Testing Divided Attention

An Honors Thesis (HONRS 499)

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Testing Divided Attention

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Abstract
The purpose of this study was to determine if auditory distraction would affect performance on a series of spatial tasks. Subjects were given various levels of distraction and mean reaction times and errors made were compared among the four groups. Level of auditory distraction did not significantly affect the ability of subjects to perform spatial tasks. When asked to describe the distraction, 95.6% of subjects could do so correctly, but only 47.6% of subjects were able to correctly identify the meaning of the messages within the distraction.
The world is becoming a much busier and fast-paced place. People now rely on drive-through windows to provide sustenance and demand prompt service for everything from car washes to photo processing. It is because of this speedy lifestyle that people have been forced to learn how to “multi-task,” that is, do several things at once. In fact, people multi-task so frequently, it has become hard to know when one is engaging in two separate tasks at once.

A good example of one such action would be driving. Often people behind the wheel engage in several other processes such as talking on the phone, listening to music, or even putting on makeup. Because these drivers are involved in several cognitive processes at once, they may be more likely to become distracted by the secondary tasks and make mistakes in their primary task (driving). Humans are often aware of when they are being distracted and can attempt to remedy the situation. However, even when one is unaware that a particular stimulus is distracting them, they may still attempt to filter out or extinguish the stimulus. For example, while one is driving in an unfamiliar area, they may turn down the radio to ensure that they do not miss the street that they are looking for. This may make little sense to an average person, but this seemingly random response to an irrelevant stimulus is not only common, but natural and appropriate in most situations. In order to understand why irrelevant stimuli are distracting, we must know how the mind dual-tasks and whether or not it is truly capable of single-tasking.

Attention is the foundation of mental processes and is especially important when considering that people often engage in several activities at once and have a limited capacity for processing information. Because of this, it is proposed that humans have what is known as selective attention, that is, one can focus on a specific type of information in order to avoid an overload of information which can cause mistakes in understanding and judgment (Schneider &
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Shiffrin, 1977). Sometimes this selective attention fails, resulting in selective-attention deficit, and will result in the inability to concentrate and filter out irrelevant information.

Many psychologists have attempted to explain how the brain responds to several processes being done at one time, and the cognitive functions associated with these processes. Baddeley (1974) attempted to explain this with a model that involved four different components to working memory. These components included the phonological loop, the visuo-spatial sketchpad, the episodic buffer, and the central executive which organizes all of the information from the other three systems. This model suggests that different portions of working memory deal with different types of stimuli, which enables one to be able to encode and process several types of stimuli at the same time. However, the central executive is the system that decides which of these systems it will give attention and resources to in order to ensure that the primary task is given priority. This model also suggests that it is possible for several tasks to be done at the same time as long as the central executive can expend processing resources to the respective systems.

Multi-tasking, or dual-tasking as it is called in psychology, is an area in which many psychologists still hold interest today. The psychologists in this area attempt to determine exactly how and to what extent humans dual-task. Some believe that tasks can be done in parallel to other tasks, meaning that they are carried out simultaneously, as opposed to tasks being carried out sequentially. Obeuer and Kliegl (2004) tested this hypothesis by having two groups of people carry out both numerical and spatial tasks. One group did these sequentially and the other group carried them out simultaneously. The simultaneous group showed a great deal of dual task costs, meaning that their reaction times and accuracy were far lower than the sequential group. However, these costs were reduced when the group was allowed to practice
both tasks at the same time. This showed that the mind was capable of processing two different kinds of information at the same time provided it had enough practice with the combination of events. Similarly, Shumacker et al. (2001) shows that it is possible for the brain to use what they call perfect timesharing to solve problems. In this experiment, subjects were shown an item on the screen and told to say if it was on the left side, middle, or right side of the screen. They also heard a tone at the same time and told to say if it was high, medium, or low. Subjects were able to correctly label both the auditory and visual stimulus with no dual task costs in their reaction times.

Yet another experiment yielded similar results, however, it was suggested that the subjects were essentially combining the two separate tasks into one task (Hazeltine, Teague, & Ivry, 1984). It was also stated that any process that can be performed effectively in the presence of another task is said to be automatic, or can be done unintentionally and without notice. Dual task costs can be minimized if one or both of the tasks are automatic. Stroop's (1935) classic experiment was one of the first to try to explain how the mind processes several things at once. In this study, he showed subjects the names of colors written in a separate color (for example: the word blue written in red). The subjects were told to name the color the word was written in, and many had a hard time not reading the word. Reaction times for reading the word were much faster than reaction times in the condition where subjects were told to identify the color (Stroop, 1935). This can be easily explained by Dunbar & MacLeod (1984). They suggest that both tasks (i.e. processing the word and processing the color) are being done at the same time, but that reading the word is an automatic process and naming the color is a controlled process, which requires conscious attention and more cognitive effort, and which will naturally take longer than the automatic process. They say that the reason that subjects responded the way they did was
because the automatic process finished first. They call this theory the Horse Race Model (Dunbar & MacLeod, 1984).

