Do gender differences and task difficulty level have an effect on audio inattentional deafness?

Ciara Ann Sears

10034339

Submitted in partial fulfilment of the requirements of the Bachelor of Arts Degree

(Psychology)

Dublin Business School

Supervisor: Dr. Patricia Frazer

March 2016

Head of department Dr. Rosie Reid

Department of psychology

Dublin Business School

Acknowledgements

I would like to sincerely thank all the participants who gave their time to take part in this study. Without all their help this research would not have been possible.

A special thank you to Dr. Patricia Frazer and Michael Nolan for providing me with supervision and direction that I needed to complete this research. Thank you for your insight and immense knowledge.

Thank you to my parents, without their support I could not have made it through the finishing line of my degree.

Abstract

The aim of this study was to test whether gender differences and task difficulty level have an effect on audio inattentional deafness rates. It was expected that there would be a significant difference in the number of male and female auditory tones detected between male and female participants on either a high or low task difficulty level due to inattentional deafness. Two independent samples t-tests and a between groups ANOVA were carried out on twenty Dublin Business School students (N=20) both male (N=10, 50%) and female (N=10, 50%).

Results showed that there were no significant differences between genders on number of tones detected. Similarly, no significant result was found between gender of participant and gender of audio input on number of tones detected. In addition, no significant results were found between task difficulty level and number of tones detected. Suggestions for limitations and further directions were discussed.

Introduction

The main aim of the experiment is to see if gender differences and task difficulty level have an effect on audio inattentional deafness.

i) Inattentional blindness

Although we intuitively believe that salient or distinctive objects will capture our attention, surprisingly often they do not (Simons 2000). People do not perceive everything that comes into their field of vision, whether it is somebody waving at them from across the street or seemingly obvious changes right before their eyes. Carpenter (2015) stated that at the beginning, scientists believed that visual perception was like a videotape, that the mind records what the eyes take in. But studies of visual perception have demonstrated how rarely people see when they are not paying attention (Simons& Levin (1998) Simons & Chabris (1999)). Vision is the most highly developed sense (studies of how and why such vision has evolved span many fields in ecology and evolution (Surridge, Osorio & Mundy, 2003 p. 198). The fact that the visual system is so well developed throughout evolution it is therefore the most likely to yield information of psychological importance (Broadbent, 2013). A few studies, mainly the work by Hannon & Richards (2010) and Richards, Hannon and Derakshan (2010) suggested that people who have a greater working memory capacity are more likely to notice unexpected objects. Change blindness is a general property of the visual system and it applies to almost all aspects of visual processing (Simons & Chabris, 1999).

The word inattentional blindness was coined by Arien Mack and Irvin Rock (1998). In studies of inattentional blindness, the likelihood of change detection depends on the focus of attention. “A typical laboratory task assessing IB (inattentional blindness) requires an individual to perform an attention-demanding task (primary task) during which an unexpected stimulus is presented at a critical time point” (Seegmiller, Watson, & Strayer, 2011 p. 6). When observers are attending to another object or event, they are less likely to notice the unexpected event (Simons & Chabris, 1999). The phenomena was first demonstrated by Neisser and Becklen (1975) (but the word inattentional blindness had not been formed yet) when they found that people rarely noticed odd events in the unattended episode that were superimposed on video screens, on which two different kinds of things were happening. It means that the more a person is engrossed in a different task the less likely they are to notice an unexpected event, even when it is presented for a long amount of time.

Most et al., (2001) also conducted research looking at the reasons people may not recognize unattended stimuli. They found that inattentional blindness for ongoing dynamic events depends on both the similarity of the unexpected object to the other objects in the display and on the observers attentional set. An example of this is in Simons and Chabris (1999) experiment, when the participants were counting the passes made by the team wearing black, they were more likely to see the gorilla than the participants counting the white team. This is because the black colour of the t-shirts better matches that of the gorilla.

ii) Task difficulty variable

The most profound example of inattentional blindness was conducted by Simon and Chabris (1999) who demonstrated that the more people concentrate on a task, such as counting the number of passes among the actors with white t shirts playing a basketball game, the less likely they were to notice a gorilla in their direct field of vision walk among the basketball players, stop, bang its chest and carry on walking. “This effect, replicated in many studies, highlights our ability to blank out even highly startling information when we are focusing on a specific task” (Koreimann, Gula & Vitouch, 2014). Even though Simon and Chabris’s experiment was a success and generated a large audience from outside the psychological community the fact that it was conducted in a computer and not a real life setting left the question as to whether inattentional blindness could occur in a real life face to face setting. A further study conducted by Simons & Levin (1998) involved a target person asking pedestrians on a college campus for directions. While the pedestrian and the target person were mid conversation, two men carrying a door crossed between them, allowing the target person to be replaced unnoticed with one of the men carrying the door. Even though the study was carried out in a real-world setting, only 50% of the pedestrians noticed the change. The study filled the gap in previous literature by bringing the study of inattentional blindness into a real world setting. “In this respect, it might be argued that studies of inattentional blindness apply more directly to real world situations, in which stimuli arrive unpredictably and without advance warning”(Dalton & Fraenkel, 2012). In a further series of studies, the experimental design of Simons and Chabris’ study has been extended frequently, and provides important insights about the structural link between attention and awareness (Koreimann, Gula & Vitouch, 2014).

