INVESTIGATING THE EFFECT OF AUDITORY INTRUSION (IRRELEVANT SPEECH /SOUND EFFECT) AND PERSONALITY ON WORKING MEMORY WHILST OBSERVING NEUROLOGICAL AND PHYSIOLOGICAL MARKERS

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ABSTRACT

The aim of the current study was to investigate the effect of varying auditory interference and personality on performance in a cognitive memory test whilst observing individual differences in EEG, GSR and pulse rate readings. The effect of auditory interference on working memory tasks is called the irrelevant sound effect. A quantitative within subjects design was employed to assess the phenomenon of the irrelevant sound effect on free recall. Three separate presentations of a list of twenty words per presentation were presented to each participant whilst auditory intrusion was introduced during the display of the words and continued through the recall time. The level of recall was then analysed. The participants were 30 employed people in Dublin, Ireland from a sample of convenience and each participant completed The Big Five Taxonomy, (John& Srivastava, 1999). Their scores on the personality questionnaire were analysed together with their level of recall and EEG, GSR and Pulse rate readings. The results of this study did not reveal the irrelevant sound effect on free recall, however other significant correlations were found.

CHAPTER 1

INTRODUCTION

The central objective of this study is to investigate the phenomenon of varying auditory interference and personality on performance in a cognitive memory test whilst observing individual differences on neurological and physiological markers.

Previous research into cognitive task performance indicates that the irrelevant sound effect (ISE) is a very real phenomenon and that cognition in memory tasks is impaired somewhat by it. This impairment leads us to look at working memory, attention and the personality traits that may influence this position. "*The irrelevant sound effect paradigm commands interest because of what it may reveal about the interplay of attention and memory*", (Jones et al, 1997, p550).

1.1 Personality

Personality refers to individuality, to how someone perceives a situation and how they then behave in a situation. Personality is a set of traits, (Goh and Farley, 1977) and is concerned with what makes a person tick? Many theorists have studied individuality and personality has been defined as "the distinctive and relatively enduring ways of thinking, feeling and acting that characterize a person's responses to life situations", (Passer & Smith et al, 2009, p.442). Throughout the history of psychology theorists have been interested in individual differences, personality uniqueness, characteristics and mannerisms and how this individuality effects behaviour. Frances Galton (1865) was interested in the hereditary traits we obtain from our ancestors. Gordon Allport, (1921) put forward a proposal on ways to measure personality. Allport and Odbert (1936) used a lexical approach when trying to theorise personality. They analysed the English dictionary and produced a list of 17953 words. This approach postulates that language provides an important illustration of behaviours and when the language is analysed traits can be identified. Allport believed that personality would explain each person's distinctive actions in their environment, (Snyder, 1994). The idea of language descriptors for personality concepts was the rudimentary beginnings of the trait theories on personality. Personality theorists are concerned with the structure, organisation and dynamics of individual's personalities. Many trait theorists believe that personality is genetic, has a biological, inherited basis and is stable (stability over time), (Eysenck, 1967; Tellegen, 1990; Costa and McCrae, 1990). The notion of personality being stable can help us predict an individual's behaviours in certain situations. Personality traits are stated to be semi-permanent, emotional and cognitive characteristics that have an influence on an individual's behaviour.

Cattell (1965), proposed the analysis of personality through a factor theory. His 16PF recognises the traits under 5 dimensions (Rossier et al, 2004). Cattell (1965) theorises that personality traits can be determined by factor analysis. He identified 16 basic traits, his questionnaire was used to measure whether a person was warm/reserved, unemotional/emotional, intelligent, assertive/cooperative, cheerful/sober, conscientious/expedient, socially bold/shy, self-reliant/ sensitive, suspicious/trusting, imaginative/practical, shrewd/forthright, guilty/self-assured, radical/conservative, self -sufficient/affiliate, controlled/impulsive, tense/tranquil.

Hans Eysenck's (1975) theory on personality and its dimensions have an influence on the preparations of a cognitive experiment stating that personality will influence performance when combined with external factors. Eysenck's theory discusses personality under the dimensions of three traits, (extraversion, neuroticism and psychosis). Eysenck (1972) stated there was a physiological basis for his theory on personality according to introversion/extraversion. He claimed that the trait extraversion derives from the excitation / inhibition in the cortex of the brain, referring to some people being over-aroused, (an introvert) whilst others are under-aroused, (an extravert). Eysenck's (1972) theory on personality and the understanding of behaviours is based on the two principles of introversion and extraversion. Extraversion is characterised by being outgoing, friendly, high on positive affect and in constant need of external inspiration. A person who scores high on extraversion qualities on the Eysenck Personality Questionnaire (revised study) EPQ-RS is said to be very sociable, impulsive, and seeks high stimulation from their environment. Someone who is said to be an introvert prefers quieter surroundings tends to be pensive and less impulsive. According to Eysenck's arousal theory of extraversion, there is an optimum level of cortical arousal, performance declines as one becomes more or less aroused than at the most favourable intensity, (optimum level). According to this

theory people who are over aroused (an introvert) will strive for a quiet situation and avoid highly charged environments.

With this theory in mind it then insinuates that extraverts perform better than introverts when the situation is highly charged namely performing better when aroused. Introverts according to Eysenck's theory are persistently over-aroused and stressed and need calm and quiet to bring them to the most favourable functioning level and therefore should perform a cognitive task best in a silent setting. Previous research on introversion/extraversion and performance on cognitive tasks can affirm this. Furnham et al (1994) found that extraverts performed better than introverts in a reading comprehension task in the presence of a television programme as a distraction, and both introverts and extraverts had improved scores in silent conditions. Personality features and levels of stimulation have an impact on how distracted a participant in a study feels (Furnham et al., 1994). Another study by Furnham & Bradley, (1997) looked at the effect of music on a reading comprehension and again the results were replicated that introverts overall performed worse than extraverts under the music interference conditions.

Many researchers agree that a five-factor model of personality testing is a valid and reliable measure of dimensions of personality traits, (Paunonen, 2003).

The "big five" are general categories of dimensions of personality traits that are measures when looking at different personality types and cognitive performance. The Five Factor Model (FFM) is based on the concept that personality is categorised by behaviours and stated that most behaviours can be classified in terms of the five dimensions of 1.) Openness to New Experiences, 2.) Conscientiousness, 3.) Extraversion, 4.) Agreeableness, 5.) Neuroticism, (OCEAN) (Costa and McCrae, 1987; Wagstaff, 1998). These traits are on a continuum and an

individual's personality may lie somewhere on that continuum, for example, someone's personality traits lying somewhere in between extraversion and introversion. Trait theorists under the Five Factor Model are trying to capture the essence of personality; its organisation and structure. Traits in this domain are seen as the foundations of behaviour, (Snyder, 1994). Personality theorists differ on whether traits or motives govern a person's behaviour, (Pervin, 1994). What theorists are clear on is that personality is generally stable however most agree that patterns of change can occur in different unfamiliar situations. There are conflicting views on the extent to which personality effects cognitive performance, in this case working memory, one point of view is that people who score higher on extraversion scales have a better working memory, (Gray&Braver, 2002).

The aim of the present study using the The Big Five Taxonomy (John& Srivastava, 1999) on personality is to identify dominant dimensions of personality traits for the purpose of looking at individual differences in memory recall, electrical brainwave activity, skin conductance and pulse rate under varying irrelevant speech/sound conditions.

1.2 Memory

"Working memory refers to the system or sytems involved in the temporary storage of information in the performance of such cognitive skills as reasoning, learning and comprehension" (Baddeley, 1996, p.1).

