An Examination of the Association Between Perceived Stress and Memory Performance and the Utilization of Mindfulness as a Memory Enhancer

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A thesis submitted in partial fulfilment for the award of BA

(Hons) in Psychology

National College of Ireland

Submitted to the National College of Ireland, April 2018

National College of Ireland

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Acknowledgments

I would like to use this opportunity to firstly thank all of the participants who gave up their time to take part in my study, it is greatly appreciated.

I would also like to express my gratitude to all of my past lecturers throughout my years of studying at the National College of Ireland, for all of their continued support and guidance.

I am ever so grateful to my parents, whom without their love and support, I would not have been able to come this far.

Finally, I would especially like to take a moment to thank my supervisor Dr. Michelle Kelly for her patience, encouragement, motivation and continued assistance throughout the duration of my thesis.

Abstract

Objective: Stress levels today among individuals are on the increase due to higher educational and workforce demands. Extensive research has suggested that stress can have major impacts on an individual's memory functioning. This study aims to investigate the relationship between perceived stress and immediate memory and to examine if mindfulness is an effective stress-reducer, which in turn improves memory scores. ***Methodology:*** 43 participants (23 females, 20 males) firstly completed a 10-item Perceived Stress Scale, followed by a pre-intervention Free Recall Memory Task. Participants then took part in a 15-minute mindfulness intervention, and finally, a second post-intervention Free Recall Memory Task was completed. ***Results:*** Female students reported the highest amount of perceived stress, revealed from a two-way ANOVA. A Pearson correlation coefficient identified a strong negative correlation between perceived stress and memory scores. A mixed between-within subjects ANOVA indicated that participants memory score significantly improved after participation in the mindfulness intervention, particularly for females. ***Discussion:*** Findings from the current study suggest that perceived stress can have a negative impact on immediate memory and that mindfulness is a successful treatment for improving memory scores. Previous literature, implications, and future recommendations are also discussed.

Keywords: memory functioning, perceived stress, immediate memory, mindfulness

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Introduction

Mindfulness has been recommended as a treatment for maintaining and improving a healthy memory functioning (Jha et al., 2010). Stress, however, has been identified as a psychological response related to memory impairments (Yuen et al., 2012). A substantial amount of research has been conducted in order to explore these statements, thus, the current literature review explores stress, memory, and their relationship, and gives insight into mindfulness as a beneficial intervention for reducing stress and improving memory. Firstly, a general overview of memory from the literature is examined.

1.1 Memory

Memory, the means by which information is stored, encoded and received, has been a topic of interest in the research world for many years. An earlier definition for memory is that it is 'the way in which individuals draw on their past experiences, in order to utilize the information in the present' (Sternberg, 1999). Matlin (2005) defines memory as 'a system that maintains information over time'. According to Eysenck (2012), without memory, we wouldn't have a personal identity. It also allows individuals to function, operate in the present and plan the future, therefore, it is absolutely critical to identify any factors that may impair it.

Researchers such as Josselyn (2010) put forward the question 'which neurons group together to make the physical representation of memory?'. The search for this answer began to be explored 100 years ago by psychologists such as Karl Lashley, who trained animals and made lesions in their brains in an attempt to locate the 'engram'. Recent literature states that the hippocampus and the prefrontal cortex interplay in the encoding, storing and retrieving of information (Preston & Eichenbaum, 2013). Also, the amygdala has a role in memory formation as it regulates emotions and memory storage is influenced by stress hormones

(Josselyn, 2010). Some neurotransmitters such as dopamine, acetylcholine, epinephrine, serotonin, and glutamate are also involved in the memory process (Myhrer, 2003).

Memory, which is now a very frequent research topic, began to be studied around 1957 when a patient known as H.M, underwent a bilateral medial temporal lobe resection to alleviate epilepsy and as a result, suffered from a memory deficit. Patient H.M's profound forgetfulness became an influential research study (Scoville and Milner, 1957; Squire, 2009). It became clear that only one type of memory was affected by patient H.M's surgery, declarative memory. The patient's ability to remember events and facts was excessively inhibited and from this, it became known that memory was not a unitary faculty, but is in fact composed of different systems that hold distinctive operations (Squire, 2004).

Memory is divided into a long-term and short-term system. Long-term memory, the final stage of the multistore model of memory (Atkinson & Shiffrin, 1968), refers to the store in which information is held for lengthily periods of time. Earlier psychologists, such as Tulving (1972), identified distinctions between episodic memory, related to information regarding events, semantic memory, related to information regarding the world, and procedural memory, related to remembering how to do things. The learning of skills occurs through procedural memory, which takes place with the absence of conscious attention (Eysenck, 2012; Foerde & Poldrack, 2009). In 1980, Cohen and Squire established a contrast between declarative and non-declarative procedural knowledge, also described as explicit and implicit memories. Explicit memories require conscious thought, whereas implicit memories don't (Foerde & Poldrack, 2009), for example, knowing how to ride a bike.

Short-term memory, also described as working memory, is where information is stored for a short time period before being relocated to long-term memory. It is the second stage of the multi-store model of memory (Atkinson & Shiffrin, 1968) and the information involved in this stage is very fragile and can be easily lost. "One of the most important and influential

proposals that have emerged from the information processing framework is the construct of working memory" (Pisoni & Cleary, 2003). In learning, working memory is fundamental in allowing for concentration, mental effort, and purposeful thinking to occur (Kronenberger, Pisoni, Henning, Colson & Hazzard, 2011). To enable executive functioning, working memory is essential, as it supports assorted abilities, such as learning, reasoning, and preparation for action (Baddeley & Hitch, 1974).

It is important to construct clinical interventions in an attempt to protect short-term memory as it is so delicate but so frequently used. Currently, interventional working memory training programmes, such as 'Cogmed', are being utilized in an attempt to improve cognition and memory. Studies conducted to examine the effectiveness of these programmes demonstrate that they produce reliable short-term improvements in working memory skills (Rode et al., 2014). However, there are mixed findings as some studies did not find these methods of enhancing working memory or intelligence to be effective (Melby-Lervag, Redick & Hulme, 2016).

*1.2 **Stress***

It is critical to identify which circumstances have an impact on memory to better understand it. Stress is a state which can cause mental or emotional strain and can interfere with an individual's capability of encoding information and their abilities to retrieve memories (de Quervain et al., 1998; Kuhlmann, 2005). One of the first definitions of stress was defined in 1936, indicating that it was "the non-specific response of the body to any demand for change" (Hans Selye, 1936). Today, psychologists claim it is a subjective phenomenon of how individuals perceive mental and emotional pressures in their life (Folkman, 2013).

Although eustress (positive stress) can be beneficial as it aids coping and motivation through providing a productive lifestyle by making work enjoyable (Hans, 1983), stress

usually has major negative impacts for individuals, making individuals feel as though goals and demands are almost unachievable (Fevre et al., 2006). Stress can be motivated by factors such as meeting deadlines (Pastorino & Doyle-Portillo, 2009), ambient stressors such as traffic (Campbell, 1983) or poor personal organisation (Whicker, 1996).

There is a huge extent of research into the area of stress as it is inevitable and almost all people are affected by it at some point in their life. In 2017, the American Psychological Association (APA) revealed that the average person rated their stress levels as 4.8 out of 10. Stress can be found in places such as the workplace, which can have a direct negative effect on individuals positive attitudes towards change (Coetzee & Chetty, 2015). It also has a direct impact on individuals drive to eat (Groesz, 2012), increasing obesity rates. According to Bressert (2016), stress is related to sleep disturbances, digestive upsets, high blood pressure, increased heart rate, forgetfulness, difficulty concentrating, decreased family and friend contact, poor work relations and many more negative life changes.

