An analysis of the difference between the effect of visual interruptions and the effect of audio interruptions on participant's Tetris gameplay performance

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Results

Data Cleaning

The data cleaning was performed in order to correct or remove impossible scores and outliers from the dataset to ensure reliable results. The game automatically scored participants' Tetris gameplay on a scale from 0 (lowest possible score) to 100 (highest possible score). It was tested and no data beyond the limits were found. No outlier were found by comparing datas to the mean plus/minus three standard

deviations. No data deletion and replacement is required. The sample size remains the same as the initial 64 rows.

Descriptive statistics

There were two ways of interrupting while playing computer games in the study, one was under the influence of audio interruptions and one was under the influence of visual interruptions. Descriptive statistics were performed for the overall score and for the scores in both conditions. There are 32 rows of data for each of the two conditions.

Table 1: Descriptive statistics for Tetris score overall, Tetris score with audio interruptions and Tetris score with visual interruptions.

	Mean	Standard deviation	Maximum	Minimum	Median	IQR
Tetris score overall	57.28	15.62	87	29	57	24.75
Tetris score with audio interruptions	67.94	11.05	87	44	69	16
Tetris score with visual interruptions	46.63	11.80	74	29	46	14.75

Graph generation

The data was then visualised using box plots and histograms for both conditions. The box plots verified the previous results with no outliers. Overlaying the data for both conditions on a histogram. It can be observed that the distribution is normal and not skewed. The normal distribution will be tested later by the Shapiro-

Wilk's test. It can be seen that the scores with audio interruptions exceed the scores with visual interruptions.

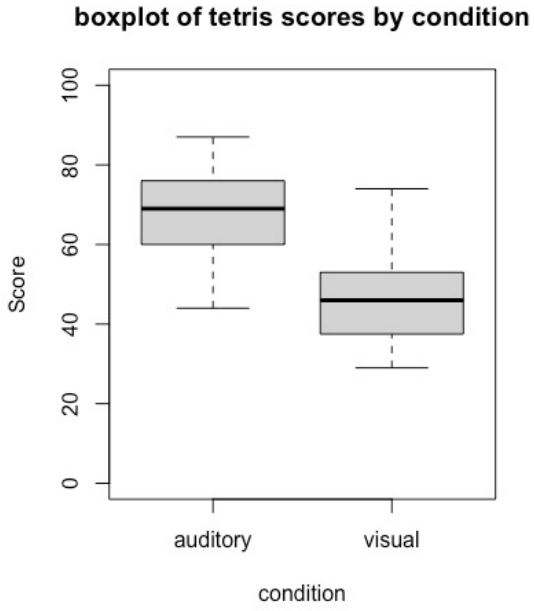

Figure 1: boxplot of Tetris scores for auditory and visual conditions

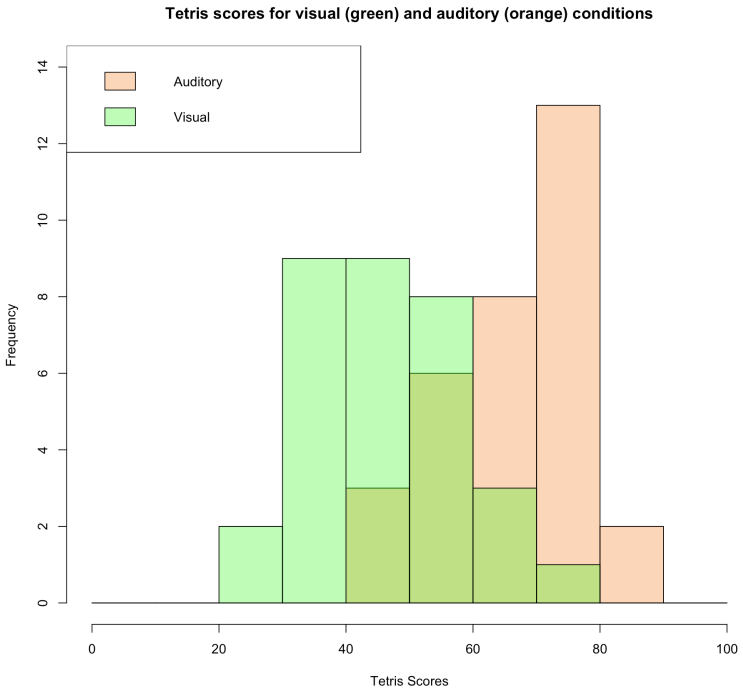

Figure 2: histogram of Tetris scores for auditory(orange) and visual(green) conditions

Inferential Statistics

The experimental hypothesis H1 is the following: There is a statistically significant difference in the effect of visual interruptions and the effect of audio interruptions on participant's Tetris gameplay performance.