Memory refers to the processes that allow us to record store and later retrieve information and experiences. Memory like divided attention is crucial to everyday functioning. Without it we would have no sense of self, we would be *lost.* There are many different types of memory,

for example, episodic, semantic, long term memory and short term memory. Episodic memory refers to the capability of travelling through time mentally and remembering events and things linked to those events, such as places. Semantic memory refers to the broad assortment of information we hold regarding the world which is detached from us. Working memory was traditionally called short term memory and refers to the preservation and conversion of data using cognition. One definition of working memory is *"the temporary form of information storage that is limited in capacity and requires re-hearsal. It is often said that working memory is information held in mind"*, (Bear, Connors and Paradiso, 2007, p. 729). Working memory is the coordination, sustaining and the manipulation of information; it is fundamental to performing many cognitive tasks and for normal daily life, (Wager & Smith, 2003) and for this reason it is extensively researched. It is regarded as the gateway between sensory input (external environment from which we receive information) and long term memory. Working memory is extremely important. It emphasises the role of cognition more so than the concept of short term memory, which is often thought of as being too passive a solution for such a complex and multi faceted process as memory. The most common method of researching working memory is with the use of memory span tests that employ both a memory and processing component. The digit span tests are useful tools in testing working memory. Participants are typically shown a list of words/ digits that they will have to recall either through serial recall or free recall these items immediately or after a short time. Miller (1956) argued the case for the number 7+- 2. He called this the magic number 7. He proposed that humans have the ability to retain seven item /seven chunks of information +- 2 (either 5 or 9). Early studies into working memory involved animals and their negotiation around experimental mazes, with the objective for the animal (usually a rat) to locate the food in the maze. The measures were repeated so the animals

working memory had to store the information so as to negotiate the maze effectively on the repeats, (Baddeley, 1996). Research on working memory has found that subjects remember pictures and words together better than words alone supporting the dual coding theory, (Mills et al, 2004; Paivio, 1971). The Dual Coding Theory of memory was originally proposed by Paivio (1971) to explain the dominant mnemonic effects of imagery. Dual coding theory has been applied to many cognitive phenomena including: mnemonics, thinking, learning and language. The central thought of the dual coding theory is simple and perceptive. Paivio proposes that the mind functions with two distinctive classes of mental representations, similar to schemas, mental descriptions and verbal symbols and memory is thus comprised of independent systems, verbal memory and image memory. Imagery increases recall of verbal material because when words call to mind an associated image two separate but linked memory traces are laid down, one in each of the memory stores, reinforcing each other. Memory retention increases if it is stored in two separate locations rather than in just one. Interference introduced during a memory task should create divided attention and therefore have an effect on recall. Associations will be lost.

Individual's differences in their ability to be in command of attention are a major contributor to variations in working memory capacity. When Baddeley et al. (1984) proposed the working memory model; they emphasized the importance of the phonological loop and the visuo-spatial workpad being managed by the central executive. The operational definition of working memory capacity is uncomplicated referring to the number of items that can be recalled during a difficult working memory task, (Barrett, Tugade and Engle, 2004). Baddeley, (1974) put forward the idea of two systems that are responsible for our working memory, the phonological loop (articulatory loop) for verbal information and the visuo-spatial sketchpad for visual data received. The Phonological Loop is a very important element in the model of

working memory. Its main function is to store up the phonological data, which can be coded as speech sounds. The visuo-spatial sketchpad manages visual and spatial information. Manipulation of the data received and processed by the phonological loop and visuospatial sketchpad occurs in the central executive which is the core of working memory. Baddeley proposed that the central executive behaves more like a system which controls attentional processes rather than as a memory store, the phonological loop and the visuo-spatial sketchpad, are specific storage systems. The central executive enables the working memory system to selectively attend to some stimuli and ignore others.

Spatial working memory stimulates the superior dorsolateral prefrontal cortex, object WM enhances neural activity in the mid-inferior frontal regions, verbal WM is found to be left lateralised (which is presumed to be because of the location of Broca's area), (Wagner & Smith, 2003). Courtney et al, (1997) and Ramai et al, (2001) found that the prefrontal regions of the brain have an active role to play in working memory specifically the posterior midfrontal region. This area contributes to working memory irrespective of type of information (verbal, object, spatial). PET and fMRI techniques have revealed that the left prefrontal cortex is activated during encoding and retrieval of data, (Owens et al, 1999). This idea is domain specific in that the prefrontal cortex is the central location for working memory processing to occur and that varying areas within the prefrontal cortex manage and control different types of information. Dorsal prefrontal regions have been supposed to be specialized areas for visual stimuli in working memory process, (Ramai et al, 2001) this is linked to attention and previous theory and research on attention. According to Baddeley and Hitch, (1974) the cognitive structures responsible for memory manipulate information we receive via the senses, visually and aurally

the visuospatial sketchpad and the phonological loop process that information. Manipulation of auditory information occurs for a short period of time before the central executive processes it further and sending it to long term memory. Baddely referred to the system as a tripartite structure.

Evidence for working memory came from a famous amnesiac patient HM. HM had a bilateral, hippocampal and temporal lobe excision to alleviate his severe epileptic seizures. The surgery was successful in ending the seizures. However HM lost specific types of his memory, namely anterograde memory. HM like other amnesiac patients had preserved digit span ability and preserved working memory whilst having lost the ability to form new long term memories. The case of HM provides evidence not only for working memory differences to long term memory but also providing neuropsychological and neurophysiological differences for difference cognitive systems, (Baddelely, 1996).

In the 1960's a cognitive revolution in psychology suggested a 3 stage model of memory. According to Atkinson & Shiffron's (1968) multi store process, memory involves encoding, storage, retention and finally retrieval. This model has been very influential not only in helping provide an early explanation for memory but also in inspiring further research into the processes involved in memory. A process that enables us to access this stored encoded information when we wish. Craik & Lockhart's (1972) concept of level processing states the more deeply we encode the information the better we remember it. Baddeley's (1974) theory on the model of working memory can be applied to this situation as we can see that if information/a stimulus is not attended to it will not be stored in short term memory. This may be relevant if the participant is distracted by interference during the task, according to theories on memory the participant may lose the information and not perform very well at the memory task.

1.3 Attention

Attention is taking possession of the mind in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thoughts.....It implies withdrawal from some things in order to deal effectively with others

- (William James, Principles of Psychology, 1890, p404)

Our ability to selectively tune into something and focus specifically on that whilst other stimuli are present and act as a distraction is very important in assisting us in adapting to our environments and allowing us to function within that environment. Divided attention is vital to everyday functioning. We could be bombarded with information; however we are saved from this due to cognitive economy. "Heightened attention also paves the way for memory processes", (Sternberg, 2009, p.124). Broadbent, (1958) put forward a theory on selective attention. Attention involves the concentrating on certain stimuli and the filtering out of other data. The concepts of divided and selective attention are quite similar. With divided attention we assign our resources to execute one or more tasks at any given time and using selective attention we are choosing which stimuli we pay attention to, choosing which stimuli in which to allocate our resources to.

Attention is the preferential processing of sensory information. Paying attention during experiments increases the reaction speeds in perceptual studies, (Bear et al, 2007). Considering the analogy, that attention is like a spotlight, moving and focusing on a point that is relevant to what we are doing, we aim to dim the lights on stimuli that are irrelevant to our task. Naveh-Benjamin et al, (1998), in their research on divided attention found that divided attention at the encoding process of memory lead to a marked impairment. Taking the spotlight away from the

to-be-remembered item whereas divided attention at retrieval had virtually no effect on memory whatsoever. Previous research has found that data that has been encoded prior to distraction is not in danger of failure of being recalled. This research was replicated Baddeley et al. (1984), and Craik et al. (1996) and the results were synonymous, divided attention at the encoding process lead to impairment in recall. This would then suggest that recall would be impaired with the introduction of auditory intrusion that would create a divided attention situation. Controlled attention is also known as *goal-directed* attention, and utilises top down processing. Top down processing is a paradigm within cognitive psychology stating that we break down and pay attention to information and form perceptions about the world around us by starting with the larger concept and then working our way down to the smaller finer details of that concept, the opposite to this is bottom up processing. Bottom-up processing states that the smaller finer details are looked at first and then a larger concept is built on the minute details.

The traditional dual-process perspective states that controlled goal directed attention manages somewhat the level to which instinctive processing influences emotions, behaviours and thoughts. When attention is held by a stimulus and activates a representation (like a schema or symbol or association made in memory) that is contradictory to processing goals, attention must be brought under control to resolve the conflict.