Racic et al. (2017) reported high levels of perceived stress in students (M= 31.09), particularly in female students, which was similarly reported by Al-Sowygh (2013). Researchers such as Khan, Altaf, and Kausar (2013) also identified high perceived stress in students, which was found to have a negative impact on academic performances.

According to APA, stress is broken into three main subcategories, chronic stress, acute stress and episodic acute stress. Chronic stress has the greatest negative consequences for individuals. As reported by APA, it destroys bodies, minds, and lives by leading to things such as suicide, violence, heart attack, stroke and, perhaps, even cancer. A meta-analysis including 16 studies with over 23,544 participants, found that individuals with a history of chronic stress during childhood had double the chance of becoming depressed in adulthood. There was also a 43% higher chance of therapies or medication not being effective for these individuals (Nanni, Uher & Danese, 2011).

Korinek and Teerawichitchainan (2016) also reported mental health problems related to chronic stress. The researchers examined the physical and mental health consequences of war-related Post-Traumatic Stress Disorder (PTSD) in older adults. Northern Vietnamese war survivors were analysed and it was found that these individuals entering into older adulthood now experienced health problems. The participants who were involved in killing/causing injury had a higher correlation with health problems such as arthritis, as well as a range of mental health problems. Women in particular, who experienced traumatic child death and spouse separation showed higher levels of PTSD symptoms, with greater mental health effects.

Acute stress is the most common type of stress, arising from the demands and pressures of the recent past, anticipated demands, and pressures from the near future (APA). LeBlanc (2009) conducted a meta-analysis on the effects of acute stress on clinical performance in healthcare professionals. The results revealed that stress was negatively correlated with performance levels. Elevation in stress impeded performance in tasks involving the use of divided attention, memory retrieval, working memory and decision-making. However, these consequences were influenced by the participant's own perception of the demands and resources at hand, the association between the task and the stressor and aspects such as coping mechanisms, control of situation and support.

This supports earlier findings that report impaired performance under acute stress (Cumming & Harris, 2001; Le Blanc et al., 2005). However, performances have also been reported to be enhanced by stress (Le Blanc et al., 2008). Previous research has shown attentional inhibition from higher stress levels (Skosnik, Chatterton & Swisher, 2000), whereas others demonstrate improved selective attention under stress (Chajut & Algom, 2003). Impaired performances in memory retrieval related to acute stress have been found (Quervain et al., 2000), whereas enhanced memory consolidation under stress has also been

reported (Cahill, 2003). Decision-making performances have been identified to be poor for individuals under stress (Baradell & Klein, 1993). However, Hypervigilant decision-making has been exhibited to be more successful than vigilant decision-making (Driskell, Johnston & Salas, 2001). These mixed results are an indication that the effects on performance from stress are varied for each individual based on their own personal factors, as shown in LeBlanc (2009)'s study.

Episodic acute stress is experienced by individuals who frequently experience acute stress. These individuals show to be over aroused, display nervous-energy, can be abrupt and are often anxious or tense (APA). Although acute stress affects individuals of both genders, Andreano and Cahill (2006), state that stress influences memory differently, depending on the sex of the participant. Examining the impacts of acute stress on cognitive flexibility, Shiels et al. (2016) also identified a difference between males and females. Individuals were assigned to either an induced acute stress group, or a control group and it was revealed that stress significantly impaired cognitive flexibility for men, but did not for women. The researchers conclude that stress holds sex-specific effects on cognitive flexibility in humans.

Song et al. (2015) identified negative impacts of stress on cognitive functioning. The researchers examined cognitive functioning of parents of children with disabilities using data from the National Survey of Midlife (2005). The researchers concluded that parenting children with disabilities over a long period of time causes a threat to cognitive functioning among older mothers, in particular, for memory, causing a cognitive decline. This is due to strengthened stress levels from higher levels of negative parenting experiences. (Deater & Deckard, 1998).

Similarly, Gutshall et al. (2017), examined the effects of occupational stress on cognitive performance in police officers. Cognition and stress were measured pre and post work cycles and the results of the investigation identified a deficit in working memory due to stress. Other

surveys were conducted to measure the impact of stress on personality and behaviour, which did not demonstrate any statistical differences in their performances. In support of this, Ray (2016), explored the cumulative effect of psychosocial stressors on changes in cognitive functioning. Individuals' performance on hippocampus-dependent tasks was measured. It was found that stress had a negative impact on cognitive decline for healthy elderly adults.

As well as cognitive decline, stress also increases the risk of obtaining amnestic Mild Cognitive Impairment (aMCI) according to the longitudinal Einstein Aging Study (Sundermann et al., 2016). 507 participants, aged 70 years or older completed the Perceived Stress Scale (PSS) annually for an average of 3.6 years. The highest stress group showed to be females, with less education and higher depression levels. 71 (14%) of participants were diagnosed with incident aMCI. The risk of developing aMCI increased by 30%, for every 5 points the participant scored on the PSS, and highly stressed individuals were over two times more likely to develop aMCI. The researchers conclude that perceived stress is a predictor of increased risk of MCI, which is a preclinical stage of Alzheimer's disease. These findings display how perceived stress should be targeted in preventative interventions such as mindfulness-based stress reduction (MBSR) and cognitive-behavioural therapies in an attempt to reduce cognitive decline. It was also noted that perceived stress could be accurately measured using self-report measures, making the implementation of stress-reducing interventions simple to assimilate in a clinical setting.

In agreement with this, Turner et al. (2017) also found higher levels of perceived stress to have a more rapid negative impact on cognition for individuals. Moreover, stress appears to have effects on cognition and various executive functions such as working memory, selective attention, and cognitive flexibility (Sanger, Bechtold, Schoofs, Blaszkewicz, & Wascher,

2014; Schoofs, Shields, Bonner, & Moons, 2015; Shields, Sazma, et al., 2016; Wolf, & Smeets, 2009), and in particular, memory.

1.3 The Impact of Stress on Memory

According to Luethi, Meier and Sandi (2008), stress is a modulator of memory. Exams, interpersonal conflict, and upcoming deadlines are common stressors seen in a lot of young people today that may cause high levels of stress for students and their educators. Stress is said to impair memory retrieval and possibly cause under-achievements in exam situations and stress in the classroom is said to cause difficulties in learning and remembering for students (Vogel & Schwabe, 2016). This is a very common occurrence; therefore, it is crucial to identify stress as a memory and learning inhibitor in the classroom so that new stress-reducing activities can be established for students.

In agreement with this, an earlier study conducted found working memory impairments in individuals under cortisol-induced stress (Elzinga & Roelofs, 2005). Yet, results of various studies examining the impact of stress on memory have shown that stress has distinctive effects of enhancing as well as impairing memory. These distinctive effects of stress may vary because stress is said to impact memory phases differently (Wolf, 2008).

Memory is not a single process and it seems that stress has different effects and impacts depending on the type of memory being studied. Luethi, Meier, and Sandi (2008) found varied results. The researchers explored the effects of stress on different aspects of memory, including explicit, implicit and working memory. The stress induced participants scored lower in the reading span of working memory, indicating a stress-induced impairment of working memory. There was no effect of stress on implicit learning for neutral, positive or emotional stimuli, however, negative stimuli enhanced implicit learning. Performance in explicit memory tasks was not affected; however, spatial episodic memory was enhanced. The researchers conclude from this that efficiency of prefrontal cortex processing (working

memory) may be reduced from stress, yet in amygdala processing (aversive conditioning), stress may facilitate the efficiency. Although these findings are strong as a range of valuable tests were used to examine cortisol stress levels and memory scores, the study's participant number was quite weak (n=35) and there was an androcentric bias. This may be a limitation of the study as previously discussed literature explains the effect of gender differences in stress and memory (Al-Sowygh, 2013; Andreo & Cahill, 2006; Madebo, Yosef & Tesfaye, 2016; Shiels, 2016).