In contrast to the parallel argument, many psychologists have powerful evidence that supports what they call the bottleneck theory (Pashler, 1994). This theory suggests that when the brain is computing several pieces of information at the same time, they cause somewhat of a traffic jam, and can only be taken care of one by one until all of the mental tasks have been completed. It says that all processes are sequential and that no task can be taken out until the first task is completed. A strong example of this comes from an experiment done by Byrnes and Anderson (2001). In their study, they asked subjects to respond to instructions on a screen such as “Punch the key below your left index finger.” Once the first instructions were displayed, there was a pause, and then similar instructions would again appear on the screen. The instructions could be carried out in the same amount of time for each set if the brain was capable of handling them simultaneously; however, reaction times for the second set of instructions were much shorter than that of the first set. This suggests that the brain was preparing to complete the second task while it was acting out the first, but was unable to act it out until the first task was completed.

It has been shown in all of these experiments that the mind is capable of handling several processes at the same time. However, a new question now is brought forward. Can the mind completely dedicate all of its resources on one particular process or problem? Even when one believes that they are focusing on one task, they are still aware of the things going on in their environment. This leads many to believe that distractions can only be ignored if the mind has a specific amount of work to do. The load theory (Lavie, Fockert, Hirst, and Viding, 2004) states that when the demand on the brain is high the Perceptual Selection Mechanism will weed out
information that is irrelevant because there is not enough cognitive capacity to process it. It also states that if the mental load is low, that the Cognitive Control Mechanism will remove an irrelevant stimulus after it has been perceived in order to maintain priority for the primary task. The load theory was tested by Lavie et al (2004). They found that distractions had a greater impact when the subject’s working memory load was high. Surprisingly, they found that distractions still had a large influence even when working memory loads were lower. This was said to happen because working memory and dual-tasking procedures take a great deal of effort and controlled processing.

Other psychologists argue that it depends on when the brain perceives the information whether distractions can be ignored or not. Early selection is the belief that selective attention can prevent irrelevant information from being processed semantically (Treisman, 1969). This can be further explained by the early works of Broadbent (1958). He suggested that there was a mental filter that would weed out the information that was being tended to automatically when the mind reached its processing capacity. Then, all information that made it through the filter would require conscious attention. This theory could support the lowering of dual-task costs by showing why automatic processes can be ignored so easily. However, Broadbent states that it is entirely possible for the filter to allow some irrelevant information to seep through. Broadbent’s theory suggests that information is weeded out long before the mind is ever made consciously aware of it, suggesting that selective attention occurs early in the cognitive process.

Of course, there is always the idea of late selection, which states that all information is encoded semantically, and that selective attention only begins working after the information has been processed. In an experiment dealing with distractions and early selection, Treisman and Geffen (1967) found that when information is unattended to, or if the subject tries to ignore it,
the stimulus often goes completely unnoticed. This finding suggests that the mind is capable of focusing on only one task without any irrelevant information interfering. Treisman further investigated this issue in her 1960 experiment in which subjects heard phrases in both ears. These phrases were partially nonsense and partially meaningful phrases. Subjects were asked to repeat what they heard from one ear, and they all responded with the entire meaningful phrase despite the fact that they heard part of it in each ear. This suggests that the information coming from the wrong ear was processed because the subject expected to hear it. Here, she disagrees with Broadbent, saying that it is the meaning of the word that allows it to be processed rather than the physical characteristics such as volume, tone, and duration (Treisman, 1960). This was further tested by Gatti and Egeth (1978) and in their experiment, distractions during the primary task did cause slower reaction times in their subjects. The subjects were asked to name the color of a visual field and to ignore the name of a color printed either above or below the colored patch field. Even when the distractions (printed words) were incongruent with the primary task (naming color), reaction times were still slow. This suggests that the mind is always processing information whether it is task relevant or not.