Other studies suggest that the inability to notice the gorilla is correlated with some form of deficit, from low working memory (Seegmiller, Watson, & Strayer, 2011) to ageing (Graham & Burke, 2011). It is hypothesised that “people who fail to see something right in front of them while they are focusing on something else have lower "working memory capacity" -- a measure of "attentional control" (University of Utah, 2011). Seegmiller, Watson and Strayer (2011) found that “when participants were accurate with their pass counts, individuals with higher working memory capacity were more likely to report seeing the gorilla (67%) than those with lesser working memory capacity (36%)”. Research on the link between attention and awareness is of great importance for understanding the rationale and mechanisms that cause both inattentional blindness and deafness.

A multitude of experiments have been performed on the visual system to see how it is affected by inattentional blindness however, those studies do not explore whether individual differences in noticing arise from differences in the ability to perform the primary task. Simons and Jensen (2009) conducted two experiments. In experiment one Simons and Jensen equated the primary task performance across individuals in a dynamic inattentional blindness task using a staircase procedure. The staircase procedure is a common adaptive psychophysical method. It begins with a high intensity stimulus then begins to reduce until the observer makes a mistake. When the observer makes a mistake the process is reversed and intensity is increased again. What Simons and Jensen found was that the individual differences in accuracy were minimized. And in the second experiment, they found that individual difference in primary task performance did not increase the chances of noticing an unexpected object. Together, their results found that the demands of a primary task affected inattentional blindness rates, but individual differences in the ability to meet those demands did not. The fact that Simons and Jensens research looked at the demands of the task and the effects that it had on inattentional blindness rates, and individuals ability to meet the demands. They opended up the question as to what specific individual differences could be looked at for inattentional blindness. Even though the question of individual differences was proposed. There is still a gap in the litrature looking at the specific differences that could be a casue of inattentional blindness and narrowing in on which ones makes the most significant impact.

iii) Gender differences variable

Although Simons and Jensen were looking at individual differences they failed to document the sex of their participants or consider gender as a main variable for differences. Few studies have examined whether gender plays a significant role in inattentional blindness. However White & Caird (2010) examined situations to see whether passenger conversation and gender affected hazard detection rates. They studied where drivers' looked-but-failed-to-see (LBFTS) hazards, and tested whether drivers either driving alone or driving and having a conversation with an attractive confederate passenger had a significant effect. A discriminant function analysis (DFA) using conversation and gender as predictors accurately classified LBFTS errors. They found that the more attractive the passenger was and whether the person was an extrovert or not were related to critical events being missed. Higher rates of LBFTS errors occurred when engaged in conversations with attractive passengers. Although not completely related to the topic, this experiment did give an insight into the topic of gender differences having an effect on inattentional blindness. White and Cairds experiment looked at gender differences and how they affected inattentional blindness in an unconventional way. They looked at gender differences from the angle of attractiveness and how it has an effect on the other person of the opposite sex. The fact that they did not look at the gender differences in the rate of inattentional blindness as an individual variable could be considered a flaw in the method of the experiment.

Interestingly, Lee and Telch (2008) designed two independent experiments using student samples that had both individuals high in social anxiety (HSAs) and individuals with low social anxiety (LSAs) and they based it on the static and sustained inattentional blindness tasks. They found that there were significant gender differences in the inattentional trial of their experiment, suggesting that males are likely to outperform females in detecting or identifying the happy face, but not the frowning face or the circle. It may be that relative to females, males are inherently predisposed to engage in a deeper attentional processing of positive rather than negative emotional cues. Even though Lee and Telchs' research does look at gender differences and attentional processing, attentional blindness is not the main focus of their study. "Future research needs to directly address potential gender differences in attentional processing" (Lee & Telch, 2008). There is a severe lack of research on the topic of gender differences and inattentional blindness.

iiii) Inattentional deafness

Multiple experiments have been performed on the visual system to see how it is affected by inattentional blindness however; the question of whether hearing can ever be susceptible to such effects (Dalton & Fraenkel, 2012) has lagged behind vision for psychologists. Despite the wide-ranging contributions of perceptual load theory to the study of visual selective attention, it has rarely been tested in other sensory modalities (Murphy, Fraenkel & Dalton, 2013), with the existing research in the auditory domain focusing exclusively on either an explicit or an implicit approach (Dalton & Hughes, 2014).

Early studies using the dichotic listening technique, demonstrated that very little was remembered of a message presented to one ear when attention was focused on the other ear (e.g. Broadbent, 1958; Cherry, 1953). Very little information was reported as heard by participants while they were completing a high perceptual task. Participants had to listen to one stream and memorise it in order to be able to repeat it back to the researcher, whilst also ignoring another stream playing in the other ear. Murphy, Fraenkel & Dalton (2013) put forward the idea that even though these early studies were not researching the area of perceptual load, it could be argued that the participants' inability to memorize the irrelevant streams information under the high perceptual demands of the relevant task might coincide with inattentional deafness theory. However an interpretation of these studies and their results is complicated. The fact that they did not change the difficulty levels of the task, or even considered perceptual load as a variable prevents direct conclusions about the role of perceptual load in the early dichotic listening studies.