A later study conducted by Shields, Sazma and Yonelinas (2017), one of the first meta-analysis to examine the effects of acute stress on episodic memory, also found varied results. The study revealed that when stress occurred prior to or during encoding it impaired memory. This effect was larger in emotional materials than neutral materials. In contrast, post-encoding stress improved memory. The studies generally show evidence that the stress timing, context, and nature also influence its effect on memory for individuals.

As well as memory having different aspects that are enhanced and inhibited differently, various types of stress also affect memory differently. Prospective memory vulnerability to stress was examined by Piefke and Glienke (2017), who claim that it is either enhanced or disturbed based on the stressors characteristics. The researchers report that acute stress increases prospective memory, however, in contrast, it is deteriorated by post-traumatic stress. Post-traumatic stress has also been reported to impair declarative memory functioning (Samuelson, 2011).

Another account of how stress impacts memory is Hubbard (2016)'s study. The impact of perceived stress and state anxiety on working memory and academic performance in 128 students was investigated. Hubbard also investigated if stress and anxiety reduction could be achieved through training in progressive muscle relaxation (PMR) in an attempt to free up working memory capacity and in turn, improve academic performance. It was found that the

PMR training reduced state anxiety, freeing up working memory capacity leading to improvements in academic performance scores. The participants of this study were obtained from a convenience sample and first-semester graduate students from one University were solely included, making it non-generalizable. The author is not a professional and this is a dissertation paper so results may not be completely reliable. However, it does contribute to the literature by clarifying the process through which working memory and anxiety impacts cognitive performance.

Studies have not always found stress to have an impact on memory. Hood, Pulvers, Spady, Kliebenstei, and Bachand (2015) examined the effects of acute stress on working memory. 103 undergraduate participants gave a self-report measure of anxiety, completed a short-term memory task, a working memory task and their salivary cortisol levels were measured. The researchers found that acute stress had no effect on working memory, however, among individuals who had high cortisol levels, it was identified that anxiety mediated the influence of stress on working memory. Similarly, Ricker, Corley, DeFries, Wadswort, and Reynolds (2018) did not find stress to have a changing effect on memory. The researchers measured participants perceived early life stress in relation to changes in memory and perceptual speed from middle childhood to early adulthood in adopted and non-adopted individuals. The findings suggested that stress in childhood and adolescence did not provide evidence of variability in memory and perceptual speed.

Nonetheless, it is critical to acknowledge the literature that states repeated exposure to stress is related to eventual permanent memory problems. As noted by Rahman et al. (2016), after just three days of being exposed to stress for just two hours a day, MRI scans of rats revealed shrinking results of the rat's hippocampus and at the end of the chronic stress inducement (10-20 days), the stressed rats performed more poorly in memory tasks in comparison to the unstressed rats.

With the great body of literature that states and explores the influences of stress on memory, there are also many theories and models to aid the understanding of it. Consolidation theories are an example of this (Cahill & McGaugh, 1998; Joels et al., 2006, 2011; McGaugh, 2000, 2004, 2015). The dual-mode theory explains how post-encoding stress enhances memory, whereas, stress occurring during retrieval or prior to retrieval, will impair memory.

1.4 Mindfulness

With understanding how, why and when stress may affect memory, it is absolutely crucial to identify a beneficial and valuable method for reducing stress that is easily conducted by individuals in a clinical setting, or from home. Mindfulness is a successful tool that has been shown to reduce stress and anxiety levels (Bamber, Kraenzle & Schneider, 2016), help focusing attention (Lowe et al., 2015) and in some cases, improve memory (Brown, Goodman, Ryan & Analayo, 2016). Mindfulness has been described as "paying attention in a particular way: on purpose, in the present moment, and nonjudgmentally" (Kabat-Zinn, 2013). Mindfulness is also a great way to better focus your mind and aids individuals to view stress differently (Alidina, 2016).

Mindfulness-based stress reduction (MBSR) was developed by Jon Kabat-Zinn in the 1970's as a program with an aim to alleviate stressful suffering for individuals. It has shown consistent efficient results for reducing stress, depression, anxiety, and distress and improving quality of life (Khoury, Sharma, Rush & Fournier, 2015). Researchers say as well as reducing stress, it is associated with improved attention abilities, enhanced working memory capacity and some improved executive functions (Chiesa, Calati & Serretti, 2011).

Smallwood and Schooler (2006) describe mindfulness as being the opposite of mind-wandering. Mrazek et al. (2013) examined whether mindfulness training could improve test scores, by focusing on the mind, making participants stay attentive and wander-less. The

participants who engaged in the mindfulness had a considerable improvement on GRE test scores and working memory scores, in comparison to the control participants. The mindfulness participants showed less mind-wandering during the tasks, which the researchers conclude was the cause of their improved performance. Their improvements were the equivalent to a 16%-point increase.

Atanes et al. (2015) examined the relationship between mindfulness, perceived stress and subjective well-being. As previously discussed, job strain can cause distress for individuals, so a sample of physicians, nurses, nursing assistants, and community health workers were assessed. Being in an occupation for more than one year showed a significant relationship with higher perceived stress and lower subjective well-being scores, but had no significant relationship with mindfulness levels. A Pearson correlation displayed a strong negative correlation between mindfulness and perceived stress, and a medium correlation between mindfulness and subjective well-being.

Similarly, Brisbon and Lachman (2017) also identify in their longitudinal study that mindfulness was associated with lower levels of perceived stress, however, no direct association was identified between mindfulness and subjective memory problems. Although, a significant indirect effect was found between mindfulness and memory through perceived stress. Memory being measured on a subjective scale in this study could have had an effect on results. However, data was obtained on a longitudinal scale, thus giving a more accurate result. The study had a sample of 299 participants, which is a substantially large sample size, increasing the accuracy again.

The first meta-analysis to examine the effects of mindfulness-based training for children and youths gives insight into interventional mindfulness in a school setting (Zenner, Herrnleben-kurz & Walach, 2014). Twenty-four studies with a pre and post design were included and interestingly, it was found that effects of mindfulness were strongest on

cognitive performance, but also had effects on psychological measures of stress, coping, and resilience. Given the heterogeneity of measures, students, settings, and programs, the researchers conclude that the variation across the studies can be explained by the amount of practice that mindfulness-based program has introduced.

Also examining the effects of mindfulness for children, Natesh, Rajesh and Nagendra (2014), reported a significant, positive correlation between mindfulness and working memory in 1,612 16-year-olds. Mindfulness was also related to lower anxiety levels and was positively correlated with improved cognitive processes. As well as being demonstrated as beneficial for children, recent research has also revealed a gender bias in mindfulness, with females having a much more effective response to it than males (Rojiani et al., 2017).

Nonetheless, in contradictory, research has also revealed that mindfulness can be related to increased susceptibility to false-memories (Wilson et al., 2015). Rosenstreich (2016) investigated mindfulness and its relationship with true and false memories. The researcher reported that after a 5-week mindfulness treatment in college students, there was an increase in recognition of true memories, however, there was also an increased rate of provoked false-memories, in comparison to the wait-list control group. In a later study conducted by Yeh and Yi-Chun Lu (2017), an increased likelihood of generating false-memories through mindfulness was also identified.

1.5 Memory, Stress, and Mindfulness in Relation to the Current Study

The psychological and scientific research based on stress and memory has rapidly grown over the past 10 years. From the above review, it is clear that varying types of stress have different impacts on the various aspects of memory. Although there is a large body of research into the effects of stress on memories such as emotional memories (Cahill et al., 2003), implicit memory and working memory (Luethi, Meier, & Sandi, 2008; Shields, Sazma, & Yonelinas, 2016), there is still a number of inconsistencies that must be addressed.