Broadbent's (1958) filter theory of attention paved the way for other researchers to advance on it and put forward different theories on selective attention. His theory suggested that we filter out information once it has passed sensory level. Once we receive information our selective attention filter cognitively processes the information and in order for that information to move to the perceptual process and then to short-term memory we must semantically attach meaning to it. Information from other stimuli that we don't need is filtered out and not attended

to at the sensory level. Researcher's advanced on this theory and stated that even information that is not relevant to our task at hand can make its way to the perceptual process and short-term memory, highly salient information (and information from stimuli that is personally important) can be attended to whilst we are concentrating on something else, this is our selective attention at work. Treisman (1960) put forward a theory of selective attention whereby a filter system does not completely block out irrelevant stimuli it simply weakens it or attenuates it. Her theory is the Attenuation Model that led to Deutsch and Deutsch's (1963) late filter model. This philosophy moved the selective filter to after the perceptual process. The three theories on selective attention retained the bottleneck concept all that changed was the position of the selective filter, (Sternberg, 2009). There are many different factors to be considered when looking at attention. The nature of task at hand is important and whether a person has had a chance at practicing it or whether it is novel to them. Practice can improve attention and decrease the amount of attention required. Doing of a novel task can often require a lot of attention as one would pay a lot of attention to doing a new task well. How much attention is required leads to personality. A participant's personality will have a role to play in the attentional process of what proceeds to working memory and what is filtered out any stage. Personalities theorists identified traits that might have a part to play in enhancing attention for example situational and trait-based anxiety can affect attention, and whether the stage of processing that attention is required for example at the sensory level or at the perceptual stage? Attention is a complex concept but an important once to consider when looking at working memory.

PET and fMRI studies of brain activity regarding attention and memory identified hemispheric asymmetry for encoding and retrieval, encoding is linked to the left prefrontal cortex activity and

retrieval is associated with right prefrontal activity, (Naveh-Benjamin et al, 1998). Johnson, Strafella and Zatorre, (2007) found using transcranial magnetic stimulation (rTMS) that the dorsolateral prefrontal cortex (DLPFC) plays are major role in divided attention and this supports Gisselgard et al's, (2004) research on ISE. Johnson, Strafella and Zatorre, (2007) looked specifically at bimodal divided attention and in their research found that the DLPFC is activated during tasks where unrelated auditory and visual stimuli are presented. They discussed the prefrontal cortex as having a role in bias towards task relevant stimuli and a role of inhibiting the task irrelevant information. A disruption of the DLPFC leads to a decrease in performance in bimodal attention tasks and memory specific tasks. Processing and recall capabilities should increase when attention is undivided. Beta wave oscillations that originate in the prefrontal cortex have been identified during concentration and therefore should present themselves once attention is divided.

1.4 Auditory Interference: The Irrelevant Speech/Sound Effect. (ISE)

In our daily lives it is very unusual that we would operate in complete silence. Sounds accompany practically our every moment. The auditory interference of insignificant dialogue and sound should have a bearing on the performance of different personality types (as per Big Five Inventory), (Furnham, Gunter and Peterson, 1994; Baddeley & Salame, 1986). Irrelevant speech / sound effect is the destruction of information in cognitive memory tasks when something auditory is introduced or accompanies the task at hand (to be remembered words/digits). The ISE term is used for an empirically tested affect of speech or background noise on memory recall both free and serial, particularly on visual memory, (LeCompte, Neely and Wilson, 1997). Memory tasks are impaired in the presence of irrelevant noise, (Neath, 2000) and the quantity of

impairment is independent of the volume of the irrelevant sound (40dB(A) to 76dB(A) when the to be remembered items are visual and the level of effect seems to be the same whether the sound is presented with or after the experiment has begun, (Neath, 2000). However, higher pitch tones have been found to cause more of an impairment to recall, (Baker and Holding, 2001). Baker and Holding, (2001) concluded that higher pitch and intensity with shorter duration had more of an impact on the task performance than lower frequency and intensity tones that occurred for longer intervals. The impact of irrelevant speech on a cognitive task is that it distracts the task at hand, thus impacting on the attention processes and in turn impairing working memory, (Baddeley & Salame, 1986). Broadbent (1983) disagreed with this as he suggested that the impairment was not with memory but with perception, and that perception and attention are divided, as in a Stroop test (Baddeley & Salame 1986). The Stroop Test is a measure of attention through visual processing. Named after John Ridley Stroop (1935) it requires participants to call out the colours they read and not the colour of the ink that the word is written in. The stroop effect highlights the intricacy in selecting and naming the actual colour as opposed to reading the colour of the ink. Neath, (2000) attempts to explain the impact of irrelevant speech on working memory through The Feature Model proposed by Nairne, (1988). The feature model looks at the major effects that are detected during a memory task of serial recall. Neath, (2000) discusses it with the relevance of primary and secondary memory. Primary memory according to this concept has no limit to capacity; it has the function of maintaining and constructing reminders. Information when required (on retrieval) is taken from secondary memory, and all memory is cue motivated, (Nairne, 1990). Considering the feature model theory, an impairment of memory must then be caused by a displacement of the- to-be-remembered item from primary memory, (Loaiza et al, 2011), disrupting WM (working memory). ISE has an impact on memory because

it disrupts the formation of a short-term episodic record. The effect of irrelevant sound and or speech is that recall in a memory task is significantly impaired; there is a reduction in performance on a memory test in the presence of background noise, (Weisz and Schlittmeier 2006; Gisselgard et al., 2004, Alley & Greene, 2008). The importance of the ISE is that it identifies a limit in human ability to completely filter out external sounds when trying to pay attention to something, (Elliot and Cowan, 2005). There is limited research available on the neurobiological basis of ISE; however Gisselgard et al, (2004) found that there was an increase in the activity of the dorsolateral prefrontal cortex, which is also involved in higher executive functioning, attention and working memory during background noise. There is no one area of the brain identified with ISE, (Gisselgard et al, 2004).

The impact of irrelevant speech/sound effect (irrespective of personality trait) appears to be linked to working memory load, (list length and amount of information being presented). Findings from previous research on working memory and ISE have highlighted that list length and WM load are important factors when considering the features of the neurophysiological response to the irrelevant sound effect. Alley & Greene, (2008) found that both music (vocal) and speech had an impact on performance. Working memory improved slightly with instrumental music when compared to vocal music; however it was not significantly different from speech or silent conditions. The steady state sound and changing state hypothesis are characteristics of the ISE. Sounds that remain the same for a period of time are steady state sounds and altering tones are said to be changing state sounds. Previous research suggests that changing state sounds have more of an effect on recall than steady sound states.

1.5 Electroencephelogram (EEG)

EEG is a measurement of electrical activity that is generated within the cerebral cortex. The foundations of EEG were laid by Richard Caton, 1875 and advanced by Berger (1929), he noticed that wake –sleep patterns of the brain were distinctly different. EEG is by and large used to assist in the diagnoses of epilepsy and with the study of circadian rhythms. Generally EEG records are for twenty-minute intervals. It is a non-invasive, painless procedure. Electrodes are placed at different points around the scull. The EEG records fluctuations of the pyramidal neuronal activity. The neural oscillations that will be present in the participants of this study are alpha and beta brainwaves. Alpha waves are recorded on an EEG between 8 -13Hz are the electrical waves of wake-resting state and are largest in the occipital region of cerebral cortex. High frequency, low amplitude rhythms are associated with alertness and waking (also seen in dreaming states), (Bear et al, 2007). Beta 1 waves may be seen during focused concentration and alertness, i.e. paying attention to the specific memory task, teaching and solving problems. Being highly alert present's beta 2 waves, seen when someone has to react quickly. Beta waves oscillate at the frequency range of twelve to thirty cycles per second (12-30Hz). These brainwaves are detected on both sides of the frontal lobes of the brain. Theta waves are seen during sleep or a waking meditative state. Delta waves are present during deep sleep. In this particular study we will be recording the electrical signals from three main nodes. Each electrode is labelled according to its position, e.g. A= auricle, P=parietal, O=occipital, C=central, T=temporal and F=frontal. A baseline will be recorded before the experiment begins.

There is no relationship between alpha wave pattern and intelligence, (Kleitman, 1987) a change in wave pattern is indicative of a change in consciousness and in this case concentration, from attention to distraction and concentration or focus on the task at hand during the presence of

interference. Ohme et al, (2009) found in their research that EEG and GSR serve well as beneficial tools when investigating neurophysiological responses to varying stimuli. From this and previous research in the area the cognitive memory task and ISE should effect the EEG and GSR readings for each participant.