Lavie (1995) chooses to take a seat on the fence in this debate. He suggests that the mind uses a combination of both early and late selection. He believes that distractions can be ignored when the task relevant load is too high to give attention to other stimuli. Distractions cannot be ignored when task relevant load is lower because there is enough mental capacity to begin processing stimuli that is not.

As we go into this study, it is my intention not only to further show that the mind is more than capable of working at two separate tasks at once, but also that it is more or less incapable of NOT processing several types of information. That is, can one really ignore distractions and
irrelevant information? And if they can, what kind of dual-task costs will arise from this attempt to ignore?

The current research will test divided attention by distracting participants while they attempt to perform spatial tasks. Groups will be distracted on several levels, all of which will be auditory in nature. It is assumed that the group experiencing the most distraction will do more poorly on the spatial tasks than those in groups experiencing less distraction. Therefore, the groups who are exposed to words should be slower and have more incorrect answers than those who do not hear words. It is hypothesized that the control group will have shorter reaction times and a smaller number of mistakes than will any other group. Group 2, experiencing music with no lyrics will have a slightly greater number of mistakes and a longer reaction time than the control group. However, Group 3 will exceed Group 2 in both reaction time and number of items missed. Group 4, which will hear spoken word, will have the longest reaction times and will miss the greatest amount of items of all groups.

Method

Participants. For this experiment, 60 subjects were gathered from a pool of undergraduate students at Ball State University enrolled in Psychology 100. The students enrolled in this course are required to participate in research in order to receive a grade. The students were all 18 years of age or older and had normal or corrected to normal hearing and vision. The students signed up for the study via the internet and remained anonymous throughout the experiment. Because their participation was voluntary, subjects were given credit for their Psychology 100 course for their cooperation.

Materials. Each subject completed the same test consisting of three separate tasks. The shape task of the test consisted of five pages with a 3-dimensional shape and two 2-dimensional
shapes labeled “A” and “B.” The subject was to indicate which of the two shapes was the correct aerial view of the 3-dimensional shape (See Appendix A). The discrepancy task had five pages each with two pictures that were seemingly the same. Subjects were to indicate three areas in which the two pictures did not match. The geographical task included a map with three pairs of shapes. Subjects were asked to match the shapes and give driving directions between them. They were to write these directions on the paper provided. Times were taken of each section separately using a stopwatch.

During the test, subjects listened to music or spoken word to distract them. The group listening to music with no lyrics was played “Soul Flute” by Saint Germaine and “Unknown Live Song” by Tim Reynolds. The group listening to music with lyrics was played “Silence Again” by Jimmie’s Chicken Shack, “Must Be Dreaming” by Frou Frou and “Glass Vase Cello Case” by Tattle Tale. The group exposed to the spoken word heard pieces of stand-up comedy by the performer Brian Reagan. These auditory distractions were all played on a computer.

Procedure. Upon arrival, subjects were given a statement to read that briefly described the experiment, they then gave informed consent to participate in the study. Before the subjects began completing the assignments, they were instructed to ignore the auditory stimuli and focus only on the task at hand. Instructions for the next section of the test were given. During the tasks, participants were exposed to one of four auditory levels of distraction: music with lyrics, music with no lyrics, spoken word, or no distraction. Upon completion of each of the three tasks, time was taken and the stimulus was removed until the next task began. Along with times, mistakes and other reactions were recorded manually by the researcher.

After all three tasks had been completed, the experimenter asked the subjects questions about the auditory stimulus. The control group received no such questions. The group exposed
to music with no lyrics was asked if they were familiar with the music; how many songs were played; whether or not they heard vocals; and what instruments they heard used. The group that listened to music with lyrics was asked if they were familiar with the music; how many songs were played; what instruments they heard used; subjects or themes from the music; whether the vocals were male or female; and any specific words or phrases they heard. The group that heard spoken word was asked if they were familiar with the recording; whether the voices heard were male or female; any themes or subjects they heard about; or specific words or phrases they heard being used. Subjects were debriefed after the questions.

Results

The purpose of the current study was to observe the effects of auditory distraction on spatial processing. In this experiment subjects were grouped into groups which received music, words, or combinations of both in order to see these effects. It was assumed that subjects who heard more distracting material would take longer to complete the tasks and would be less accurate than those who were less distracted by the auditory information. Messages that were thought to be more distracting were those including words. Independent groups were used in order to avoid instrument decay. Data from this experiment were examined by way of an Analysis of Variance (ANOVA).