Given the prevalent view of hearing as an ‘early-warning system’, tuned to detect unexpected stimuli (e.g. Scharf, 1998), it is important to ask whether inattention can have similarly pronounced effects on auditory awareness as it does on visual awareness (Dalton & Fraenkel, 2012). Under conditions of focused attention, we see and hear far less of the unattended information than we might expect (Macdonald & Lavie, 2011; Wayand, Levin, & Varakin, 2005). Indeed, one experiment conducted by Wayand, Levin & Varakin (2005) saw a woman enter a room and run her fingernails across a blackboard to create a noxious audio sound called a ‘gride’. Even when the sound was amplified and isolated from surrounding noises the audio-visual stimuli still went relatively unnoticed as only 40.7% (44 of 108) detected the unexpected stimulus. “This shows that the strength of the visual selective attention effect achieved using this set-up can cause the critical stimulus to be missed even when it has a high level of auditory salience” (Dalton & Fraenkel, 2012).

Macdonald and Lavies (2011) research was the first to establish the new equivalent of inattentional blindness in the auditory domain; they named it ‘inattentional deafness’. They looked at the effects of perceptual load on inattentional deafness. Perceptual load has been widely studied and researched for years. The early selection approach, originally proposed by Broadbent (1958) and developed further by Treisman (1969; Treisman & Geffen, 1967), claims that in order for perception to be processed it requires selective attention to proceed. Lavie (1995) suggested that if the perceptual system is overloaded and the capacity limit is exceeded, selection of the information to be processed will be required and that selective processing will occur. Perceptual load is selective processing due to the perceptual system being overloaded. “Studies interpret lower distractor interference under high perceptual load as an expression of spatial attention that is more narrowly focused on the target” (Linnell, 2013). Macdonald and Lavies research on the area highlighted that the level of perceptual load in a visual task was the critical determinant of inattentional deafness. They did this by presenting a brief pure tone with the visual task display on a final trial. Their results showed that people failed to notice a simple audio tone if presented unexpectedly while the person preforms a task. This study was of unprecedented importance to the psychological community due to the founding of inattentional deafness and providing evidence of the links between perceptual load and failure to detect unexpected stimuli in the environment.

The limits of attention are not purely visual. Instead, they appear to reflect limits on the capacity of attention. Without attention to the unexpected event, you are unlikely to become aware of it (Mack & Rock, 1998; Most, Scholl, Clifford, & Simons, 2005). Molloy, Griffiths, Chait & Lavie (2015) conducted research that established a cause and effect for inattentional deafness. They found that “when volunteers were performing the demanding visual task, they were unable to hear sounds that they would normally hear. The brain scans showed that people were not only ignoring or filtering out the sounds, they were not actually hearing them in the first place" (Molloy, Griffiths, Chait & Lavie, 2015). Their research highlights that the brains visual and auditory processing centres share neural resources. When overwhelmed, the brain must choose one process for attention, at the expense of the other.

v) Effect of speakers' gender

Another inattentional deafness study that brought Simons and Chabris's infamous inattentional blindness experiment into the auditory domain was that of Dalton & Fraenkel (2012), who tested whether hearing is susceptible to similar inattention effects. They did this by creating a naturalistic, three-dimensional auditory scene using binaural recording and presentation. The binaural scene was achieved by having a conversation between two women running parallel to a different conversation between two men, and halfway through the conversations for nineteen seconds a male character continuously repeated the phrase "I'm a gorilla" (after Simons & Chabris, 1999) as he walked right across a realistic auditory scene. The "central question was whether participants in this condition would experience 'inattentional deafness', such that they might fail to notice the gorilla" (Dalton & Fraenkel, 2012). The forty participants who participated in the experiment were divided in half, with one half instructed to listen to the women's conversation and the other half instructed to listen to the men's. The participants' gender and whether they were listening to the male of female conversation was not recorded. The results found that, of the twenty participants listening to the male conversation ninety percent of them reported hearing the gorilla voice. This result was strikingly different to the participants in the other group attending to the female conversation with only thirty percent reporting hearing the gorilla voice. "The results show that the absence of attention can leave people 'deaf' to a sustained and dynamic auditory stimulus that is clearly noticeable under normal listening conditions" (Dalton & Fraenkel, 2012). The work of Dalton and Fraenkel began to look at gender differences in inattentional deafness. However there are two flaws in the research, one was that they failed to look at whether a female voice would also be left unattended in the same conditions and presented unexpectedly. The second gap in their experiment was that they failed to document the gender of the participants in the two groups. They failed to look at whether participant gender interacted with speaker gender to have an effect.