There is no technique available to researchers that allow us to directly locate memory in the brain.

1.6 Galvanic Skin Response (GSR)

Galvanic skin response records the changes in a person skin conductance. GSR is used as an indication of psychological and physiological arousal. GSR is an electrodermal response, (EDR) this measures the electrical properties of the skin caused by interaction with the environment via the senses; sights, scents, sounds etc. and the changes that these interactions have on the one's psychological state. Galvanic skin response is measured according to Ohm's law on an ohmmeter. There are two types of skin conductance, phasic and tonic. Tonic skin conductance is the baseline level, when there is no stimulus or interaction with the environment. Changes in the state when interaction with the environment occurs are called phasic skin conductance. These changes in the conductance are called skin conductance responses (SCR). There are usually between one and three spontaneous GSR's per minute. From previous research on personality and different arousal states, it would suggest that there will be a significant difference in the GSR and SCR of extraverts and introverts when auditory interference is presented during a task, (Dawson, Shell and Courtney, 2011). Mundy-Castle and McKeiver, (1953), found that comparatively labile people showed a higher rate of non-specific electrodermal response (EDR) emission slower adjustment than stabile individuals. EDR labiles

can be identified as emotional impassive and agreeable, whereas EDR stabiles present as emotionally communicative and challenging. An objective of the current study is to examine if there is a relationship between EDR and the personality traits of introverts or extraverts.

1.7 Hypotheses

This study will address the dimensions of personality traits and the effects of those traits on memory recall under the conditions of irrelevant speech 1.) A chapter from a book 2.) Irrelevant tone (white noise/radio chatter), and 3.) In silence, whilst observing EEG/GSR and pulse readings. Gender differences may present themselves.

From reviewing previous studies it is expected that a correlation between EDR and personality will be identified**.** Previous studies have shown that background distractions have different effects on cognitive performances of introverts and extraverts, (Chamorro-Premuzic et al, 2009; Furnham & Bradley, 1997; Furnham, Gunner & Peterson, 1994).

One of the objectives of this study is to look at the GSR and SCR (skin conductance responses) when auditory interference is introduced during a task performance and to see if there are statistical differences for gender and for different personality traits.

This literature review has looked at previous research in the area of recall and memory, attention and the effect of irrelevant speech and personality on cognitive tests. Previous research has identified the effect of irrelevant speech on word recall of memory tests and observing personality traits. Of particular importance are previous studies by Neath (2000) and LeCompte, (1994) and Gisselgard et al, (2004). The current study will look at the ISE, personality and gender on free recall whilst observing electrical brain activity, galvanic skin response and pulse rate and under varying conditions try to identify a link between gender, personality and ISE.

1.7a Main Hypothesis

Hypothesis 1

It is hypothesized that different types of background intrusion will affect free recall and that there will be a significant difference in word recall and background intrusion.

Hypothesis 2

It is hypothesized that there will be a statistically significant correlation between dimensions of personality type and levels of word recall.

Hypothesis 3

It is hypothesized that there will be a statistically significant correlation between GSR and dimensions of personality type.

Hypothesis 4

It is hypothesized that there will be a statistically significant difference between EEG readings and dimensions of personality types

Hypothesis 5

It is hypothesized that there will be a statistically significant difference in pulse readings of dimensions of personality types.

Hypothesis 6

It is hypothesized that there will be a statistically significant difference in gender and word recall, gender and EEG readings, gender and GSR readings and gender and personality type.

$\mathbf{H_0}$ States that there will be no statistically significant differences between the variables.

CHAPTER 2

METHOD

2.1 Materials /Apparatus

Assessment measures included a basic demographic questionnaire within the cover pages together with The Big Five Taxonomy of Personality (John& Srivastava, 1999). This was administered before the biofeedback equipment was set up and attached to the participant. The biofeedback equipment included AD Instruments Making Science Easier Power lab 26T Bio Amp machine (EEG, Pulse and Heart Rate monitor) and AD Instruments Making Science Easier GSR reader. Lab Chart 7 Reader was used to analyse the biofeedback data. ECI Electro-Gel was used for conductance and put on each electrode using a syringe before each electrode being put in place on the subjects head and held there by a headband. The electrodes have a width of 9 mm. They have a hole in the top for electrolyte conductance gel and lead wires that connect to the Bio Amp machine. The AD Instruments Making Science Easier GSR finger electrodes were used to record EDR and also connected to the Bio amp machine.

The (AD Instruments Making Science Easier) Powerlab 26T EEG operations involved the EEG system being constructed for alpha recordings looking at the variance between interfering signals/waves. EEG also records the effects of visual activity on alpha rhythm in the brain. MS Powerpoint on a Lenovo PC was used for the presentations to display the words as part of the memory recall test. Phillips headphones together with an Apple Iphone 4 were used to provide auditory interference. A pen and paper was provided for the recall of the words.

SPSS V. 19 (Statistical Package for Social Sciences) was used to analyse the collated data.

2.2 The Big Five Inventory

The Big Five Taxonomy (John& Srivastava, 1999) was administered. This measure was employed to identify dominant dimensions of the personality traits which may have an impact on the test scores under the varying conditions. The Big Five Taxonomy of personality questionnaire consists of 44 questions. Participants are asked to rate their level of association to each of the forty four statements using a 5-point likert scale (i.e.,1= Disagree Strongly to 5= Agree Strongly). These ratings provide a profile of an individual's personality by assessing their strength in each of the five traits of personality (Openness to New Experiences, Conscientiousness, Extraversion, Agreeableness, and Neuroticism). The highest of the five ratings can be used to classify participants into a personality trait category. Scores range from 1 to 5. Reverse score items was used. The Big Five Taxonomy demonstrates high levels of reliability and validity. The Cronbach's Alpha of psychometric instruments was used to test reliability.

Table 1. *Reliability of Big Five Taxonomy*

Personality Dimension	Internal reliability measure Cronbach's Alpha	Number of Items
Openness	0.79	10
Conscientiousness	0.67	9
Extraversion	0.87	8
Agreeableness	0.67	8
Neuroticism	0.78	8

Openness was measured on a 10 item score, conscientiousness was measured on a 9 item

score, extraversion, agreeableness and neuroticism were measured on an 8 item scale from the BFI.

2.3 Participants

Thirty (N=30) participated in this study. There were sixteen males (n = 16) and fourteen females (n = 14). The mean age, (M= 32.9, SD= 7.383, Mode = 30) with an age range from 20 to 53 years. Snowball sampling was used. Respondents were found in various work sectors across Dublin, Ireland. All subjects were in employment.

2.4 Procedure

Those subjects who wished to participate were verbally asked to take part in the research. When the participant agreed to be a part of the research they were informed of the study via email and times were arranged for each participant to come to the laboratory to complete the tasks. Participants were tested individually. On arrival to the laboratory a typed cover sheet re-explained the research and outlined the experiment in detail as to what the procedure would be. The front cover sheet informed participants that their answers would remain anonymous and confidentiality was assured. The explanation also informed the participants that they had the right to withdraw at any time.

Control conditions ensured that the control task was distinguishable from the auditory interference. (The control condition was the memory task preformed in silence).

Internal validity was controlled for as each participant wore headphones for the three presentations of words to drown out any external noise (from the building/street) particularly

important for the control experiment (silent condition). The volume level was the same for both conditions where auditory intrusion was introduced.

On arriving at the lab each participant was asked to complete The Big Five Taxonomy. Once this questionnaire was completed the participant was attached to the biofeedback equipment (for EEG, GSR, Pulse rate readings). The participant placed the headphones (attached to the Apple Iphone 4 over their ears). Prior to the biofeedback equipment being attached an open circuit reading was obtained on the AD Instruments Making Science Easier Lab Chart 7 programme as the baseline. The electrodes were then placed in position on the participant's head, (earth green at the left side above the eye near the temple, black negative at the back of the head on the skull and the white positive electrode at the right hand side above the eye near the temple). The positive electrode is called the signal and the negative electrode is the called the reference and the third electrode is the earth.

The GSR electrodes for monitoring EDR were positioned on the fingers of the hand they did not use to write and the pulse monitor at the thumb of this same hand. A subject reader reading was then obtained separately for each participant.