Table 1 shows the mean amount of time taken to complete tasks and mean number of mistakes made for each task. A statistical analysis of the results indicated that there were no significant differences between level of distraction and time taken to complete the spatial tasks, $[F(3, 59) = .810, p = .494]$. No significant results were found indicating an effect of levels of distraction and number of items missed on all spatial tasks $[F(3, 59) = .644, p = .590]$. 
Results indicate that when asked about the content of the distracting stimuli, participants were able to comment correctly about the content or appearance of the material 95.6% of the time. However, when asked about the meaning or subject matter of the distracting information, only 46.7% could comment correctly.

Discussion

The current study investigated whether or not levels of distraction had any effect on reaction time or accuracy for spatial tasks. It also examined how much of the distracting information was being processed despite efforts to ignore the stimulus.

It was shown that although subjects were exposed to different types of auditory stimuli while completing tasks, their performances was not hindered. This suggests that perhaps that people are capable of using selective attention to filter out irrelevant information as suggested by Schnider and Shiffrin (1977). The fact that the subjects’ accuracy and reaction time were not affected by the auditory distraction is in direct contrast with the findings of Obeuer and Kliegl (2004) who found that a secondary task did cause changes in time and accuracy. However, Obeuer and Kliegl used mathematical problems as a distracter as opposed to the music or spoken word used in the current study. Perhaps the reason that time and accuracy was not changed by the distraction had nothing to do with the level of distraction, but the type.

The lack of significant changes indicates that this type of distraction did not interact with spatial tasks. This further supports Baddeley’s (1974) model of working memory. If the spatial tasks were being processed by the viso-spatial sketchpad, the information being processed by the phonological loop (i.e. the auditory distractions) should not interfere. In this case, since participants had very little memory or knowledge of the auditory information, it would appear
that the central executive allotted more energy to be spent paying attention to the primary task of
the spatial items.

Hazeltine, Teague, and Ivry (1984) showed in their experiment that dual task costs
could be lowered if one of the tasks was automatic, that is, no conscious effort was needed to
complete it. It is perhaps easier for listening to become automatic if the participant has been
exposed to the stimulus repeatedly or if the information is difficult to decipher. This may show
why subjects in this study were able to ignore the auditory distraction.

Although participants were not affected by the distraction, they still were able to
describe it even when told to ignore it entirely. This suggests that although they were not
listening to the messages, they were still perceiving them and therefore could recall general
aspects of the messages such as what instruments they heard and whether they heard male or
female voices. Dual task costs were lowered due to automatic processing of the distraction, but
some of the irrelevant information was still processed perhaps because mental loads were not
very high. The results also give support for Broadbent’s (1958) theory of early selection which
stated that information that can be attended to automatically could be filtered out early in the
attention process. This would lead to a lowering of dual-task costs as was seen in the current
study.

**Future Recommendations**

Further research on this topic should employ a larger and more representative sample
size. Using a different type of distraction such as lighting changes may elicit significant results
since the distraction and primary task are similar. Furthermore, a replication of this study could
yield significant results if the attention required to process the distraction was greater.
While conducting this study, the researcher noted that while in the control condition, subjects often made sounds or tapping noises while completing spatial tasks. Future research could investigate the meaning of this behavior to discover if these people are making up for the lack of distraction in order to increase productivity.

Conclusions

Although results of this study were not significant, much can be learned from it. Auditory distraction had no effect on spatial accuracy or reaction times. Participants were almost always capable of describing the distraction, but frequently could not recall the meaning of it. This suggests that the information was being processed although the participants were not aware of it. Since the distraction was being processed with no conscious effort on the part of the subject, it can be said that this is due to the automatic process of listening.
References


### Average Reaction Times and Mistakes for all Tasks

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<th>Dependent Measures</th>
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<tr>
<td>Time</td>
<td></td>
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<td>Shape Task</td>
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<td>Discrepancy Task</td>
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<tr>
<td>Geographical Task</td>
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<td>Mistakes</td>
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<tr>
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<tr>
<td>Geographical Task</td>
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<tr>
<td>Total</td>
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</table>
Appendix A

Shape Task
Appendix B

Discrepancy Task
Appendix C

Geographical Task
Appendix D

Questions About Auditory Stimuli

Group #2:

What instruments were being played in the music?

How many separate songs were played?

Were there any words used in the music?

Group #3:

What instruments were being played in the music?

How many separate songs were played?

What words or phrases can you recall being used?

Was the voice that of a male or female?

What subjects was the person addressing?

Group #4:

What words or phrases can you recall being used?

Was the voice that of a male or female?

What subjects was the person addressing?