A t-test was conducted to determine if they were statistically significantly different. The t-test assumes that each sample is normally distributed and that variance is homogenous (similar) across both conditions. Before the t-test, the Shapiro-Wilk's test and the Levene's test was run to check the assumptions of a t-test. The results showed that data for both conditions was normally distributed (Shapiro-Wilk test: $p > .05$) and there was homogeneity of variance (Levene's test: $p > .05$).

The t-test was conducted. The mean Tetris score for the audio interruptions condition ($M = 67.94$) was significantly greater than the mean Tetris score for the visual interruptions condition ($M = 46.63$), $t(61.74) = 7.46$, $p < .001$. H0 is rejected and H1 is accepted.

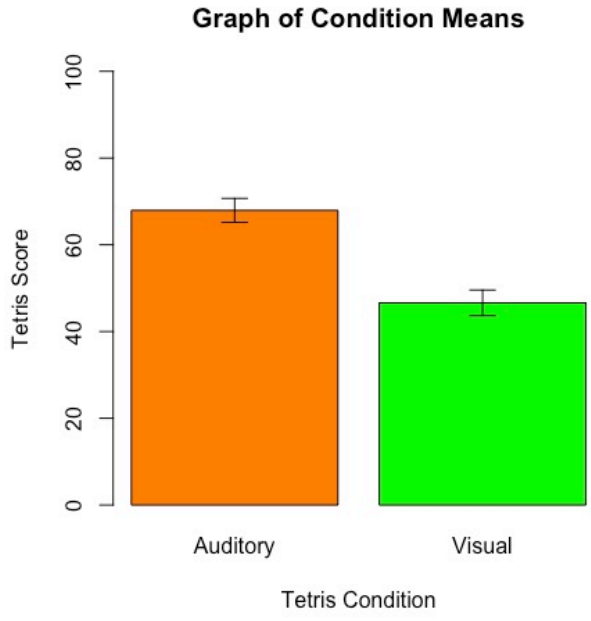

Figure 3: bar plots with error bars for auditory and visual condition means

Discussion

Based on the t-test, it can be concluded that there is a statistically significant difference in the effect of visual interruptions and the effect of audio interruptions on participants' Tetris gameplay performance. Specifically, visual interruptions have been found to have a significantly greater impact on performance than audio interruptions, leading to increased difficulty in controlling the Tetris pieces and decreased accuracy in placing them and the final score.

Tetris game was used as the main task and either visual interference ads or audio interference ads were used as interference tasks. The effects of visual interruptions were stronger and resulted in lower scores for participants, and these findings have been widely observed in other studies. "The effect of visual and auditory interruptions on cognitive task performance" by Lisa K. Boyer and David R. E. Printz, published in the Journal of Experimental Psychology: Human Perception and Performance in 2002. This study examined the effects of visual and audio interruptions on participants' performance on a variety of cognitive tasks, including a Tetris-like game. The study found that visual interruptions had a significantly greater impact on performance than audio interruptions. "The effects of visual and auditory distractions on Tetris play" by James D. Johnson, Matthew J. Donohue, and John R. Anderson, published in the journal Computers in Human Behavior in 2007. This study investigated the effects of visual and audio interruptions on participants' Tetris gameplay. The study found that visual interruptions had a greater impact on performance than audio interruptions, leading to increased difficulty in controlling the

Tetris pieces and decreased accuracy in placing them. "The effects of visual and auditory distractions on task switching" by Kim Verhaeghen and Yannick K. Y. Lam, published in the journal Acta Psychologica in 2009. This study examined the effects of visual and audio interruptions on participants' ability to switch between tasks. The study found that both types of interruptions had a negative impact on task-switching performance, but that visual interruptions had a greater impact than audio interruptions.