There seems to be a lack of research examining perceived stress and immediate memory and the research that does exist is controversial, as some research indicates that stress impairs encoding of memory (Maheu et al., 2005), but other research indicates that stress enhances encoding (Payne et al., 2007; Smeets et al., 2007).

The complexity of the effects induced by stress gives great reason to explore it even further. Given the constant everyday memory retrieval, it is critical to understand the theoretical and applied impacts of stress on it. Although mindfulness was established quite some time ago, it has increased hugely in popularity in the past 10 years, and in particular, in the area of stress and memory. It has proven to be a successful stress-reducer (Brisbon & Lachman, 2017), but further study is required to establish if immediate memory can be improved from MBSR, as this seems to be a gap in the literature.

There seems to be varying results on stress in males and females, therefore, this will also be examined. Previously discussed literature also reports high levels of stress in students and the negative impacts it has, therefore, the current study will also examine perceived stress in students versus non-students. Perceived stress is measured in the current study because individual's perception of their control of what is happening in their life is crucial and the literature appears to lack studies that explore it. The Free Recall Memory Task is used to assess immediate memory as it has shown to be a successful measure (Andreano & Cahill, 2006; Cahill et al., 2003). Mindfulness has also been demonstrated to affect males to females differently (Rojiani et al., 2017), therefore this will be included in the analysis.

The aim of the current study is to identify the effect perceived stress has on immediate memory and to measure the extent to which mindfulness can alter this. The research questions put forward are; 'will males and females report different levels of stress?', 'will students report higher stress levels to non-students?', 'does stress have an impact on memory?', 'can a mindfulness intervention reduce stress and in turn improve memory?', 'will

mindfulness be more effective for males or females?'. The findings of the current study could potentially contribute to the development of new mindfulness interventions in schools, workplaces and at home to help reduce individuals stress levels and potentially improve memory. From all of this, the current study develops five main hypotheses;

1. Students will report higher levels of perceived stress than non-students.
2. Females will report higher levels of perceived stress than males.
3. Perceived stress scores will be negatively correlated with memory performance.
4. After participating in a mindfulness intervention, participants memory performance will improve.
5. Mindfulness will prove to be more effective for females than males.

Methods

2.1 ***Participants***

Data from 43 participants was collected. Of those individuals, 46.5% were male n=20 and 53.5% were female n=23. The mean age of participants was 24, with a range of 19-45 years. For the purposes of the study, the sample of participants was obtained from a non-probability sampling technique. Participants volunteered to take part and were selected based on their accessibility, therefore, it is a convenience sample. Participants were obtained from areas around England, and in the Dublin and Wicklow areas of Ireland. Participants were not excluded on the basis of their gender, sexual orientation, class, origin, race, religion or education, but were excluded if they had previously been diagnosed with any memory or stress-related illnesses, for example, Alzheimer's, aphasia, amnesia, false memory syndrome, acute stress disorder or Post Traumatic Stress Disorder (PTSD). Participants over the age of 45 were excluded as scientists use this age as a guideline for when memory decline may begin (Marmot, et al., 1991; Singh-Manoux, 2012). Blind individuals were also excluded as visual tasks were involved in the study. Before participating, participants were asked if they fell under any of the exclusion categories. Participants were included if they were memory and stress disorder free, between the ages of 18-45 and wished themselves to participate in the study.

Frequencies for the current study

Variable	Frequency	Valid Percentage
Gender		
Male	20	46.5
Female	23	53.5
Occupation		
Student	19	44.2
Employed	22	51.2
Unemployed	2	4.7

Note. N=43

*2.2 **Measures***

A participant information sheet and consent form was included, outlining information such as; the type of research it was, the procedure protocol, the duration, risks, benefits, confidentiality and contact information (*See Appendices A & B).*

A 10-item Perceived Stress Scale (PSS) (Cohen, 1983), is a self-report questionnaire with the purpose of measuring individual levels of perceived life stress. It is a 4-point Likert scale with a possible score range of 0-40, with higher scores indicating higher perceived stress. Scores ranging from 0-13 are considered low perceived stress, 14-26 are considered moderate and 27-40 are considered high. The PSS demonstrates a great amount of validity and reliability from previous examinations of it (Andreou et al., 2011; Khalili, Sirati Nir, Ebadi, Tavallai, Habibi, 2017; Reis, Hino & Añez, 2010). The 10-item PSS measure also shows to have superior properties over the 14-item and 4-item PSS's (Lee, 2012). The current study showed high internal consistency for the PSS with Cronbach's alpha of 0.85.

The Free Recall Memory Task paradigm is a test that measures immediate recall memory functioning of participants. The test consists of 3 rounds of 10 words to recall. Scores could range between 0-30. Words are randomly presented from the 'Toronto Word Pool', varying in length and type. Free Recall tends to be a harder test to succeed in versus recognition and cued-recall tests, as it does not give any clues during retrieval, therefore causes an extended sequential search process for individuals (Atkinson and Shiffrin, 1968; Shiffrin, 1970). The Free Recall task was accessed through 'Pebl' software, a free psychology software which allows for the use of ready-made psychological tests without licensing or charge.

Instead of recording participants identity for the PSS and memory task results, a random generator on the researcher's computer provided unique codes to name results, for example, "participant x645".

A mindfulness-based stress reduction (MBSR) intervention is a strategy utilized to aid the management of stress, mood, emotional coping, attention and working memory. The mindfulness intervention was loaded on the researcher's computer through the 'YouTube' website. The intervention is based on Jon Kabat-Zinn's MBSR and was created by Vicki Panagotacos. Earphones were used as part of the mindfulness to allow for complete concentration.

The data, including primary research materials, was recorded cautiously and referenced appropriately, and then stored on an encrypted file. Therapeutic interventions were made available to any participant if necessary, however, no participant required this.

2.3 ***Procedure***

Ethical approval was firstly granted to the current study from The National College of Ireland's ethics committee. Participants were recruited by word of mouth and were invited to take part, as this was the most effective way to gather a large number of participants.

Participants vigilantly read, signed and dated the written consent form. This informed consent form was immediately collected by the researcher and cautiously filed away for protective storage. From a random generator, participants were given a random number-(such as x567), to protect their identity in the study. Participants then answered some demographic questions such as age, gender, and occupation (*See Appendix C.)*

The first part of the study was the self-report PSS. This scale consisted of ten questions with direct queries on the participant's current feelings and perceptions of their experienced stress in certain day-to-day situations in their life over the past month, for example, "In the last month, how often have you felt that you were on top of things?", or "In the last month, how often have you felt that things were going your way?". The participants were asked to score the scale from 0-4 (0 being never and 4 being very often). This was completed by pen and paper (*See Appendix D).*

Participants were then given a laptop computer which had the Free Recall Memory Task from the 'Pebl' software loaded on the screen. This gave participants instructions on how to complete the memory task before instructing the participant to press 'enter' to begin. A list of ten varied, random words flashed up on the screen, one at a time, for a duration of two seconds each, which were to be recalled by the participant. The participant typed as many words as they could remember, then entered an empty entry to move on to the next round. This process was carried out three times. Once this was completed, the data automatically saved to a computer file and was not opened until all of the data was received from each of the participants. This separated links between participants and their scores. The participant codes allowed for data analysis without participants being identifiable (*See Appendix E).*

A 15-minute mindfulness intervention was then carried out as part of the MBSR. The researcher first asked the participant to sit comfortably, rest the bottoms of their feet on the floor, straighten their upper body, but not stiffen their back, pay attention to their arms, placing them however feels most natural, soften their gaze or completely close their eyes, whatever made them most comfortable and bring their focus to their breath. The participant then put earphones in, which were connected to the computer, to ensure they were fully concentrated, without any possible noise distractions. The speaker from the mindfulness intervention delivered quotes such as 'start to be present', 'become aware of the breath', and 'bring your awareness to sound'. This was continuously followed by relaxing music for the duration of the intervention (*See Appendix F).*

Participants then carried out the Free Recall Memory Task one more time. The words to be remembered from the lists were varied each time. The researcher gathered all the data off each participant individually, but did not mark their result with any information that could link it back to them. Once the data was entered into an SPSS file, it was not traceable back to the participant, ensuring it was fully confidential.