The main studies looking at speakers gender as a variable was that of the research conducted by Fenn et al,. (2011), they looked at speakers' gender, not in a visual task, but while engaged in a phone conversation. Their results found that most participants engaged in a telephone conversation failed to notice a change in speaker voice in the middle of the conversation unless they expected a change to occur or the two voices differed in gender. Although not looking at the speakers' gender in a visual task the findings from this research was important for when looking at the speakers' gender variable, and whether it was the speakers' content or the speakers' identity that caused the detection. "Vitevitch (2003) argues further that if attention is allocated to the index dimension of the voice (e.g., speaker identity), then the processing speed of the linguistic content dimension decreases" (Koreimann, Gula & Vitouch, 2014 p. 306). Vitevitch (2003) found that those of the participants that noticed the voice change tended to preform slower on the task than the participants that failed to detect the voice change. These studies addressed allocation of attention to different features (content vs. speaker identity) of a single auditory stream (voice stream) (Koreimann, Gula & Vitouch, 2014), whereas in the present study we address the issue of speakers gender further but while also looking at gender differences and task difficulty level.

vi) Rationale & Aims

To conclude, justification for carrying out this study is prompted by Dalton and Fraenkels' (2012) work on whether hearing is susceptible to inattention effects, and Macdonald and Lavies (2011) research on the effects the level of perceptual load in a visual task has in determining inattentional deafness, the current study will seek to further explore the effects that task difficulty has on inattentional deafness but while also assessing if gender effects inattentional deafness rates. There has not been an Irish study on the topic to date, and while most of the other research in the area looks at inattentional deafness and assessing various types of tones and the different conditions that result in them not being attended to, few studies have looked at whether gender has a significant role in the phenomenon. With such a lack of studies having directly looked at gender variables in relation to inattentional deafness, the gap in the existing literature probed the different gender audio input to be one of the main variables of the experiment, and paved the way the experiment would look at inattentional deafness. It is the task of this experiment to add to the previous research and attempt to further evaluate some aspects of this topic.

The effect of both participant and speaker gender on inattentional deafness will be examined in a true-experiment, using a visual distractor task. As the participant completes the computer task, an audio sound would be played in the background. The audio sound would be a female or male voice talking in a monotone. There are three main variables to be compared in this study. The gender of the participant is a nominal demographic variable, as is the gender of the audio input and task difficulty level. The hypotheses being tested include various combinations of these variables.

vii) Hypotheses

1) There will be a significant difference in the number of tones detected between male and female participants.

2) There will be significant interaction between participants' gender and speaker gender on the number of tones detected

3) There will be a significant effect of task difficulty on number of tones detected.

Method

i) Participants

A convenience sample of 20 Dublin Business School undergraduate students (N=20) were used to conduct this experiment, three participants were excluded and replaced because their accuracy on the control cross task was lower than 50 %. No participants were replaced due to low auditory detection rates. The mean age of those included was (M= 21) years. There were ten males and ten females that took part in the experiment. All of the participants in this experiment reported normal or corrected-to-normal vision and normal hearing. In addition to this all the participants were naïve to the purpose of the experiment.

ii) Apparatus and procedure

The experiment outlined in Macdonald & Lavie (2011) was replicated in E-prime 2.0 stimulus experiment software. The audio for the experiment was generated using Audacity 2.1.2 editing software. The E-prime experiment consisted of a block of 8 trials. Each trial had a procedure that was composed of first displaying a slide onscreen with a fixation image of a dot in the centre of the screen for 900ms followed by the stimulus image of two lines one blue, one green, in a cross for 150ms. In each stimulus image one line was always shorter than its partner. The stimulus image was selected from a list of 4 possible images so that each trial had an equal chance of selecting one of the 4 possible combinations (Blue & Green, Longer/Shorter). The participants were assigned to one of two condition groups 'High' or 'Low'. The difference in length of the two lines was more marked in the trials of the 'Low' condition while the 'High' condition had lines closer in length. Finally a blank screen was displayed for 2850ms where the participant pressed either the 'B' or 'G' key to denote which line was longer in the preceding stimulus image.