There were three MS Powerpoint presentations of twenty words, each word was displayed for a total of six seconds (each presentation of words was for two minutes). Different words were used for each presentation. Two of the presentations were accompanied by audio interference through the headphones. An unknown chapter accompanied Presentation 1 from a book, The Man Who Mistook His Wife for a Hat by Oliver Sacks. A random mixture of radio talk shows and white noise (that was interchangeable) accompanied Presentation 2 and Presentation 3 was performed in silence, (as the control). The intrusion began at the word display of the to-be remembered word and continued through the time for word recall. For a total of four minutes for

each presentation. The participants were unaware of/ if any intrusion would occur. Task instructions outlined that the participant should pay sole attention to the display of the words on the screen.

2.5 Design

This study is a quantitative correlational experiment. This experiment is a within subjects design using repeated measures. Each participant completed the study under each of the conditions. The independent variable is background intrusion (noise/condition of experiment) and the dependent variable is word recall. (The IV is controlled in the experiment; the control condition was the memory test conducted in silence).

2.6 Data Analysis

Analysis of variance (ANOVA) for repeated measures was used to identify if there were significant differences between the recall conditions and different dimensions of personality.

A Pearson R Coefficient correlation was used to identify significant relationships between the variables. These parametric tests were used because they are robust in their findings.

Independent Samples t tests were conducted to identify statistically significant differences in gender across the variables.

CHAPTER 3

RESULTS

3.1 Descriptive Statistics

All data was analysed for normality distribution via exploratory data analysis. Frequency distribution of each dimension of personality traits as shown on Table 2.

The mean scores for each condition were calculated. (Table 3. H1)

The mean scores for EEG, GSR and Pulse rate readings were calculated (see appendix).

Table 2.

Frequency Distribution of Dimensions of Personality Traits

Valid	Frequency	Percentage
Openness	13	43.3
Conscientiousness	10	33.3
Extraversion	4	13.3
Neuroticism	1	3.3
Agreeableness	0	0
Multi-dimensional	2	6.7
Total (N)	30	100

3.2 Inferential Statistics

An analysis of variance test was run to identify significant relationships between the IV and the DV. Pearson r coefficient correlation tests were also run to highlight significant relationships between the variables. Independent Sample t tests were conducted to identify statistically significant differences in gender and the other variables.

3.3 Hypothesis

Hypothesis 1

It is hypothesized that different types of background intrusion will affect free recall. (Table 3. H1)

An analysis of variance (ANOVA) repeated measures was conducted to compare the effect of background intrusion on word recall (memory). No significant difference was found between the three conditions for word recall and type of background intrusion. The mean scores for the three conditions showed no significant difference at 5% level: (F (2, 58) = .131; p=.87 Partial eta squared = .04)

Table. 3 (H1)

Descriptive Statistics and Word Recall

	Mean	Std. Deviation	N
Recall1Chptr	10.87	2.956	30
Recall2Tone	10.70	3.984	30
Recall3Silence	10.97	3.996	30

Hypothesis 2

It is hypothesized that there will be a significant relationship between dimensions of personality type and levels of word recall. (Table 5. H2 and Table 6. H2)

Using a Pearson r correlation a strong positive correlation was found between personality type openness and word recall for presentation 1 where the background intrusion was a chapter from a book, (r=.49, n=30, p=006, 2- tailed)

Using a Pearson r correlation a strong positive correlation was found between personality type openness and word recall for presentation 2 where the background intrusion was a mixture of white noise and radio talk show, (r=.59, n=30, p=001, 2-tailed).

Using a Pearson r correlation there was no significant correlation between personality type and word recall for presentation 3 (the control) conducted in silence outlined in Table 5

Table 4. (H2)

Significant Pearson r coefficient correlations for Hypothesis 2

Variables		**r** Sig. (2-tailed)	**P<.05**
Recall1Chptr	Openness	.49	.006
Recall2 Tone	Openness	.59	.001
Extraversion	Openness	.0626	.000**
Extraversion	Neuroticism	-.352	.05
Extraversion	Agreeableness	.455	.01

**p<.01

Table 5. (H2)

No significant Pearson r coefficient correlation for Hypothesis 2

Recall3Silence	**r (Sig 2-tailed)**	**P<.01/P<.05**
Extraversion Scale Score	.049	.798
Agreeableness Scale Score	.239	.204
Conscientiousness Scale Score	-.009	.962
Neuroticism Scale Score	-.032	.868
Openness Scale Score	.251	.181

Hypothesis 3

It is hypothesized that there will be a statistically significant correlation between GSR readings and dimensions of personality traits. (Table 6. (H3))

Using a Pearson r correlation a strong positive correlation was found between GSR1 and extraversion, (r=484, n=30, p=.007, 2-tailed)

Using a Pearson r correlation a strong positive correlation found between GSR2 and extraversion, (r=506, n=30, p=.004, 2-tailed)

Using a Pearson r correlation a strong positive correlation found between GSR3 and extraversion, (r=515, n=30, p=.004, 2-tailed).

Using a Pearson r correlation a negative significant correlation was found between GSR3 and neuroticism, (r= -.394, n=30, p=.031*, two-tailed)*(p<.05)

Table 6. (H3)

Significant Pearson r coefficient correlations for Hypothesis 3

Variables		**r (Sig 2-tailed)**	**P<.01**
GSR1	Extraversion	.484	.007
GSR2	Extraversion	.506	.004
GSR3	Extraversion	.515	.004
GSR3	Neuroticism	-.394	.031 *

*p<.05

Using a Pearson r correlation no other significant relationships were identified between GSR in any of the three presentations and the dimensions of personality traits of conscientiousness, openness and agreeableness. GSR1 and conscientiousness, (r=-.006, n=30, p=.975, 2-tailed, GSR2 and conscientiousness, (r=.030, n=30, p=.874, 2-tailed) and GSR3 and conscientiousness, (r=-.012, n=30, p=.950, 2-tailed). GSR1 and openness, (r=.361, n=30, p=.050, 2-tailed) GSR2 and openness, (r=.271, n=30, p=.148, 2-tailed) and GSR3 and openness, (r=-.211, n=30, p=.264, 2-tailed). GSR1 and agreeableness, (r=208, n=30, p=.269, 2-tailed, GSR2 and agreeableness, (r=.294, n=30, p=.115, 2-tailed) and GSR3 and agreeableness (r=.269, n=30, p=.112, 2-tailed).

Table 7 (H3)

No significant Pearson r coefficient correlation between GSR readings and conscientiousness

Conscientiousness	**r (Sig. 2-tailed)**	**P<.01**
GSR1	-.006	.975
GSR2	.030	.874
GSR3	-.012	.950

Table 8 (H3

No significant Pearson r coefficient correlation between GSR readings and openness

Openness	**r (Sig. 2-tailed)**	**P<.01**
GSR1	.361	.050
GSR2	.271	.148
GSR3	.211	.264

Table 9 (H3)

No significant Pearson r coefficient correlation between GSR readings and agreeableness

Agreeableness	**r (Sig. 2-tailed)**	**P<.01**
GSR1	.208	.269
GSR2	.294	.115
GSR3	.296	.112

Hypothesis 4

It is hypothesized that there will be a statistically significant correlation between EEG readings and dimensions of personality traits.

Using a Pearson r correlation there was no significant correlation found between EEG1 and openness, (r=014, n=30, p=.940, 2-tailed), EEG2 and openness, (r=-.016, n=30, p=.935, 2-tailed), and EEG3 and openness, (r=-.341, n=30, p=.065, 2-tailed) readings between the three presentations and five dimensions of personality traits.

Using a Pearson r correlation there was no significant correlation found between EEG1 and extraversion, (r=-.309, n=30, p=.097, 2-tailed), EEG2 and extraversion, (r=.094, n=30, p=.620, 2-tailed), EEG3 and extraversion (r=-.064, n=30, p=.738, 2-tailed) readings between the three presentations and five dimensions of personality traits.

Using a Pearson r correlation there was no significant correlation found between EEG1 and conscientiousness, (r=.052, n=30, p=.784, 2-tailed), EEG2 and conscientiousness, (r=.021, p=.949, n=30, 2-tailed), EEG3 and conscientiousness (r=-.146, n=30, p=.441, 2-tailed) readings between the three presentations and five dimensions of personality traits.