In total, it took participants approximately 30 minutes to complete the test, with the data collected over a two-month period. To begin the data analysis, a data file was created on IBM SPSS by entering the data, defining the variables and then screening of the data file for any errors. To analyse the data, descriptives, a two-way analysis of variance, a Pearson correlation coefficient and a mixed between-within subject analysis of variance were conducted. All the results were analysed, written up and presented in the final write up of the study.

2.4 ***Design***

The research design of the current interventional study is a correlational, cross-sectional design. The study is correlational as it attempts to identify a relationship between stress levels and memory performance, and also examines the association between mindfulness and memory by means of quantitative data. The study is cross-sectional due to the data being collected and the relationships being assessed at one point in time. This within-subjects designed study exposed all participants to the mindfulness intervention and their memory abilities were tested pre and post-intervention, also giving the study a pre-test-post-test design. The independent variables for all of the hypotheses include gender, occupation, perceived stress levels and the mindfulness intervention. The dependent variables for all of the hypotheses include, perceived stress and memory ability.

Results

3.1 ***Reliability Statistics***

The Perceived Stress Scale was tested for reliability using Cronbach's Alpha. The Perceived Stress Scale consisted of 10 items and showed to have high reliability (*a*= .85), meaning it has internal consistency, *as shown in Table 1 below*.

Table 1

Reliability Statistics for The Perceived Stress Scale

	No. of Items	Cronbach's Alpha
Perceived Stress	10	0.85

Note. N=43

3.2 ***Descriptive Statistics***

Descriptive statistics were conducted to measure the means/medians (M), standard errors, standard deviations (SD), and range of all the study's continuous variables (age, total perceived stress scale score, speed of response at time 1, speed of response at time 2, percent correct at time 1 and percent correct at time 2). Of the 43 participants, ages ranged from 19-45 years (M= 22, SD= 7.22). The total perceived stress scores for participants (M= 17.51, SD= 5.82) indicated that participants scored moderate levels of perceived stress as individual scores could have ranged anywhere from 0-40. The response time in the memory task for participants at time 1 (M= 3456.88, SD= 1359.14) was slightly less than the response time at time 2 (M=3584.57, SD=878.84), indicating participants took longer to respond at time 2. The percent correct at time 1 (M=54.88, SD= 17.54) was less than the percent correct at time 2 (M=59.65, SD= 15.03), indicating participants scored higher post-intervention, *as shown in Table 2 below*.

Age, speed of responses at time 1, percent correct at time 1 and percent correct at time 2 indicate non-normally distributed data from the Kolmogorov-Smirnov test of normality (P <

.05), whereas perceived stress total scores and speed of responses at time 2 indicate normally distributed data (P > .05).

Table 2

Presenting Descriptive Statistics for Continuous Variables

Variable	Mean (95% Confidence Intervals)	Std. Error Mean	Median	SD	Range
Age	24.44 (22.21-26.66)	1.1	22	7.22	19-45
PStress Total	17.51 (15.72-19.30)	.89	18	5.82	7-28
SRT1	3746.02 (3327.74-4164.30)	207.27	3456.88	1359.14	2073.81-7884.0
SRT2	3628.57 (3358.11-3899.04)	134.02	3584.57	878.84	2186.25-6110.63
PCT1	54.88 (49.48-60.28)	2.67	47	17.54	17-86
PCT2	59.65(55.02-64.27)	2.29	56	15.03	36-90

Note. N= 43. Pstress Total= The participants total Perceived Stress Scale score; SRT1= The participants speed of response in the Free Recall Memory Task at time 1; SRT2= The participants speed of response in the Free Recall Memory Task at time 2; PCT1= The participants percent of correct scores in the Free Recall Memory Task at time 1; PCT2= The participants percent of correct scores in the Free Recall Memory Task at time 2.

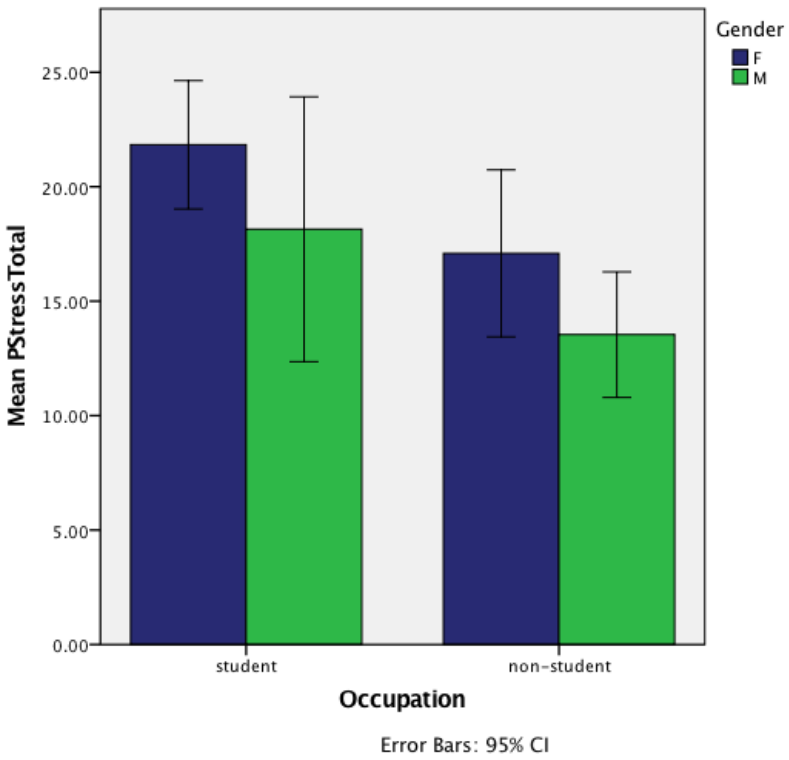

Figure 1. Male, female, student and non-student perceived stress. This figure illustrates male versus female and student versus non-student total Perceived Stress Scale scores. (F= female, M= male).

3.3 ***Inferential Statistics***

A two-way between-groups ANOVA was conducted to explore the impact of occupation and gender on levels of perceived stress, as measured by the Perceived Stress Scale (PSS). Participants were divided into three groups, according to their occupation (Group 1: Employed; Group 2: Student; Group 3: Unemployed). The interaction effect found between occupation and gender was not statistically significant, $F(2, 37) = 2.85$, $p = 0.071$. There was a statistically significant main effect for gender, $F(2, 37) = 11.11$, $p = 0.002$, with a large effect size ($\eta 2 = 0.23$). There was also a statistically significant main effect for occupation, $F(2, 37) = 5.19$, $p = 0.01$, with a large effect size ($\eta 2 = 0.22$). Post-hoc comparisons using the Tukey HSD test indicated that the mean score for the student group (M = 20.47, SD = 5.32) was significantly different from the employed group (M = 14.95, SD = 4.5). The unemployed

group (M = 17.5, SD = 13.44) did not differ significantly from either of the other groups, *as shown in Tables 3 & 4 below*.

