An analysis of the effect of visual interruptions and audio interruptions on Tetris gameplay performance

Results

There is a statistically significant difference in the effect of visual interruptions and the effect of audio interruptions on participants' Tetris gameplay performance.

Data Cleaning

The score of Tetris gameplay ranges from a minimum of 0 to a maximum of 100. Upon assessing descriptive statistics, it was shown that there was no impossible value.

Data were normally distributed (Shapiro-Wilk test: $p>0.05$) and there was homogeneity of variance (Levene's test: $p>0.05$).

Table 1

Descriptive statistics for Auditory, Visual and overall score

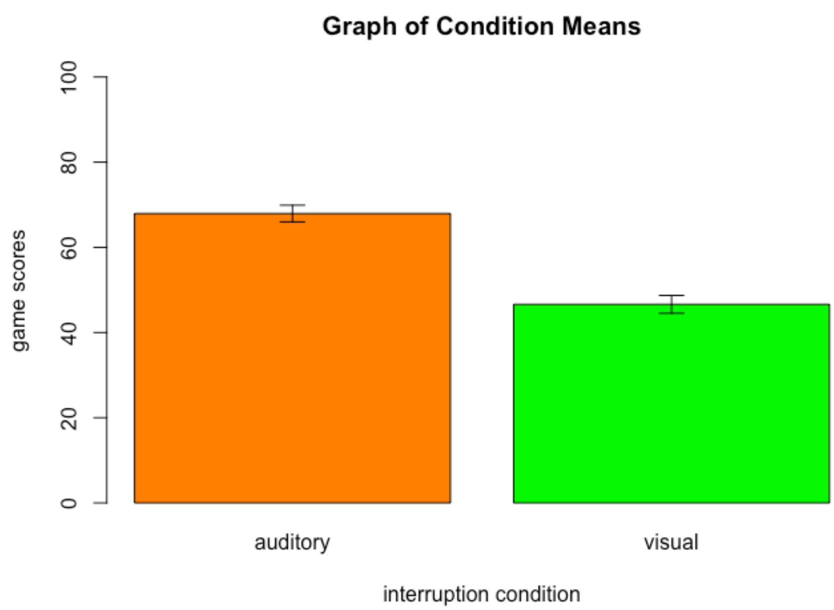
Measure	Mean	SD
Auditory	67.94	11.05
Visual	46.63	11.80
Overall Score	57.28	15.62

Inferential Statistics

The T-test was carried out to evaluate the following research hypothesis(H1): There is a statistically significant difference in the effect of visual interruptions and the effect of audio interruptions on participants' Tetris gameplay performance. A statistically significant difference was discovered, the mean Tetris score for the auditory($M=67.94$) was significantly greater than the mean Tetris score for the visual condition($M=46.63$), $t(61.74)=7.46$, $p < 0.01$. Consequently, H1 is supported, and the null hypothesis (H0) is rejected.

Figure 1

Graph of Condition Means



Discussion

Recent work on visual and auditory interruption shows that the modality of interruption negatively affects participants' response time and safety (Latorella, 1998b), has a disruptive effect on task performance (Brian, 2001), leads to stress (Mark et al., 2008b) and higher frustration (Gloria,2008), generate annoyance and anxiety (Joseph, 2001), cause making mistakes (Kapitsa,2003). But the difference between the effect of auditory and visual interruption has been widely observed by researchers (Wearden et al., 2006). Researchers proposed that visual stimuli generate more influence per unit of time than auditory stimuli (Wearden et al.1998). Visual delivery of information remains superior to auditory (Wickens et al., 2005). The visual stimuli appeared to last longer than the auditory stimuli (Wearden et al., 2006b).

The greater effect of visual interruption than auditory interruption is indicated in three dimensions: response time, information processing model and working memory storage capability, which is mainly due to three reasons: neurophysiological underpinnings, simple acoustics information transformation and eye movement sensitivity for vision (Goldstone & Lhamon, 1974).