Using a Pearson r correlation there was no significant correlation found between EEG1 and neuroticism, (r=-.074, n=30, p=.696, 2-tailed), EEG2 and neuroticism, (r=.029, n=30, p=.879, 2-tailed), EEG3 and neuroticism (r=-.042, n=30, p=.824, 2-tailed) readings between the three presentations and five dimensions of personality traits.

Using a Pearson r correlation there was no significant correlation found between EEG1 and agreeableness, (r=038, n=30, p=.842, 2-tailed), EEG2 and agreeableness, (r=.-082, n=30, p=.641, 2-tailed), EEG3 and agreeableness (r=-.108, n=30, p=.568, 2-tailed) readings between the three presentations and five dimensions of personality traits

Table 10. (H4)

No significant Pearson r coefficient correlation between EEG readings and extraversion

Extraversion	**r (Sig. 2-tailed)**	**P<.01**
EEG1	-.309	.097
EEG2	. 094	.620
EEG3	-.064	.738

Table 11. (H4)

No significant Pearson r coefficient correlation between EEG readings and conscientiousness

Conscientiousness	**r (Sig. 2-tailed)**	**P<.01**
EEG1	-.052	.784
EEG2	. 012	.949
EEG3	-.146	.441

Table 12. (H4)

No significant Pearson r coefficient correlation between EEG readings and neuroticism

Neuroticism	**r (Sig. 2-tailed)**	**P<.01**
EEG1	-.074	.696
EEG2	. 029	.879
EEG3	-.042	.824

Table 13. (H4)

No significant Pearson r coefficient correlation between EEG readings and Openness

Openness	**r (Sig. 2-tailed)**	**P<.01**
EEG1	.014	.940
EEG2	-.016	.935
EEG3	-.341	.065

Table 14. (H4)

No significant Pearson r coefficient correlation between EEG readings and agreeableness

Agreeableness	**r (Sig. 2-tailed)**	**P<.01**
EEG1	.038	.842
EEG2	-.089	.641
EEG3	-.108	.568

Hypothesis 5

It is hypothesized that there will be a statistically significant correlation in pulse readings of participants with different dimensions of personality traits.

Using a Pearson r correlation a negative significant correlation was found between Pulse 3 (pulse reading for presentation 3) and conscientiousness, (r=-.383, n=30, p=.037, 2-tailed). (Table 15. H5).

Using a Pearson r correlation there was no significant correlation found between Pulse1 and extraversion, (r=-.078, n=30, p=.683, 2-tailed), pulse2 and extraversion, (r=-.232, n=30, p=.216,

2-tailed), pulse3 and extraversion (r=-089, n=30, p=.638, 2-tailed) readings between the three presentations and five dimensions of personality traits. (Table 16. (H5)

Using a Pearson r correlation there was no significant correlation found between Pulse1 and neuroticism, (r=.353, n=30, p=.056, 2-tailed), pulse2 and neuroticism, (r=.273, n=30, p=.145, 2-tailed), pulse3 and neuroticism(r=.097, n=30, p=.611, 2-tailed) readings between the three presentations and five dimensions of personality traits. (Table17. H5)

Using a Pearson r correlation there was no significant correlation found between Pulse1 and openness, (r=.046, n=30, p=.811, 2-tailed), pulse2 and openness, (r=.003, n=30, p=.989, 2-tailed), pulse3 and openness (r=-123, n=30, p=.500, 2-tailed) readings between the three presentations and five dimensions of personality traits. (Table18. H5)

Using a Pearson r correlation there was no significant correlation found between Pulse1 and agreeableness, (r=-.028, n=30, p=.133, 2-tailed), pulse2 and agreeableness, (r=-.359, n=30, p=.051, 2-tailed), pulse3 and agreeableness (r=-230, n=30, p=.221, 2-tailed) readings between the three presentations and five dimensions of personality traits. (Table19. H5)

Table 15. H5)

Significant negative correlation between pulse rate in condition 3 (silence) and conscientiousness

Conscientiousness	**r (Sig. 2-tailed)**	**P<.01**
Pulse3	-.383	.037

Table 16 . (H5)

No significant Pearson r coefficient correlation between pulse readings and extraversion

Extraversion	**r (Sig. 2-tailed)**	**P<.01**
Pulse1	-.078	.683
Pulse2	-.232	.216
Pulse3	-.089	.638

Table 17. (H5)

No significant Pearson r coefficient correlation between pulse readings and neuroticism

Neuroticism	**r (Sig. 2-tailed)**	**P<.01**
Pulse1	.353	.056
Pulse2	.273	.145
Pulse3	097	.611

Table 18. (H5)

No significant Pearson r coefficient correlation between pulse readings and openness

Openness	**r (Sig. 2-tailed)**	**P<.01**
Pulse1	.046	.811
Pulse2	.003	.989
Pulse3	-.123	.500

Table 19. (H5)

No significant Pearson r coefficient correlation between pulse readings and agreeableness

Agreeableness	**r (Sig. 2-tailed)**	**P<.01**
Pulse1	-.280	.133
Pulse2	-.359	.051
Pulse3	-.230	.221

Hypothesis 6

It is hypothesized that there will be a significant difference in gender and word recall, gender and pulse rates, gender and EEG, gender and GSR, and gender and personality type.

An Independent Samples t test was used to compare gender and word recall, no significant differences were found between gender and recall1, (t=.880, df=28, 2-tailed p=.387), gender and recall2, (t=1.318, df=26.01, 2-tailed p=.199) and gender and recall3, (t=1.002, df=23.27, 2-tailed p=.327). (Table 20. H6)

Table 20. (H6)

No statistical difference between gender and word recall

	Gender	N	t	df	Sig (2-tailed)
Recall1	Male	16	.880	28	.387
	Female	14			
Recall2	Male	16	1.318	26.01	.199
	Female	14			
Recall3	Male	16	1.002	23.27	.327
	Female	14			

An Independent Samples t test was used to compare gender and pulse rate readings across the three conditions, no significant difference was found between gender and pulse 1, (t=1.179,df=26.76,2-tailed p=.259), gender and pulse 2, (t=.367, df=28, 2-tailed p=.716) and gender and pulse 3, (t=1.007, df=27.96, 2-tailed p=.322). (Table 21. H6)

Table 21. (H6)

No statistical difference between gender and pulse rate readings

	Gender	N	t	df	Sig (2-tailed)
Pulse1	Male	16	1.179	26.76	.259
	Female	14			
Pulse2	Male	16	.376	28	.716
	Female	14			
Pulse3	Male	16	1.007	27.96	.322
	Female	14			

An Independent Samples t test was used to compare gender and EEG readings across the three conditions, no significant difference was identified between gender and EEG1, (t=.394,df=28,2-tailed p=.696), gender and EEG 2, (t=.051, df=28, 2-tailed p=.960) and gender and EEG, (t=.482, df=28, 2-tailed p=.634). (Table 22. H6)

Table 22. (H6)

No statistical difference between gender and EEG readings

	Gender	**N**	**t**	**df**	**Sig (2-tailed)**
EEG1	Male	16	.394	28	.696
	Female	14			
EEG2	Male	16	.051	28	.960
	Female	14			
EEG3	Male	16	.482	28	.634
	Female	14			

An Independent Samples t test was used to compare gender and GSR readings across the three conditions, no significant difference was found between gender and GSR1, (t=.811,df=28,2-tailed p=.424), gender and GSR 2, (t=1.478, df=28, 2-tailed p=.151) and gender and GSR 3, (t=1.765, df=28, 2-tailed p=.089). (Table 23. H6)

Table 23. (H6)

No statistical difference between gender and GSR readings

	Gender	N	t	df	Sig (2-tailed)
GSR1	Male	16	.811	28	.424
	Female	14			
GSR2	Male	16	1.478	28	.151
	Female	14			
GSR3	Male	16	1.765	28	.089
	Female	14			

An Independent Samples t test was used to compare gender and dimensions of personality traits, no significant differences were found between gender and extraversion, (t=1.193, df=28,2-tailed p=.243), gender and agreeableness, (t=.430, df=28, 2-tailed p=.671), gender and conscientiousness, (t=-1.68, df=28, 2-tailed p=.104), gender and neuroticism (t=-.987, df=28, 2-tailed p=.332), gender and openness, (t=1.841, df=28 p=.076). (Table 24. H6

Table 24. (H6)

No statistical difference between gender and dimensions of personality

Dimension of Personality	t	df	Sig (2-tailed)
Extraversion	1.193	28	.243
Agreeableness	-.430	28	.671
Conscientiousness	-1.68	28	.104
Neuroticism	-.987	28	.332
Openness	1.841	28	.076

CHAPTER 4

DISCUSSION

The objective of this chapter is to restate the aim and design of the research and to provide a summary of the results with a discussion of their relevance. Strengths and weaknesses of the current study and implications for future research will also be addressed. This discussion chapter will assemble the literature review of chapter one on which the present study is based and the results of chapter three to identify if the current findings collaborate with previous research in the area.