Table 3
Descriptive Statistics for Two-Way Between Groups ANOVA for PSS scores

Gender	Occupation	Mean	Std. Deviation	N
Female	Employed	16.1	4.56	10
	Student	21.83	4.41	12
	Unemployed	27.0	.	1
Male	Employed	14.0	4.41	12
	Student	18.14	6.26	7
	Unemployed	8.0	.	1
Total		17.51	5.82	43

Table 4
Two-Way Between Groups ANOVA Summary Table for PSS scores

Source	*df*	MS	*F*	*p*	Effect Size
Gender (G)	1	255.06	2.56	.002	.231
Occupation (O)	2	119.14	5.19	.01	.219
G x O Interaction	2	65.44	2.85	.071	.134
Total	43				

Note. MS = Mean squares, effect size = $\eta 2$ or partial $\eta 2$.

The relationship between total perceived stress (as measured by the Perceived Stress Scale) and immediate memory ability (as measured by the Free Recall Task) was investigated using a Pearson product-moment correlation coefficient. Preliminary analyses were performed to ensure no violation of the assumptions of normality, linearity, and homoscedasticity. There was a strong, negative correlation between the two variables, $r = -0.52$, n = 43, $p < 0.001$, with high levels of perceived stress associated with lower scores on the memory task.

For the purposes of the study, it was necessary to conduct a mixed between-within subjects ANOVA to assess the impact of the mindfulness intervention on participants scores on the Free Recall Memory Task (pre-intervention and post-intervention), and to examine

differences between male and female scores. There was no significant interaction between participants memory scores and gender, Wilks Lambda = 0.93, $F(1, 41) = 3.27$, $p = 0.08$, $\eta 2 = 0.074$. There was a large main effect for memory scores pre and post-intervention, Wilks Lambda = 0.82, $F(1, 41) = 8.88$, $p = 0.005$, $\eta 2 = 0.18$, with both males and females showing an improvement in memory scores between time 1 and time 2. The main effect comparing males and females was significant $F(1, 41) = 6.89$, $p = 0.012$, $\eta 2 = 0.144$, suggesting a large effect size between male and female memory scores, *as shown in Tables 5 & 6 below*.

Table 5

Descriptive Statistics for Mixed Between-Within Subjects ANOVA

	Male			Female		
Time Period	n	M	SD	n	M	SD
Pre-intervention	20	62.6	18.17	23	48.17	14.18
Post-intervention	20	64.4	16.59	23	55.52	12.46

Note. M= Mean; SD= Standard deviation

Table 6

Mixed Between-Within Subjects ANOVA Summary Table

Source	*df*	MS	*F*	*p*	Effect Size
Memory Score (MS)	1	447.6	8.88	.005	.178
Gender (G)	1	2904.91	6.89	.012	.144
MS x G Interaction	1	164.63	3.27	.078	.074

Note. MS = Mean squares, effect size = *η2* or partial *η2*.

Discussion

The current study investigated differences in perceived stress levels among genders and occupations, the association between perceived stress and immediate memory ability was explored and an examination of mindfulness as a potential memory enhancer was conducted. Previous literature has focused on the relationship between various types of stress such as objective stress (Elzinga & Roelofs, 2005; Rahman et al., 2016), post-traumatic stress (Samuelson, 2011) and acute stress (Piefke & Glienke, 2017) with memory phases such as working memory (Hood, Pulvers, Spady, Kliebenstein & Bachand, 2015) and implicit and explicit memory (Luethi, Meier & Sandi, 2008). The present study, however, focuses on subjective, perceived stress and immediate memory.

4.1 Discussion of Results

A two-way ANOVA (Tables 3 & 4) demonstrate that the first hypothesis is true, with students reporting significantly higher perceived stress scores than non-students. The difference between student and non-student perceived stress was very large (eta squared = 1.12), indicating a large amount of the variance of perceived stress is, in fact, explained by occupation. Non-students referred to anyone who did not currently attend any type of full-time or part-time education and 92% (22 out of 24) of these individuals were employed.

Although previous studies have identified stress as being related to the workplace and poor performances at work (Coetzel & Chetty, 2015), with high occupational stress also being reported (Gutshall et al., 2017), the current study has found that students deem themselves to be under more stress than non-students. Although it has been shown that students are significantly more affected by stress, non-student, employed individuals also reported moderate PSS scores (M= 15.17). Stress is said to impede work relations (Bressert, 2016) and has also been described as having a direct negative effect on performance levels (Cumming & Harris, 2001; LeBlanc 2009; Le Blanc et al., 2005).

The present study's result was in line with findings from researchers such as, Al-Sowygh (2013), who report high levels of perceived stress in students, and Khan, Altaf and Kausar (2013) who revealed poor academic performances due to high PSS scores in students. Madebo, Yosef and Tasfaye (2016) also found more than half of students to report high perceived stress levels. These findings and the current study's finding are critical as research previously discussed indicates that stress can impair memory retrieval and possibly cause under-achievements in exam situations, also causing difficulties in learning and remembering for students (Vogel & Schwabe, 2016).

This finding may suggest that the source of stress among individuals today may be academia or education and means that college work is likely to contribute significantly to individual's overall perception of life stress. Thereby, it can be concluded that by reducing educational workloads, perceived life stress could considerably be reduced, in turn, reducing the impact it has on individual's life and well-being.

The second hypothesis that females would report higher perceived stress levels than males was put forward due to the literature stating that stress holds sex-specific variances (Korinek & Teerawichitchainan, 2014; Shiels et al., 2016). The results of the current study confirmed that this hypothesis is true, agreeing with literature that states that females report higher perceived stress than males (Wiegner, Hange, Bjorkelund & Ahlborg, 2015). This comparison was also complete in the two-way ANOVA (Tables 3 & 4), demonstrating a large effect size. The extent of the large effect size revealed was however surprising, as some earlier studies state that there are no differences at all between stress levels in male and females (Kania 2014; Khan, Atlaf & Kausar, 2013).

However, it has also been reported that men and women tend to react differently in response to stress, both physiologically and biologically (Verma, Balhara & Gupta, 2011) and past literature states that stress influences memory differently for males and females (Andreo

& Cahill, 2006). The current finding explains a strong variation in stress levels between genders, which is in agreement with a report by APA that states that stress is on the rise, in particular for women. APA reports that women are much more likely than men to report physical and emotional stress symptoms, which is also exhibited in the current study.

This study also sought to ascertain the association between perceived stress and immediate memory ability (hypothesis three). It was exposed from the Pearson correlation that higher levels of perceived stress on the PSS is significantly associated with lower scores on the Free Recall memory paradigm, indicating that there is a strong negative association between the two. This study identifies stress as a psychological factor that is associated with memory problems, similarly found by previous literature (Elzinga & Roelofs, 2005). This finding is in support of the third hypothesis, which was expected as studies such as Potter, Hartman, and Ward (2009) also reported everyday memory complaints among individuals with higher perceived stress levels.

Nonetheless, it is important to note that the extensive body of literature has generally found mixed results, with stress also having enhancement effects on memory (Luethi, Meier & Sandi, 2008; Shields, Sazma, McCullough & Yonelinas, 2017), contradicting the current study's finding. The strength of the relationship was unexpected as very few of the previously conducted studies have found such a strong relationship, with some studies finding no effect at all (Hood, Pulvers, Spady, Kliebenstein and Bachand, 2015; Ricker, Corley, DeFries, Wadsworth and Reynolds, 2018).

Some theories and models may aid the understanding of how this finding in the current study has occurred. Consolidation theories such as the standard model and multiple trace theory explain how memories are stored. Interruptions to consolidation, such as stressors, can interfere with this process (Payne, 2004), which could explain why this memory deficit is occurring. The dual-mode theory indicates that post-encoding stress enhances memory,

which may justify the mixed findings that were revealed from the literature, whereas, stress prior to retrieval should impair memory, which clarifies the current study's finding.