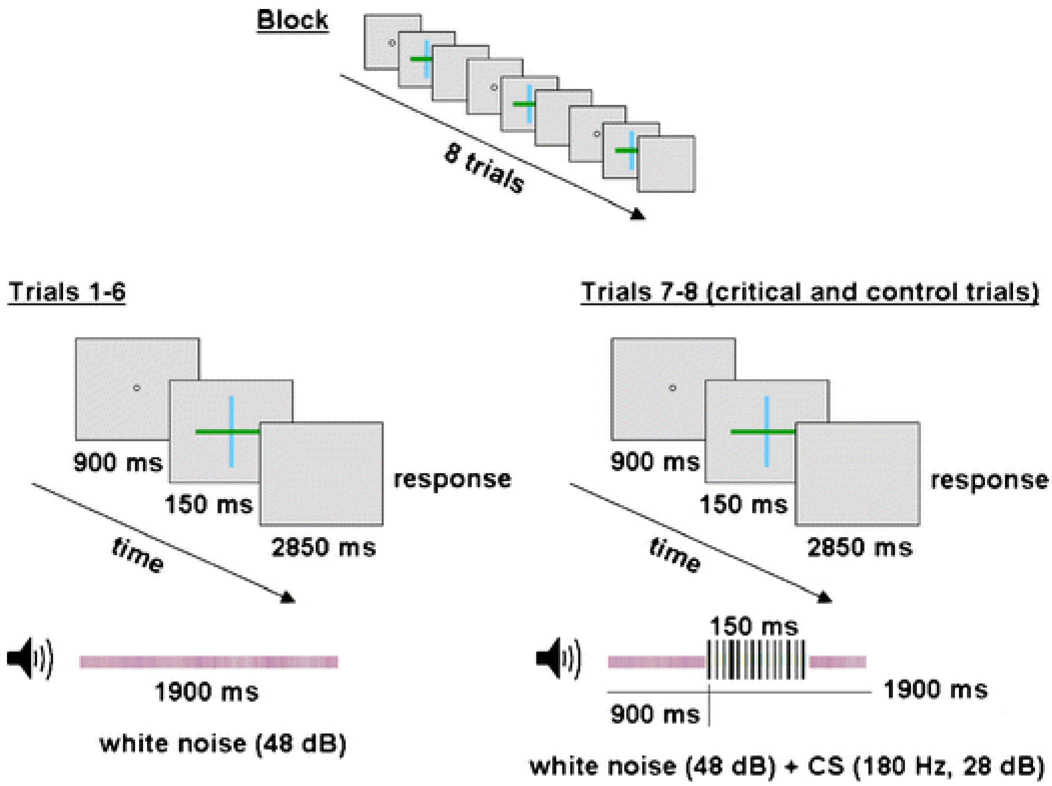

Figure1: Macdonald and Davies (2011)

Each participant performed either low- or high-load trials (selected alternately; low for half of the participants (N=10, five male and five female), high for the other half (N=10, five male and five female). The participants were asked to complete a computer task following the online instructions. Participants were instructed to make their cross response as accurately as possible, and responses were not speeded. Before starting the experiment, each participant was shown six example trials. There was no feedback for cross task responses except during these practice trials. After the participant had completed the control trial/practice trial they were told that the experiment was about to begin and that they would receive no more feedback for their answers. For the first 6 control trials a whitenoise audio generated by Audacity was played through headphones for 1900ms starting from the fixation slide.

Participants were informed that they should wear headphones for the duration of the experiment and that the white noise was present during each trial in order to aid concentration by blocking out noise from people passing the testing room. Participants seemed to take this instruction at face value and did not seem suspicious.

For the final two critical trials the fixation slide played an edited version of the whitenoise audio: starting at 900ms the audio contained a 150ms clip of either a female or male voice saying the letter 'A'. The volume on the voice clip was adjusted to -20db lower than the audio of the white noise. Each participant heard both gender audio options for trials 7 & 8. The whitenoise then resumed after the voice audio for a further 850ms so that the running time terminated at 1900ms. The edited audio file for the final two critical trials (7 & 8) was selected at random from the list of two possible voice options (female or male). This was so that each participant had an equal chance of hearing the female audio first for trial 7 then male audio for trial 8 or, male audio first for trial 7 then female audio for trial 8. The E-prime software logged the participant's correct/incorrect response to identifying the longer line in the stimulus image along with their reaction time in milliseconds to pressing either the 'B' or 'G' keys. The participants were subsequently asked a series of three questions to answer on a sheet of paper. They were asked their age, gender, how hard they found the task and to describe to the experimenter if they had heard anything (even if they said they had not noticed anything different).

Consent

Informed written consent was sought from all participants before taking part in the study. They were informed at consent stage of their right not to take part, or to withdraw at any time. Participants were informed that participation would involve a visual task to be carried out and to fill in a short answer sheet following the task. After the experiment had terminated, the participants were presented with a debrief sheet that informed them of the deception used in the study. The debrief sheet also outlined that if they had any later questions about the study, or wanted to find out the result that they could do so by the email address provided.

Data Anylasis

The data was analysed using the software package SPSS version 22 for windows. Descriptive statistics such as the mean, standard deviation and maximum and minimum values were ascertained where relevant for the variables of number of male inputs reported heard by male and female participants, Number of female inputs reported heard by male and female participants.

Two independent samples t-tests were carried out to test whether (i) gender differences had an effect on the number of tones detected and (ii) to test whether task difficulty had an effect on the number of tones detected. Also, A between groups ANOVA was performed to see did the gender of the participant and the gender of the audio tone presented have an effect on the number of tones detected.

Results

i) Descriptive statistics.

Descriptive statistics were conducted to obtain the means, standard deviations and minimum and maximum scores for Task Difficulty, Gender of audio input, number of tones detected and gender of participants. Results showed that the number of tones detected (M= 1.2, SD= 1.0) had a minimum of 0 and a maximum of 2. All the other variables in the study had a (M=.5, SD=.51). the descriptive statistics for gender of participants showed that 50% of the participants were female (n= 20), and 50% were male (n= 20). The mean age of participants is (M=21.1) with a range of 20 to 24 years

ii) Inferential Statistics

Hypothesis one- An independent samples t-test found that there was not a statistically significant difference between males (M=1.20, SD=1.03) and females (M=1.20, SD=1.03) on the number of tones detected.

Hypothesis two- A two-way between-group ANOVA examined the role of gender of participants and gender of audio tone on the number of tones detected and found no significant effect (F(1,16)=.03,p=.867). No main effects were reported for gender of audio input (F(1,16)= .73,p= .406) nor gender of participant (F(1,16)= .03, p= .867).

Hypothesis three- An independent samples t-test found that there was not a statistically significant difference between high task difficulty (M=1.6, SD= .84) and low task difficulty (M= .8, SD= 1.0) on the number of tones detected (t(20)= -1.89, p= .074, CI(95%) .09- .058).

