		
	CON	DV_1 Mean	N
1	Q4OFF	34.64644	49
2	Q4ON	81.69196	49
3	Q4US	57.87758	49

Cell No.	CON*GROUP; Unweighted Means (NEWDATA1.STA) Current effect: F(2, 94)=.44027, p=.64518 Effective hypothesis decomposition			
	GROUP	CON	DV_1 Mean	N
1	1	Q4OFF	40.26267	25
2	1	Q4ON	87.11100	25
3	1	Q4US	60.39800	25
4	2	Q4OFF	29.03021	24
5	2	Q4ON	76.27292	24
6	2	Q4US	55.35715	24

Effect	Descriptive Statistics (NEWDATA1.STA) Level of Factor	N	Q4OFF Mean	Q4OFF Std.Dev.	Q4ON Mean	Q4ON Std.Dev.	Q4US Mean	Q4US Std.Dev.
Total		49	34.76105	22.79926	81.80255	20.57825	57.92901	23.73739
GROUP	1	25	40.26267	23.81781	87.11100	17.89836	60.39800	24.45541
GROUP	2	24	29.03021	20.63225	76.27292	22.06663	55.35715	23.20186

BDI-II ANCOVA

Effect	Multivariate Tests of Significance (NEWDATA1.STA) Sigma-restricted parameterization Effective hypothesis decomposition Test	Value	F	Effect df	Error df	p
Intercept	Wilks	0.112334	115.8961	3	44	0.000000
BDI	Wilks	0.899496	1.6388	3	44	0.194102
GROUP	Wilks	0.897322	1.6783	3	44	0.185448

BAI ANCOVA

Effect	Multivariate Tests of Significance (NEWDATA1.STA) Sigma-restricted parameterization Effective hypothesis decomposition Test	Value	F	Effect df	Error df	p
Intercept	Wilks	0.131155	97.16034	3	44	0.000000
BAI	Wilks	0.833377	2.93240	3	44	0.043818
GROUP	Wilks	0.829668	3.01109	3	44	0.040072

Q5. Memory Confidence

Effect	Repeated Measures Analysis of Variance (NEWDATA1.STA) Sigma-restricted parameterization Effective hypothesis decomposition SS	Degr. of Freedom	MS	F	p
Intercept	852527.1	1	852527.1	906.5791	0.000000
GROUP	468.8	1	468.8	0.4985	0.483626
Error	44197.8	47	940.4		
CON	6414.6	2	3207.3	18.1684	0.000000
CON*GROUP	577.3	2	288.6	1.6350	0.200448
Error	16593.9	94	176.5		

Cell No.	CON; Unweighted Means (NEWDATA1.STA) Current effect: F(2, 94)=18.168, p=.00000 Effective hypothesis decomposition CON	DV_1 Mean	N
1	Q5OFF	72.27065	49
2	Q5ON	85.47387	49
3	Q5US	70.76650	49

Cell No.	GROUP	CON	DV_1 Mean	N
CON*GROUP; LS Means (NEWDATA1.STA) Current effect: F(2, 94)=1.6350, p=.20045 Effective hypothesis decomposition				
1	1	Q5OFF	71.50900	25
2	1	Q5ON	89.54600	25
3	1	Q5US	72.81467	25
4	2	Q5OFF	73.03229	24
5	2	Q5ON	81.40174	24
6	2	Q5US	68.71833	24

Effect	Level of Factor	N	Q5OFF Mean	Q5OFF Std.Dev.	Q5ON Mean	Q5ON Std.Dev.	Q5US Mean	Q5US Std.Dev.
Descriptive Statistics (NEWDATA1.STA)								
Total		49	72.25510	19.48995	85.55697	18.60778	70.80830	23.71033
GROUP	1	25	71.50900	19.22642	89.54600	17.63765	72.81467	23.75598
GROUP	2	24	73.03229	20.14409	81.40174	19.04424	68.71833	23.98807

Q6. Desire to Check

Effect	SS	Degr. of Freedom	MS	F	p
Repeated Measures Analysis of Variance (NEWD Sigma-restricted parameterization Effective hypothesis decomposition					
Intercept	383142.9	1	383142.9	163.9244	0.0000
GROUP	12686.6	1	12686.6	5.4279	0.0241
Error	109853.8	47	2337.3		
CON	10402.2	2	5201.1	21.6127	0.0000
CON*GROUP	465.9	2	232.9	0.9680	0.3836
Error	22621.0	94	240.6		

Cell No.	GROUP	DV_1 Mean	N
GROUP; Unweighted Means (NEWDATA1.STA) Current effect: F(1, 47)=5.4279, p=.02416 Effective hypothesis decomposition			
1	1	41.77178	25
2	2	60.35560	24