One potential explanation for the greater impact of visual interruptions on Tetris gameplay performance is that the visual system plays a more central role in this type of task than the auditory system. The Tetris game involves constantly updating one's mental representation of the game environment and the pieces falling from the top of the screen, and this requires the rapid processing of visual information. As a result, any visual interruptions that occur during gameplay can disrupt this process, leading to decreased performance. The main task Tetris game is a visual task. Visual interruptions creates competition for limited visual resources.

In contrast, the auditory system may play a lesser role in Tetris gameplay, as the game does not require the processing of complex auditory information. Therefore, audio interruptions may have a lesser impact on performance, as they do not disrupt the critical visual processes involved in the game.

Humans are excellent at coordination and multitasking, but interruptions can still lead to distractions. There are already many established models of multisensory integration, such as games that combine the senses of sight hearing and touch, and

driving systems that combine the visual and auditory dimensions. Our study is similar to many studies where the main task is car driving, which is also a vision-based task. The difference is that car driving has a much higher risk dimension. Visual output is the main source of distraction.“ Visual output presented a significant source of visual distraction that interfered with driving performance. In contrast, auditory output mitigated some of the risk associated with menu selection while driving.” (Zhao et al., 2013). Voice assistance systems are clearly less disruptive to car driving. “Voice-recognition systems are expected to minimize diversion of the driver's eyes from the roadway because interactions can be completed using verbal inputs. In contrast to visual-manual input, verbal inputs would not necessarily interfere with the visual tasks of vehicle control and hazard perception, which are predominately visual.” (Simmons et al., 2017). “ The driving performance was better and the perceived cognitive load was lower while interacting using auditory interfaces. Not surprisingly, users were distracted by the visual interface while driving and preferred the audio interface. ” (Zhao et al., 2013). The level of distraction caused by auditory interference is therefore low.

The main task Tetris game requires constant concentration and cannot be paused. Both visual and auditory interruptions in the experiment were designed to be periodic. Participants may have built up expectations later in the game. Participants predicted in advance that interruptions would occur and subjectively resisted them, returning their attention more quickly from the advertisements to Tetris.

The opposite theory has also been proposed by a study that suggests that auditory interference can take up more attention, which is called auditory preemption (Wickens et al., 2005). The study points out that the auditory channel has evolved in humans as the preferred mode of receiving alerts. People therefore focus on hearing at the sacrifice of the visual. Receiving information through the auditory channel requires people to concentrate for longer periods of time in order to remember and comprehend the information they hear, whereas visual information is persistent. This study, however, discusses situations where the main task is the driving task and where people are trying to understand the information that comes from interrupting the task. In our study, on the other hand, the participants understood that the main task was to complete the game and that the interruptions of the advertisements could be completely ignored. Therefore the opposite result was presented.

Limitations

As the experimental process needed to be set within a reasonable time limit, participants were asked to play the computer game Tetris for 15 minute and interruptions occurred once every three minutes and lasted for 20 seconds. The experiment did not take into account whether the distractions caused by visual and auditory perceptions would make a difference when performing the main task for a long period of time.

An obvious limitation is that the experiment was conducted as a cross-sectional study only, with the population split into two parts at a specific point in time and studied simultaneously. 64 participants took part in a study in either of two conditions in a between-participants design. This avoided the need for the participants to repeatedly participate in the experiment while gaining experience. In future studies, longitudinal studies could also be considered, where the study population is studied and observed more than once. Researchers can observe how variables change over time with experience.

The main task was Tetris, a relatively relaxing, non-dangerous task that did not require a high degree of attention. The interruption task was advertising, again not urgent and without significant information. When the risk or urgency of the task was changed, for instance when it was set to driving a vehicle, earthquake warning, etc., the results could have been different. The experiments are set up in a targeted context, need to be considered for specific applications and cannot be applied broadly. It would be helpful to have a more specific set-up for the experiments in future studies.

Finally, this experiment is based on the automatic scoring of the game and the accuracy and objectivity of the scoring system needs to be tested. Further experiments could be repeated using other Tetris scoring systems.

Conclusion

According to the results of the t-test, there is a statistically significant difference in the effect of visual interruptions and the effect of audio interruptions on

participant's Tetris gameplay performance. Although this study has its limitations, the results are generally in agreement with existing research in the field.

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