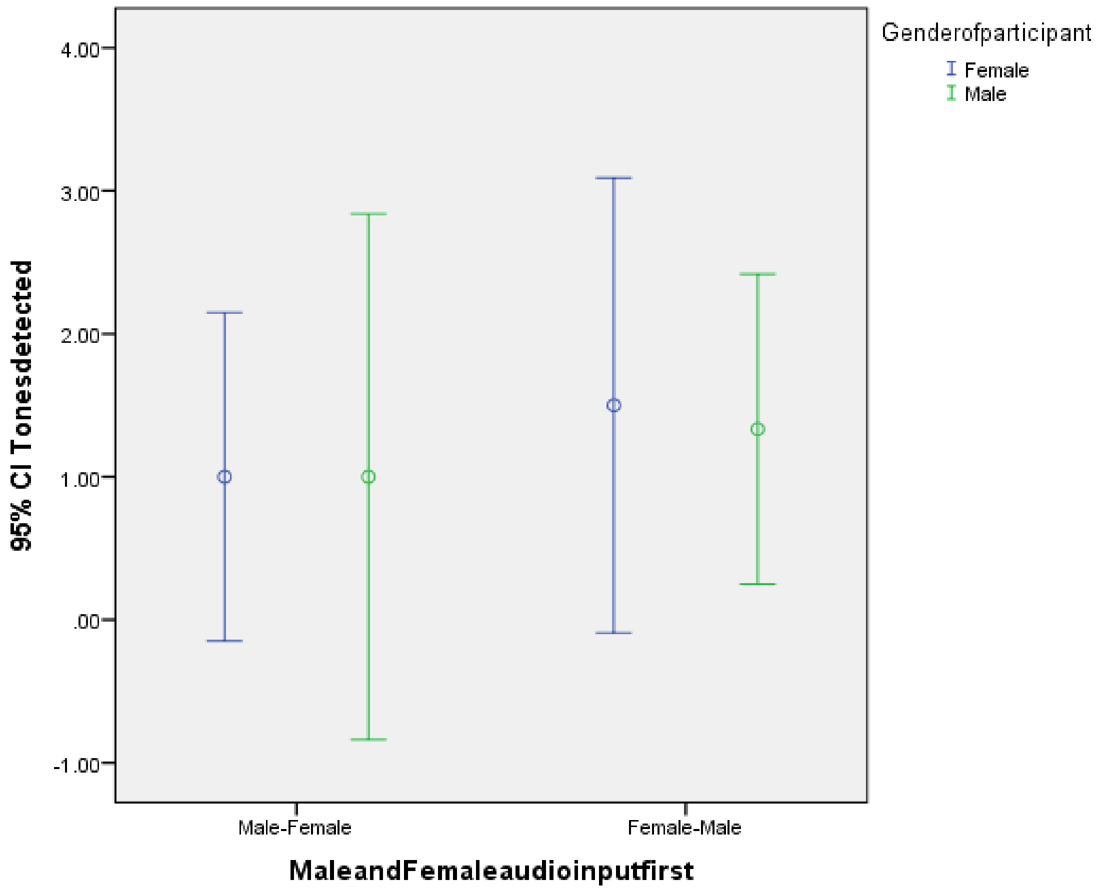

Figure2: Number of tones reported heard by male and female participants and gender of audio input.

Discussion

This study was designed to investigate the effects gender differences and task difficulties have on audio inattentional deafness. The aim of the current study is to attempt to fill the gap in the existing research by considering the specific variable of gender differences, rather than general inattentional deafness. This study examined three hypothesis regarding gender differences and task difficulty level. Firstly, it was hypothesized that there would be a significant difference in the number of tones detected between male and female participants. It was also hypothesised that there would be a significant interaction between participants' gender and gender of auditory tone on the number of tones detected. Furthermore a third hypothesis suggested that there will be a significant effect of task difficulty on number of tones detected.

For hypothesis one the null hypothesis was accepted and the experimental hypothesis is rejected. This means that there was no statistically significant difference between the numbers of tones detected by male and female participants. Gender differences were found to not have an effect on the number of tones detected. This finding is important for filling the gap in the literature between gender differences and inattentional deafness. Because inattentional deafness is a relatively new subject for psychologist, not many studies have looked at the multiple different variables that could be an underlying factor, one being gender differences. The fact that no significant result was found between gender differences is interesting, but with such little previous literature to compare the findings too it's difficult to gauge if the finding were unusual or coincide with others findings.

This is not the case for hypothesis two, which found no statistically significant interaction between gender of participant, gender of the audio input and the number of tones detected. This finding seems to correspond to some of the research looking at speaker's gender including Cherry's (1953) finding that changes in gender are reliably noticed even if they occur in an unattended channel. Similar results were found by Fenn et al (2011) who tested the extent to which participants would notice a change in talker if the two talkers differed in gender. The majority of the participants (11 out of 12) noticed the change in gender. This result was "significantly more than even the highest rate of spontaneous detection of same-gender voice change (in Experiment 1), x2 (1) ¼ 16.9, p , .0001." (Fenn et al,. 2011). However this result is surprising as multiple other studies have looked at gender of the speaker and found significant results, such as the results of Dalton & Fraenkel (2012).