Cell No.	CON	DV_1 Mean	N
CON; Unweighted Means (NEWDATA1.STA) Current effect: F(2, 94)=21.613, p=.00000 Effective hypothesis decomposition			
1	Q6OFF	59.43094	49
2	Q6ON	39.55336	49
3	Q6US	54.20677	49

Cell No.	CON*GROUP; Unweighted Means (NEWDATA1.STA) Current effect: F(2, 94)=.96798, p=.38360 Effective hypothesis decomposition			
	GROUP	CON	DV_1 Mean	N
1	1	Q6OFF	50.10667	25
2	1	Q6ON	28.09700	25
3	1	Q6US	47.11167	25
4	2	Q6OFF	68.75521	24
5	2	Q6ON	51.00972	24
6	2	Q6US	61.30188	24

Effect	Descriptive Statistics (NEWDATA1.STA)							
	Level of Factor	N	Q6OFF Mean	Q6OFF Std.Dev.	Q6ON Mean	Q6ON Std.Dev.	Q6US Mean	Q6US Std.Dev.
Total		49	59.24065	28.93163	39.31956	34.01911	54.06197	32.24229
GROUP	1	25	50.10667	30.24012	28.09700	33.55419	47.11167	35.00861
GROUP	2	24	68.75521	24.64736	51.00972	30.99838	61.30188	27.98991

BDI-II ANCOVA

Effect	Multivariate Tests of Significance (NEWDATA1.STA) Sigma-restricted parameterization Effective hypothesis decomposition					
	Test	Value	F	Effect df	Error df	p
Intercept	Wilks	0.385602	23.36906	3	44	0.000000
BDI	Wilks	0.958280	0.63853	3	44	0.594251
GROUP	Wilks	0.861267	2.36251	3	44	0.084136

BAI ANCOVA

Effect	Multivariate Tests of Significance (NEWDATA1.STA) Sigma-restricted parameterization Effective hypothesis decomposition					
	Test	Value	F	Effect df	Error df	p
Intercept	Wilks	0.395168	22.44832	3	44	0.000000
BAI	Wilks	0.890575	1.80210	3	44	0.160729
GROUP	Wilks	0.853034	2.52687	3	44	0.069645

Appendix D2: Theme Analyses

Table 8. Theme analysis for Set 1 and Set 2.

		Break-in/Theft	Fire/ Burn	Flood	Waste water/ Run out	Other	Nothing/Is locked/Left on or open
Set 1 (N=23)							
Car Door	ON	23					
	OFF	20				2	1
	US	21				1	1
Backdoor	ON	19				2	2
	OFF	18				0	5
	US	21				1	1
Oven	ON		18			2	3
	OFF		17			3	3
	US		18			2	3
Heater	ON		15			6	2
	OFF		14			6	3
	US		16			4	3
B/Tap	ON			12	9	2	0
	OFF			11	7	3	2
	US			13	7	2	1
Set 2 (N=26)							
Car boot	ON	25				1	
	OFF	22				2	2
	US	23				2	1
Front door	ON	26					
	OFF	24					2
	US	24					2
Hotplate	ON		25			1	
	OFF		23			1	2
	US		23			1	2
Iron	ON		26				
	OFF		24				2
	US		24				2
Sink tap	ON			22	3	1	
	OFF			20	5		1
	US			23	3		

Note. 'Other' includes responses such as overheating, feel guilty, waste electricity etc.

Table 9. Theme Analysis for High and Low Checking groups.

High Checkers (N=24)							
		Break-in/Theft	Fire/ Burn	Flood	Waste water/ Run out	Other	Nothing/Is locked/Left on or open
Car Door/Boot	ON	**24**					
	OFF	**22**				**1**	**1**
	US	**23**				**1**	
Front/Backdoor	ON	**24**					
	OFF	**24**					
	US	**24**					
Oven/Hotplate	ON		**24**				
	OFF		**24**				
	US		**24**				
Heater/Iron	ON		**21**			**3**	
	OFF		**23**			**1**	
	US		**23**			**1**	
B/K.Tap	ON			**18**	**4**	**2**	
	OFF			**15**	**5**	**3**	**1**
	US			**19**	**2**	**2**	**1**
Low Checkers (N=25)							
Car Door/Boot	ON	**24**					**1**
	OFF	**20**				**2**	**3**
	US	**22**					**3**
Front/Back door	ON	**21**				**1**	**3**
	OFF	**18**					**7**
	US	**21**					**4**
Oven/Hotplate	ON		**19**			**2**	**4**
	OFF		**17**			**3**	**5**
	US		**19**			**2**	**4**
Heater/Iron	ON		**18**			**5**	**2**
	OFF		**14**			**6**	**5**
	US		**16**			**4**	**5**
B/K.Tap	ON			**16**	**8**	**1**	
	OFF			**16**	**7**		**2**
	US			**18**	**7**		

Note. 'Other' includes responses such as overheating, feel guilty, waste electricity etc.