Response time has been considered a key measure of the function of the sensorimotor association that is present in the auditory and visual modalities (Shenvi,1994). Prior research has presented evidence supporting the claim that visual feedback was faster in locating items than auditory (Shelton & Kumar, 2010). Genetics, genomics and gene factors provide important insight into how visual stimuli is faster at locating items and response time (Morton, 2002). The human superior temporal cortex contains multiple interconnected visual areas (Matthew,2000). Advanced visual perception and visually mediated actions (Amir et al., 2003), high-frequency neurons in visual units (Guinan et al., 1972), and amplitude visual spatial attention (Münte et al., 2001) contribute to faster locating of a target item.

The information processing model is a robust predictor of the effect of auditory and visual interruption (Talcott et al., 2002). Auditory stimulus attenuates the processing of information and mitigated some of the risks associated with interruption more than visual stimulus (Robinson & Sloutsky, 2007). Stabilized retinal images to the thalamus (Tatler et al., 2010), flash movement trajectories to the target (Müller & Rabbitt, 1989b), eye movement towards horizontal and vertical displacement (Zhao et al., 2013), dynamic variable and gaze control mechanism (Ballard, 1991b), colour and form perception (Land, 1977) optimize the process to identify visual interruption. Attentional processing of vision at a pre-attentive level (Koelsch et al., 1999), and automatic detection response to the visual environment (Grothe, 2000) facilitates the processing of visual interruption.

Working memory storage capacity is another characteristic that plays an important role in the effect of auditory and visual interruption on cognitive tasks (Cowan, 2010). Compared to auditory interruption, Structural maturation of the human visual system and the brainstem pathway (Moore & Linthicum, 2007b), visual presentation superior recall (Metcalfe et al., 1981), the spectrum of the visual signal and wavelength (Green, 1983), resulting in high capacity in visual working memory storage, consequently, deteriorating comprehension, reasoning and problem-solving when encountering visual interruption (Cowan, 1998).

However, there is a conflict in some of the literature regarding the relationship between the effect of auditory and visual interruption. While interrupting a task risks distraction, it may also bring to productivity or facilitate a response to emergent tasks. (Christian,2015). Data reported by some authors did not reveal a significant difference between the disruptiveness of auditory and visual (Warnock et al., 2011).

Limitations & Future Research

A single stimulus was deployed in this study. According to the theory of multisensory integration (Beauchamp,2008), it is more persuasive for future research to set bimodal stimulation with the integration of auditory and visual interruption (King & Palmer, 1985), and add one more variable to converge influences from visual and auditory (Wallace et al., 1993) based on the principle of that brain integrates them into a coherent percept (Beauchamp et al., 2004).

Whether the participants and experimenter were both blind to the order or type of interruptions was divergent. In order to enrich this experiment, interruption urgency manipulation (Edwards et al., 2021) and interruptions delivered randomly (Rajiv,2015), interruption complexity and urgency could be considered.

Tetris is a manageably complex task with Tetris-task-dependent strategies. (Edwards et al., 2021). Games with different levels of complexity and corresponding adaptation strategies are a supplement to enrich the experiment. Additionally, the various way to measure game scores by combining perfect matches and missed opportunities provide the most accurate and reliable method for future study. (Latorella, 1998b).

Individual differences exist in the management of interruption (Mark et al., 2008b). Regular Tetris player was mentioned, and it is useful to ask participants to complete a questionnaire about their background and experience to avoid the effect of age, gender, and body mass index (Lalita,2012). Variable about user impairment could be considered due to moral and ethical dimensions (Posner et al., 1976).

Conclusion

Auditory and visual modalities are two common output channels embedded in today's devices, building on current work on auditory and visual interruptions, this study aims to discuss how and why the effect of visual interruptions is greater than auditory interruptions.

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R Script with Notes

#Check out the head and tail after setting my working directory and importing the dataset. Noted that this dataframe has 64rows,2 variables.

head(tetris)

tail(tetris)

It looks like I have a columnn for IDs just called ID, a column for condition, and a column for game score. For now, let's get rid of that weird ID column as I won't need it.

tetris$ID=NULL

head(tetris)

tail(tetris)

##I told R to delete every value in that column by setting column ID equal to NULL.This dataframe now only has 2 columns – condition and score.