4.1 Aim

The aim of this study is to investigate the effect of the phenomenon of the irrelevant sound effect (ISE) of varying auditory interference and personality on performance in a cognitive memory test whilst observing differences in EEG, GSR and pulse rate readings.

4.2 Hypotheses Analysis / Evaluation

Hypothesis 1

It was hypothesized that different types of background intrusion would affect free recall and that there would be a significant difference in word recall and background intrusion as discussed by Beaman and Jones, (1998). The hypothesis in this instance was not supported so we can reject it (H1) and accept the null hypothesis (H_0). There was no statistically significant difference in the levels of recall for the three conditions. These results are consistent with some previous research that suggests that the irrelevant speech/sound effect does not affect free recall and only effects serial recall of items, (Tremblay et al, 2000; Jones & Macken, 1993) as in this case of a free

recall experiment no statistically significant result was yielded. However a differing view of the irrelevant speech/sound effect put forward by LeCompte, (1994) suggests that we can expand the effect of the irrelevant tone further than serial recall to free recall. However the results in this particular instance do not support either position because in this circumstance memory levels were statistically unaffected by the both the presence and absence of noise. A reason for this may be adaptation/habituation and also the method in which the participant used to memorize the words they were presented with may have changed and improved between the conditions resulting in the sounds having no affect. Further investigation is required.

Hypothesis 2

It was hypothesized that there would be a statistically significant correlation between dimensions of personality type and levels of word recall. The results in this instance support the hypothesis providing a statistically significant association between levels of word recall and an aspect of personality. We can accept H2 and reject the null hypothesis (H_0).

This result is regarding one out of the five dimensions of personality, “openness to new experiences” within the irrelevant sound and speech condition and was not observed in the silent condition. “Openness to New Experiences” was the most frequently distributed dimension within the sample tested. The dimension of “openness to new experiences” of personality traits according to trait theory is characterized by a person who proactively pursues new experiences, enjoys and is enthusiastic about the unfamiliar and strives to appreciate every new experience. Someone who lies on the “openness to new experiences” continuum who demonstrates high openness to new experiences (by scoring high on the openness scale) is imaginative, creative and due to the proactively trying to appreciate every new experience may have applied great

concentration to the presentation of words; paying undivided attention to the words by ignoring the auditory interference and therefore obtaining higher levels of recall than persons who scored higher on the other traits. This insignificant association in the silent condition may account for adaptation or the openness character becoming bored of the "new" experience. Further inquiry in this area is required.

This result was unexpected; previous research that provided the basis for this current study had indicated that the scales of extraversion/introversion would be most relevant to a cognitive task performance under varying conditions, (Furnham & Bradley, 1997; Gray&Braver, 2002). In this particular study this was not the case.

Hypothesis 3

It was hypothesized that there would be a significant correlation between GSR and dimensions of personality traits. The results in this instance support the hypothesis providing a statistically significant association between galvanic skin response and an aspect of personality. We can accept H3 and reject the null hypothesis (H_0). There was a positively positioned strong correlation between GSR and extraversion for all three conditions in the presence of speech/tone and in silence. This result is in line with the previous research in the area suggesting that a significant difference in the GSR of extraverts and introverts will be observed when auditory interference is presented during a task, (Dawson, Shell and Courtney, 2011). Extraversion on the continuum according to Costa and McCrae, (1985) is characterised by evaluating a situation by the level of social interaction and needing stimulation for enjoyment of a situation. An extravert is very gregarious, active, sociable and unconventional. Introversion and introverts lie on the polar end of that continuum, being very pensive, quiet, un-talkative and reserved.

What also presented was a relationship between GSR and neuroticism. This was a negatively directed weak association for the silent condition. Neuroticism is characterised by emotional instability, a person who worries a lot and gets overly nervous and has maladaptive coping strategies. The characteristics of a low scorer on the neuroticism scale are someone who is calm, unemotional and stable, sometimes stoic, secure and relaxed. This result is consistent with previous research in the area as Mundy-Castle and McKeiver, (1953) found that highly changeable individuals produced little electro dermal responses when compared to stabile individuals. When Allport, (1921; 1937) approached personality theory his aim was to look at personality and how a person adjusted to the environment. GSR provides us with evidence that we are changing possibly trying to regulate ourselves with what is occurring in our environment. Further investigation is required.

Hypothesis 4

It was hypothesized that there would be a significant correlation between EEG readings and dimensions of personality types

No statistically significant correlation was observed therefore we can reject the H4 and accept the null hypothesis (H_0). This is inconsistent with Ohme et al's, (2009) and Klimesch (1997) research whereby they found that EEG and GSR serve well as beneficial tools when investigating neuro-physiological responses to differing conditions. In this study there were no EEG findings. Further research is needed in this area.

Hypothesis 5

It was hypothesized that there would be a statistically significant correlation in pulse rate readings of participants with different dimensions of personality traits. This hypothesis was partially observed regarding the pulse rate for presentation3 (the silent condition) and the dimension of the trait conscientiousness, we can accept the H5 and reject the null hypothesis (H_0). If we consider the characteristics of conscientiousness as someone who is organized, hard-working, reliable and self-disciplined. We can see from the negatively directed relationship that this would suggest that as levels of conscientiousness went down the pulse rate went up. The reasons for this negative position may be that a conscientious person who is characteristically goal-orientated had a change in their natural state of emotions (i.e. became tired, bored, frustrated) leading to a change in their pulse rate.

Hypothesis 6

It was hypothesized that there would be a statistically significant difference in gender and word recall, gender and pulse rates, gender and EEG, gender and GSR, and gender and personality type.

An independent samples t test was conducted in this research and no statistically significant results were observed between gender and the varying variables. We can reject H6 and accept the null hypothesis (H_0). This is inconsistent with previous research in the area as gender differences have been observed in personality traits as reported by Benjamin et al, (2008) who observed differences in agreeableness and neuroticism. Female participants scored higher on the scales for neuroticism and agreeableness than their male counterparts. However, previous research on males and females on the traits of extraversion and openness to new experiences has

been contradictory, (Benjamin et al, 2008). Previous research into working memory suggests that females outperform males in working memory tests, (Kaushanskaya, Marian &Yoo, 2011) the results of this study are inconsistent as no differences were observed in any of the areas.

4.3 Implications

Primarily this current study is consistent in supporting previous research using galvanic skin response when look at changing physiological and psychological states when interaction with the environment occurs. It is also consistent with the concept that personality will affect cognitive performance. The result of the statistically significant findings of levels of word recall and "openness to new experience" can contribute to the design of future experiments whereby the trait of openness is taken into consideration together with introversion/extraversion in a cognitive task study. Further research is required in this area. In general the results of this experiment could contribute to literature and research on dimensions of personality traits and the interlinking relationship between the different traits, for example, the strong positive relationship found between extraversion and openness, extraversion and agreeableness and the negative correlation found between neuroticism and extraversion and how those traits affect the electro-dermal response when one is performing a cognitive task.

4.4 Limitations

A strength of the study is that in the experimental condition internal validity was controlled for with the use of headphones to drown out external noise (unrelated to the experiment) from the street and building.