The findings for hypothesis three did not agree with the current literature. The findings suggested that there was not a significant effect of task difficulty on number of tones detected. Therefore we could not reject the null hypothesis. These findings are in direct contrast to the findings of multiple different studies looking at inattentional deafness (Molloy et al., 2015; Macdonald and Lavies, 2011; Levin & Varakin, 2005). However research conducted by Murphy, Fraenkel & Dalton (2013) offered an alternative view in regards to looking at perceptual load and inattentional deafness. Using two different perceptual load manipulations across four experiments, they consistently failed to find support for the role of perceptual load in auditory selective attention. They propose “that the auditory system – although able to selectively focus processing on a relevant stream of sounds – is likely to have surplus capacity to process auditory information from other streams, regardless of the perceptual load in the attended stream.” (Murphy, Fraenkel & Dalton, 2013).

ii) Limitations

The first limitation to be considered is that of the sample and sample size. Participants were taken from a class of psychology undergraduates only and the number (N=20) may be a little small to reflect the population. To address this limitation, a study comparing samples from other faculties and other colleges would be interesting for a more representative sample of the population. The vast majority of the research to date has been conducted outside of Ireland and although cultural differences are not thought to play a part in inattentional deafness rates, cultural differences could be a possible research topic in the future. A future research area in this topic could involve researchers looking at different tones and frequencies across multiple diverse cultural backgrounds and test whether they have an effect on inattentional deafness rates.

Further limitations in the current study relate to the audio tone presented in the background. The white noise presented in the background halted in the critical trial when the gender tone was presented. The unusual stopping of the white noise could have grabbed the participants’ attention and made then more susceptible to hearing the audio tone following, more so than it would have if the white noise continued playing with the audio tone. The findings of Mondor et al., (1998) and Schröger and Wolff (1998) suggest that auditory attention cannot be selectively focused on one dimension of a sound while another dimension of the same sound is ignored. This result could be the key to understanding why the current study yielded no significant results. Because participants were already aware of the white noise present in the study, it may have increased their detection rates of the audio tone. But this assumption is in contrast to that of Macdonald and Lavies' (2011) who, even with the white noise present, found significant difference between task difficulty level and the number of tones detected due to inattentional deafness.

iii) Further Research/Studies

Because of the findings that the white noise may have affected the results, it would be a suggestion that future research would look at gender of tone, but without the white noise present, to see if it had caused an effect. The current study could be replicated, with another group of participants completing the same tasks but with no white noise present.

Although the current study failed to verify the hypothesis that gender differences and task difficulty have an effect on audio inattentional deafness, previously mentioned studies have found the difficulty of a visual task to effect audio detection rates. This failure to notice the presence of an auditory stimulus has significant implications for everyday life. An implication of inattentional deafness would be a person failing to hear a warning alarm if engaged in a high intensity visual task, a person failing to hear a car horn if texting on their phone (a task proven to be high-load), or in an operating theatre/ workplace where a surgeon or individual is concentrating on their work might not hear the equipment beeping.

Hearing is often claimed to act as an 'early warning system' (e.g. Dalton & Lavie, 2004), because it is not does not operate with the same physicality as other senses. For example, in comparison to other senses hearing can register unexpected changes in the environment from a range of directions. However, hearing does have attentional limitations and is susceptible to faults. For example, Pilots' failure to detect unexpected changes in their auditory environment (eg alarms) is a major safety issue. The lack of response to alarms is usually not attributed to attentional limitations, but usually the pilot is blamed for choosing to ignore warnings due to decision bias, hearing issues or conscious risk taking. Dehais et al., (2014) looked at inattentional deafness and tested whether critical alarms would be observed in a simulated cockpit. Their findings established inattentional deafness as a cognitive phenomenon that is critical for air safety. Their research showed that pro-exposure to a critical event triggering an auditory alarm can enhance alarm detection when a similar event is encountered subsequently. An application of their findings was that "case-based learning is a solution to mitigate auditory alarm misinterpretation" (Dehais et al., 2014). Aamodt and Plaza (1994) described case-based learning or reasoning as the ability to utilize the specific knowledge from a previous experience, and reusing that previous knowledge and applying it in the new problem situation.

Lavie stated that inattentional deafness also "applies to drivers concentrating on complex directions as well as cyclists and motorists who are focusing intently on something such as an advert or even simply an interesting-looking passer-by" (Venosa, 2015). "The implications of research on inattentional blindness for daily life tasks such as driving have begun to be noted by some public authorities—for example, Traffic for London"(Macdonald and Lavie (2011). However, Instead of only warning drivers of the dangers on inattentional blindness they should also make drivers more aware of inattentional deafness under load as both processes have a great effect on people's daily lives.

Inattentional capacity also works both ways; auditory inputs can have an effect on inattentional blindness, much to the same extent that visual tasks have an effect on inattentional deafness. This can be seen with failures of visual awareness resulting from auditory distractions like talking on a mobile phone (Hyman et al, 2009). In the case of inattentional blindness people tend to believe that they see and remember far more of our surroundings than they actually do. In research conducted by Levin & Angelone (2008), 90% of people reported that they believe they would spot the gorilla in Simon and Chablis (1999) study for inattentional blindness. They also found that people are convinced that they would spot errors in movies or changes to a conversation partner (Levin & Angelone, 2008).