I notice there is a categorical variable called condition. In order to describle scores across each condition, Before running descriptive statistics, I want to get new dataframes in global environment that only contain data from one condition or the other.

I am telling r to treat condition as a factor.

tetris$condition=factor(tetris$condition)

#I am going to check what levels are in categorical variable with levels command.

levels(tetris$condition)

#In order to get dataframes that are smaller chunks of the full dataframe, specifying particular conditions I want subset to have by using subset command.

auditory=subset(tetris$score,tetris$condition=="auditory")

auditory

[1] 76 68 45 44 69 80 50 87 75 69 79 79 60 71 78 68 72 73 58 60 65

[22] 56 71 69 76 75 76 66 54 85 69 51

visual=subset(tetris$score,tetris$condition=="visual")

visual

[1] 50 39 41 52 46 32 37 46 44 68 61 43 74 67 43 48 47 60 60 52 33

[22] 30 36 52 29 39 54 33 55 38 52 31

I am going to get some descriptive statistics for the scores as well as descriptives of scores in each condition.

mean(tetris$score) 57.28125

sd(tetris$score) 15.62098

max(tetris$score) 87

min(tetris$score) 29

median(tetris$score)57

IQR(tetris$score)24.75

mean(auditory)67.9375

sd(auditory) 11.05394

max(auditory)87

min(auditory) 44

median(auditory) 69

IQR(auditory) 16

mean(visual)46.625

sd(visual) 11.80145

max(visual) 74

min(visual) 29

median(visual) 46

IQR(visual) 14.75

#Make boxplots for each condition and the scores overall.

boxplot(tetris$score,main="boxplot of game scores",ylim=c(0,100),ylab="score")

boxplot(tetris$score~tetris$condition,main="boxplot of game scores by condition",ylim=c(0,100),xlab="condition",ylab = "score")

#Make histograms for each condition and the scores overall.

hist(auditory,xlab="game scores",main="games socres for auditory(green) and visual(orange) conditions",xlim=c(0,100),breaks=seq(0,100,20),col=rgb(1,.5,0,1/3))

hist(visual,breaks = seq(0,100,20),col=rgb(0,1,0,1/3),add=TRUE,)

legend("topleft",c("auditory","visual"),fill=c(rgb(1,.5,0,1/3),rgb(0,1,0,1/3)))

I run a t-test to know for sure if they're statisitcally significantly different.I decide to use a statistical test, the Shapiro-Wilk's test, to tell for sure whether these distributions are normal.

shapiro.test(auditory)

Shapiro-Wilk normality tes tdata: auditory

W = 0.95218, p-value = 0.1662

shapiro.test(visual)

Shapiro-Wilk normality test data: visual

W = 0.9638, p-value = 0.3477

#Assumptions tests like Shapiro-Wilk's test have a hypothesis that my assumption is supported. The distribution is normal.

I use Levene's test to test for homogeneity of variance.

```
leveneTest(tetris$score,tetris$condition)
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  1  0.3748 0.5426
      62
```

I am going to run t.test command to specify two dataframes or vectors. As a third argument, I can tell R whether this is a paired (dependent means) t-test or not.

```
t.test(auditory,visual,paired=FALSE)

        Welch Two Sample t-test

data:  auditory and visual
t = 7.456, df = 61.736, p-value = 3.564e-10
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 15.59805 27.02695
sample estimates:
mean of x mean of y
  67.9375   46.6250
```

Make new objects in our dataframe that hold the means and SDs for both conditions.

tetris.mean=c(mean(auditory),mean(visual))

tetris.sd=c(sd(auditory),sd(visual))

I also use the names command to label means.

names(tetris.mean)=c("auditory","visual")

#Add barplot to environment by making a new variable name and setting it equal to the barplot. Then run the se.bar command, specifying your barplot, list of means, list of SDs, and sample size.

br=barplot(tetris.mean,main="Graph of Condition Means",xlab="interruption condition",ylab="game scores",ylim=c(0,100),col = c(col=rgb(1,.5,0,1),rgb(0,1,0,1)))

se.bar(br,tetris.mean,tetris.sd,32)