Hypothesis four states that a mindfulness intervention would improve memory scores for individuals, with hypothesis five claiming that females would show stronger improvements from it. The results of the study demonstrate that these hypotheses are also true. A mixed between-within subjects ANOVA (Tables 5 & 6) reflect a change in memory score between time 1 (pre-intervention) and time 2 (post-intervention), with a large effect size. 0.144 of the variance in memory ability between pre and post-mindfulness intervention is explained by gender, indicating a significant difference in immediate memory scores for males and females, thus reinforcing the study's fifth hypothesis. The effectiveness of the mindfulness treatment did benefit females more than males, however, overall, both genders memory scores significantly improved post-intervention.

Although there is a scarce amount of literature examining gender differences in mindfulness, this finding is partially in line with researchers, Rojiani et al. (2017), in that the current study and Rojiani et al. (2017) both conclude that females respond better to and have more favourable responses and improvements to mindfulness. However, Rojiani et al. (2017), report that mindfulness was not significantly effective for males as it was found to be for females, yet, the current study did find a significant improvement in male memory ability post-mindfulness-treatment. These findings are related to Cabrera (2016) who states that women perform much better when they are mindful and females require engagement in mindfulness meditation at a higher rate than males do.

The finding is also consistent with prior research (Brown, Goodman, Ryan & Analayo, 2016; Chiesa, Calati & Serretti, 2011) which also identify mindfulness as a memory-enhancer. The finding revealed from the ANOVA was expected as previous research has found improvements in working memory tasks after participation in mindfulness treatments

(Mrazek et al., 2013). Although the current study did not include participants under 18 years of age, the result is somewhat consistent with research that has found mindfulness to be effective for memory improvements in children in school settings (Natesh, Rajesh & Nagendra, 2014; Zenner, Herrnleben-kurz & Walach, 2014).

Nonetheless, the current finding contradicts the work of researchers Brisbon and Lachman (2016), who did not identify mindfulness and a memory enhancer. Their longitudinal study found mindfulness to be associated with lower levels of perceived stress, however, in contradiction to the present study, no direct association was identified between mindfulness and subjective memory problems. The large effect size of memory improvements in the Free Recall Task reported in the results was unexpected, as mindfulness has also been related to increased false-memory susceptibility (Wilson et al., 2015; Rosenstreich, 2016; Yeh & Yi-Chun, 2017), which could potentially have caused participants percent correct scores to be lowered.

To understand how the current study has found this improvement of memory through mindfulness, it is beneficial to understand the work of (Alidina, 2016; Bamber & Schneider, 2015; Lowe et al., 2015; Mrazek et al., 2013; Zenner, Herrnleben-kurz & Walach, 2014), who explain how engagement in mindfulness reduces individuals stress levels, improving cognition, including their memory abilities. Overall, it is suggested from the current study's findings that participation in mindfulness improves immediate memory ability, to a significantly high effect size, particularly for females.

*4.2 **Implications***

This brings us to the implications of the study's findings. It is clear that both students and non-students report stress at some stage in their lives, yet the current study exhibits that students report the highest levels of stress. Stress in academia is said to impair memory retrieval, causing under-achievements in exam situations (Vogel & Schwabe, 2016), therefore

it would be of great benefit to establish college and classroom practices with the purposes of alleviating student stress levels.

Understanding ways to reduce memory problems and improve memory performances for adults is of significant concern (Alzheimer's Society of Ireland). It appears from the present study that females describe themselves as suffering from stress at a higher rate than males. As this result is on the increase (APA), it is of great relevance to understand this difference revealed by the study as such an understanding would give significant insights into adult mental health and how disturbances to it could be prevented in men and women. The findings of the current study highlight that further resources should be made available and should possibly be more focused on females in the mental health sector for handling and managing stress, as they appear to be more susceptible to it than their male counterparts.

The knowledge provided from the present finding that outlines a significant relationship between stress and memory problems, could perhaps be implemented in the development of tailored treatments for individuals who present memory problems. Currently, there are few established treatment options available for these individuals (Envig et al., 2014), therefore, although further research is required, stress-reducing treatments such as MBSR should be established.

Mindfulness is an excellent stress reduction and memory enhancing treatment as it can be implemented in educational and occupational settings, as well as in the home. The study's results demonstrate that even engaging in a once-off mindfulness intervention can significantly improve memory recall. It should be encouraged for individuals to participate in this prior to exam or test situations. Nonetheless, with mindfulness being recommended as an effective treatment for these individuals, additional treatments should be considered for males, such as cognitive behavioural therapies or 'Cogmed', as it has been revealed that mindfulness is not as effective for males as it is for females.

4.3 Limitations and Future Recommendations

When interpreting the results, it must be identified that there are some salient limitations of the present study to consider. Firstly, response bias must be taken into consideration. The PSS is a self-report measure, which could have created some issues in regards to honesty. Participants may also have answered the PSS or the memory task rapidly, without full consideration or attention, in attempts to complete the tasks more quickly. Due to time constraints, the mindfulness intervention in the study was conducted over just one-time period. The efficacy of mindfulness over time cannot be known from this. Although ages ranged from 19-45, the majority of participants were in their 20s (M= 22); future research should include more participants in their 30s and 40s for a more accurate result. Confounding variables must be taken into account; the presence of the researcher during the mindfulness intervention may have had an effect on its efficacy for participants.

Although the current study presents some interesting preliminary findings, a larger sample size and a more complex study design could potentially aid a more advanced study and provide more accurate results. A more complex study design could also measure objective stress levels, such as cortisol levels, adding to the study's validity. Although the present study found impeded memory ability with stress, performances have also been reported to be enhanced under stress (Chajut & Algom, 2003; Le Blanc et al., 2008; Skosnik, Chatterton & Swisher, 2000). These inconsistent results suggest that the effects of stress on performance vary for each individual. Future research could possibly look at individual differences in perceived stress levels to potentially identify more consistent results.

As mindfulness has been related to increased false-memory susceptibility (Rosenstreich, 2016; Wilson et al., 2015; Yeh & Yi-Chun, 2017), future research should identify the underlying constructs of mindfulness that are associated with the development of false memories, to better improve mindfulness as an intervention. In short, the present study is

successful, with significant results, however, a more advanced methodology would be of great benefit to future work.

4.4 ***Strengths***

The study, however, also holds several strengths as it presents a number of highly significant and valuable findings which contribute to the previous body of research and adds novel results to the literature. The current study, being the first one of its kind to quantitatively examine the relationship between perceived stress and immediate memory recall and the impact a once-off mindfulness intervention can have on immediate memory, is of great importance.

The current study is also among the few, if not, the only study that measured differences in perceived stress levels between students and non-students, finding significant results. Due to the study finding highly significant results for all of the hypotheses, it contributes greatly to the literature and potential future work. The aim of the present study to enhance memory abilities by reducing stress levels for individuals through mindfulness was undoubtedly successful.

4.5 ***Conclusion***

To conclude, as expected, and consistent with previous literature (Elzing & Roelofs, 2005; Potter, Hartman & Ward, 2009), those with higher perceived stress scores were more likely to obtain lower memory scores. Female students revealed to be the strongest sufferers of perceived stress and mindfulness predicted an improvement in memory score, with efficacy for females being stronger than males. The present findings suggest that mindfulness may improve memory malfunctions, potentially through reducing its relationship with perceived stress. Thus, engaging in mindfulness may be a successful treatment of immediate memory problems, which is prevalent for individuals of all circumstances. The findings of the current study also suggest that even a short MBSR activity just before a memory required task, such

as an exam, could enhance performance to a higher level. This, having implications for healthcare, could potentially be utilized in the workforce, the classroom and from home to aid reduction in stress and enhancements in memory ability. Although further research is required, the findings advance our current understanding of stress, memory, and mindfulness. Future work in this field should repeat this study, with modifications of the limitations, including a more complex research design, to give a more accurate result. This study exposes the importance of stress in memory performance, the benefits of mindfulness, and also reveals the variations of gender and occupation, with highly significant results, and thus can be considered influential in the research areas of stress, memory and mindfulness.