One explanation for this mistaken intuition is that our experiences themselves mislead us (Simons & Chabris, 2010). In a real world setting people are never aware of the events that they have missed, they are rarely confronted on things that have been missed in a real life setting. On one event, a Boston police officer chasing a suspect ran past a brutal assault and was prosecuted for perjury when he claimed not to have seen it. There were no experimental studies of inattentional blindness in real-world conditions at the time, and therefore no evidence to back up his claim. It was not until Chabris, Weinberger, Fontaine and Simons, (2011) replicated the real world setting, and found significant results to back up his claim. The findings from the research should be applied to real world settings. The fact that an experiment on inattentional blindness with ecological validity was only first conducted in 2011, after being such a well-established phenomenon since the term was coined in 1998 highlights the lack of research looking at the area. With inattentional deafness being a new topic on the spectrum of inattentional limitations, future studies should take a more ecologically valid approach. Inattentional deafness could be having a major effect on our current systems, for example on the jury in the courts. Results found by Fenn et al., (2011) suggest that expectations may affect the way listeners attend to speech and in particular to voices, in conversation, and that listeners do not habitually attend to all perceptually available information. If the prosecutor or defence played a highly detailed visual projection, important evidence that would be being presented at the same time as the visual projection could be missed due to inattentional deafness.

More studies should be done on inattentional deafness in general as it is a relatively new concept, but there is a severe lack of research looking at gender differences and other potential variables responsible for it. Simons and Jensen (2009) stated that even though there has been a growth in the understanding of the limits of attention and the factors that lead to more or less noticing, “few studies have explored whether individual differences contribute to the failure to notice unexpected events” (p. 398).

iii) Conclusion

The present study served to highlight aspects of the topic of inattentional deafness which have not yet been looked at within certain contexts such as the role gender differences and gender of audio tone play. There appears to be a debate in some of the existing research whether the gender of the speaker had an effect on audio detection rates, with researchers like Vitevitch (2003) looking at the allocation of attention to different features, potentially changing the view of inattentional deafness over recent years.

To conclude, this study attempted to test whether gender differences and task difficulty level had an effect on inattentional deafness rates. However, there was no significant result found between participants' gender, gender of speaker and task difficulty level on the number of tones detected. There was no difference between men and women in audio detection rates, and speakers' gender did not seem to play a role in inattentional deafness.

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Appendices

Appendix A: Consent form

Consent form

You are being asked to take part in a research study on the effects that task difficulty and gender differences play on attention

In this study, you will be asked to complete a task on the computer, the instructions on how to complete the task will be displayed on the screen before you. The headphones used are to block out any background noises that may distract you.

The study typically takes five minutes (per session) and you are only asked to participate once. You may decide to stop being a part of the research study at any time without explanation. You have the right to ask that any data you have supplied to that point be withdrawn/destroyed. You have the right to omit or refuse to answer or respond to any question that is asked of you (as appropriate, and without penalty*)*.

If you have any questions as a result of reading this information sheet, you should ask the investigator.

Your participation in this study is voluntary. The data we collect does not contain any personal information about you. The findings that I obtain from the data will be presented on and used for my final year project.

If you wish to receive any further information I will be glad to answer your questions about this study at any time. I can be contacted at . If you would like to find out the final results of this study you can do so by contacting me on the same email.

Thank you for taking the time to read this and participate in my study.

Name:_________________ Date:______________

Supervisor- Patricia Frazer. Email- patricia.frazer@dbs.ie.

Appendix B: Answer sheet

If you could just take a few more minutes to fill out these few questions

- Age _______
- Gender __________
- On a scale of one to ten how difficult did you find the task? 1 being easy- 10 being difficult ________
- Did you hear any noises in the background while completing the task?_____

-if yes, what were the noises? ______________

-How many times did any noise come to your attention? _________

Appendix C: Debrief sheet

Debrief sheet

Thank you for participating in the study to test whether gender based audio inattentional deafness is affected by task difficulty.

The purpose of this study is to see if gender differences and task difficulty had an effect on audio inattentional deafness. In this study you were asked to complete a task on the computer while listening to white noise in the background through earphones. I told you the earphones were to block out distracting noises from the surroundings, but there was also a second reason for the earphones. During the study an audio tone was presented unknowingly in the background as the computer task was being completed. We expect to find that gender and the level of task difficulty has an effect on the rate of detection of audio tones presented unknowingly in the background.

You may have learned about inattentional blindness in your psychology class, this research is an extension of that. Previous research has shown that people are less likely to notice a stimulus if it is unknowingly paired with another stimulus. If you would like to learn more about this topic I can give you some references. Do you have any questions about this study?

Thank you for your participation in my research. If you have any questions you can ask me now or you can contact me at later date. If you would like to receive a copy of the results I can email them to you upon completion of the study.

If you are feeling distressed by any part of this study, here are some numbers that you can call

Samaritans - a free, confidential listening service. You can contact them on 116123.

Aware - Support Line 1890 303 302