In retrospect this study could be improved in a number of areas to take into consideration generalizability and representativeness. Some limitations to this experiment, are that it was conducted on a relatively small sample (N=30) where the dimensions of personality traits were not evenly represented. It is possible that the small sample number failed at the opportunity to yield statistically significant differences between physiological states (using GSR and Pulse rate readings together with EEG readings) and personality traits and gender. If the sample had been larger we may have seen more people score higher on the extraversion/introversion scale, which in previous research has produced significant findings regarding performance in cognitive tasks. The sample yielded more people scoring very highly on the "openness to new experiences" dimension than on any other dimension (frequency of openness to new experiences, N= 13). Had the dimensions of the personality traits according to the factor model of trait theories on personality been more equally represented then different results may have been observed. Extraversion scores were quite low for a group which may have affected the findings as previous research suggests that levels of extraversion/introversion and environmental stimulation have implications on task performance. A larger sample would provide more interpretable results for the correlation of GSR and neuroticism. In summary with a small sample size there may be limitations to generalizability, representativeness and this may have had an impact on the results.

A further limitation could have been the auditory interference itself, previous research on the ISE paradigm has indicated that noise disrupts memory tasks. Beaman and Jones (1998) suggest that the actual invasiveness of the sounds and the features of the cognitive task are important factors to take into consideration which is also consistent with the findings of Baker and Holding, (2001). Future research may consider this as a very important feature when

looking at free recall and alter the experimental conditions somewhat and this may deliver differing results.

4.5 Future research

Further research is required, looking at correlations between the different dimensions of personality traits whilst observing the EEG, GSR and Pulse rates readings that may present themselves during a cognitive task whilst using a larger sample. Further inquiry into the alpha rhythm activity when visual objects are displayed together with auditory interference during a cognitive task is required to attempt replication of previous research as per Klimesch's, (1997; 1996) research on EEG alpha wave activity and memory processes. A larger sample may also provide more personality traits and other significant findings may be discovered. The changing state hypothesis could be applied to future investigations in the ISE on free recall. Future research with an aim at replicating LeCompte's (1994) and Beaman and Jones (1998) research on the implications of ISE on free recall is required possibly considering Baker and Holding's (2001) findings that shorter higher pitch tones could be used together with the changing state hypothesis (Beaman & Jones 1997) to obtain results consistent with ISE research.

4.6 Conclusion

The objective of the study was to investigate the effect of the phenomenon of the irrelevant speech/sound effect on working memory whilst observing neurological and physiological changes. The results of the study do not support the irrelevant sound effect paradigm for impairment of working memory on free recall, (LeCompte, 1994) as the mean scores of word recall for all three experimental conditions displayed no statistically significant

difference. The research is however consistent with previous studies on the importance of personality (characteristics and dimensions of traits) in cognitive task performance as seen with the trait on “openness to new experiences”.

Interestingly separate from the hypotheses, what emerged from the study were significant associations between the personality traits from within the big five inventory and dimensions of personality traits (Using a Pearson r correlation a strong positive relationship between extraversion and openness scales, (r=.626, n=30, p=000, 2- tailed)

Using a Pearson r correlation a negative significant correlation between extraversion and neuroticism, (r=-.352, n=30, p=.056, 2-tailed)

Using a Pearson r correlation a positive significant correlation found between extraversion and agreeableness, (r=.455, n=30, p=.012, 2-tailed).

Further studies are needed to assess how personality traits are reflected on the physiological markers, galvanic skin response and pulse rate readings. Additional studies are required considering all the variables mentioned. Investigations considering how they are connected with an aim at replicating the research on which this study was based, looking at EEG and memory, the ISE paradigm on free recall, taking into account attentional processes and level and invasiveness of auditory interference and also the personality characteristics that have previously been thought to affect such tasks.

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Appendix

List of Words

Presentation 1	**Presentation 2**	**Presentation 3**
(Recall) Chapter	**(Recall) Tone**	**(Recall) Silence**
Chair	Mouse	Sofa
Kettle	Door	Bicycle
Pencil	Candle	Hose
Ball	Card	Scarf
Book	Bowl	Jacket
Shoe	Cat	Dog
Kite	Pillow	Rake
Car	Flower	Mop
Lamp	Jug	Sun
Hat	Bus	Tissue
Magazine	Microwave	Slipper
Cushion	Bell	Clock
Wheel	Jar	Train
Table	Coin	Sock
Hand	Button	Ruler
Tap	Star	Incense
Hairbrush	Mirror	Soap
Rabbit	String	Fish
Tree	Pen	Wave
Moon	Leaf	Pipe

Cover Page

Thank you for participating in this experiment as part of research for my thesis for completion of a Bachelor of Arts Degree in Psychology in DBS.

Instructions for experiment:
I will place 3 electrodes to your head to get an EEG reading (at 2 points at the front and 1 at the back_
I will place 2 bands on your fingers or toes for galvanic skin response and a pulse rate monitor to your thumb.

Please complete the following questionnaires and follow the instructions on the MS Powerpoint presentations.

In each presentation you will see a list of words once Presentation 1 is over you will have 2 minutes to write down as many words as you can remember.
After these 2 mins have lapsed Presentation 2 will commences nad the same rules will apply followed by Presentation 3.

For each presentation please concentrate only on the words presented on the screen.

Results will be anonymous. Confidentiality assured.

You are free to leave the experiment at any time.

Thank you for your time.

Ruth Carroll
1282771

Section 1

Please circle the answer most relevant

Time of Day

Morning Afternoon Evening

Sex: Male Female

Age:

How I am in general

Here are a number of characteristics that may or may not apply to you. For example, do you agree that you are someone who *likes to spend time with others*? Please write a number next to each statement to indicate the extent to which **you agree or disagree with that statement.**

1 Disagree Strongly	**2** Disagree a little	**3** Neither agree nor disagree	**4** Agree a little	**5** Agree strongly

I am someone who…

1. _____ Is talkative
2. _____ Tends to find fault with others
3. _____ Does a thorough job
4. _____ Is depressed, blue
5. _____ Is original, comes up with new ideas
6. _____ Is reserved
7. _____ Is helpful and unselfish with others
8. _____ Can be somewhat careless
9. _____ Is relaxed, handles stress well.
10. _____ Is curious about many different things
11. _____ Is full of energy
12. _____ Starts quarrels with others
13. _____ Is a reliable worker
14. _____ Can be tense
15. _____ Is ingenious, a deep thinker
16. _____ Generates a lot of enthusiasm
17. _____ Has a forgiving nature
18. _____ Tends to be disorganized
19. _____ Worries a lot
20. _____ Has an active imagination
21. _____ Tends to be quiet
22. _____ Is generally trusting
23. _____ Tends to be lazy
24. _____ Is emotionally stable, not easily upset
25. _____ Is inventive
26. _____ Has an assertive personality
27. _____ Can be cold and aloof
28. _____ Perseveres until the task is finished
29. _____ Can be moody
30. _____ Values artistic, aesthetic experiences
31. _____ Is sometimes shy, inhibited
32. _____ Is considerate and kind to almost everyone
33. _____ Does things efficiently
34. _____ Remains calm in tense situations
35. _____ Prefers work that is routine
36. _____ Is outgoing, sociable
37. _____ Is sometimes rude to others
38. _____ Makes plans and follows through with them
39. _____ Gets nervous easily
40. _____ Likes to reflect, play with ideas
41. _____ Has few artistic interests

42. _____ Likes to cooperate with others

43. _____ Is easily distracted

44. _____ Is sophisticated in art, music, or literature

Mean Scores for EEG, Pulse Rate and GSR readings.

Table 24. *EEG readings*

EEG Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
EEG1	30	-8.90290	.16180	-.8973966	2.09653648
EEG2	30	-7.77370	.28290	-1.1852367	2.39283994
EEG3	30	-5.56730	.23360	-.8137433	1.25920717
Valid N	30				

Table 25. *Pulse Rate Readings*

Pulse Rate Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Pulse1	30	.00020	.00240	.0012313	.00054387
Pulse2	30	.00010	.00140	.0008533	.00034011
Pulse3	30	.00000	.00130	.0007333	.00035363
Valid N	30				

Table 26. *GSR Readings*

GSR Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
GSR1	30	.95460	20.11890	8.9166545	5.36994298
GSR2	30	2.28000	20.47940	10.9257633	5.89134308
GSR3	30	2.81050	20.47940	11.0172933	6.39801737
Valid N	30				