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Appendices

Appendix A

Participant Information Sheet

Project Title:

An Examination of the Association Between Perceived Stress and Memory Performance and the Utilization of Mindfulness as a Memory Enhancer.

Invitation:

You are being invited to participate in a research study that is examining individual's perceived stress levels to identify the effect it has on immediate memory functioning. You are also invited to participate in a brief mindfulness task in an attempt to reduce stress levels and enhance memory performance. My name is Lauren Vesey and I am the researcher of the current study. I will be supervising the tasks that will take place during the study and I will also be carrying out the data analysis and write up. The study is being conducted as part of a final year project in the National College of Ireland (NCI) and it has been approved by the NCI Psychology Ethics Committee.

What Will Happen:

In this study, you will be first asked to complete the Perceived Stress Scale (PSS). This scale consists of 10 questions with direct queries on your current feelings and thoughts of stress in certain day-to-day situations in your life over the past month. You will be asked to score the scale from 0-4 (0 being never and 4 being very often). You will be then assessed on immediate memory functioning. You will be asked to complete the Free Recall Memory Task paradigm. You will be shown a list of numerous different words which you will be then asked to recall. You will then be invited to carry out a short 15-minute mindfulness task as part of a mindfulness-based stress reduction (MBSR) intervention. This will involve breathing techniques, closing of the eyes, sitting still and staying calm and relaxed for the

duration. Then, you will be asked to complete a second Free Recall memory task (containing a different list of words to be recalled). This will provide the researcher with data that will indicate whether perceived stress is related to memory performance and if mindfulness can successfully improve memory.

Time Commitment:

The study intends to take under one hour to fully complete all tasks (Approximately 30 minutes).

Participant's Rights

You have the right to stop being part of the study at any time of the research without any explanation. You have the right to ask that your data/result be withdrawn and destroyed if you wish and you will not face any penalty. You have the right to refuse to answer or not respond to any of the questions asked in the PSS scale. You have the right to not complete the memory task once you have begun. You also have the right to terminate your participation in the mindfulness task. You have the right to have any of your questions in regards to the study answered by the researcher.

Benefits and Risks

No physical harm will be brought to you during the study as the questionnaire, memory test and MBSR will be carried out sitting down in a safe, supervised environment. However, as this study includes an examination of stress levels, if it is a sensitive topic for you, it may cause some distress for you.

The study may however, teach you some stress-reducing techniques that may be of benefit to you in the future. The study will also add to current knowledge of how stress may have a major negative impact on memory, which in the long run could help in reducing the likelihood of individuals developing illnesses such as dementia or Alzheimer's and aid the development of memory enhancement interventions in clinical and educational settings.

Cost, Reimbursements, and Compensation

Your participation in this study is voluntary.

Confidentiality/Anonymity

The data collected will not include any personal information about you. Your name will not be included, and once you have sent the researcher your result, it will become completely confidential and untraceable to you. All data will be stored cautiously and fully encrypted, with only the researcher having access. The results will be recorded and presented in a dissertation paper. This paper will be marked by an examiner as part of the researcher's final year project and will be presented on the NCI's online TRAP facility.

For Further Information

Lauren Vesey will be happy to answer any of your questions in regards to the study at any time. You may contact her by;

Phone: 0851275159

Or Email: laurenvesey29@hotmail.com

If you would like to find out information on the final result of the study you should contact Lauren directly and she will be glad to provide you with it.

Appendix B

Informed Consent Form

By signing below, you are agreeing that: (1) you have read and understood the Participant Information Sheet, (2) questions about your participation in this study have been answered satisfactorily, (3) you are aware of the potential risks (if any), and (4) you are taking part in this research study voluntarily (without coercion).

_____ _____

Participant's Name (Printed)* Date

_____ _____

Participant's signature* Signature of person obtaining consent

_____

Name of person obtaining consent (Printed)

Appendix C

Demographics

1. Gender: (please circle one) Male Female

2. Age: _____ years

3. Occupation: (please circle one) Student Employed Unemployed

Appendix D

Perceived Stress Scale

The questions in this scale ask you about your feelings and thoughts **during the last month**. In each case, you will be asked to indicate by circling *how often* you felt or thought a certain way.

0 = Never 1 = Almost Never 2 = Sometimes 3 = Fairly Often 4 = Very Often

1. In the last month, how often have you been upset because of something that happened unexpectedly?.....**0 1 2 3 4**

2. In the last month, how often have you felt that you were unable to control the important things in your life?.....**0 1 2 3 4**

3. In the last month, how often have you felt nervous and "stressed"? **0 1 2 3 4**

4. In the last month, how often have you felt confident about your ability to handle your personal problems?.....**0 1 2 3 4**

5. In the last month, how often have you felt that things were going your way?.....**0 1 2 3 4**

6. In the last month, how often have you found that you could not cope with all the things that you had to do? **0 1 2 3 4**

7. In the last month, how often have you been able to control irritations in your life?.....**0 1 2 3 4**

8. In the last month, how often have you felt that you were on top of things?.**0 1 2 3 4**

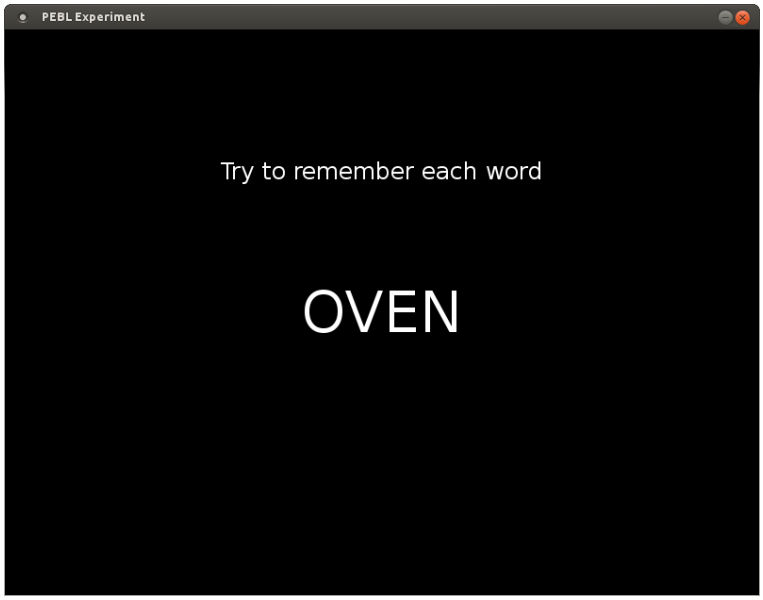
9. In the last month, how often have you been angered because of things that were outside of your control? **0 1 2 3 4**

10. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?.....**0 1 2 3 4**

Appendix E

Free Recall Memory Task

The Free Recall Task is a psychological paradigm that measures immediate memory ability. Participants are visually presented with a random list of words from the 'Toronto Word Pool'. See the image below for a demonstration of how the words are presented.



Appendix F

Mindfulness-Based Stress Reduction

The study involved participation in a 15-minute mindfulness-based stress reduction exercise that was accessed on You-Tube through the link-

https://www.youtube.com/watch?v=8v45WSuAeYI