The potential of head-mounted display virtual reality as an attention retention and anti- distraction tool: A study

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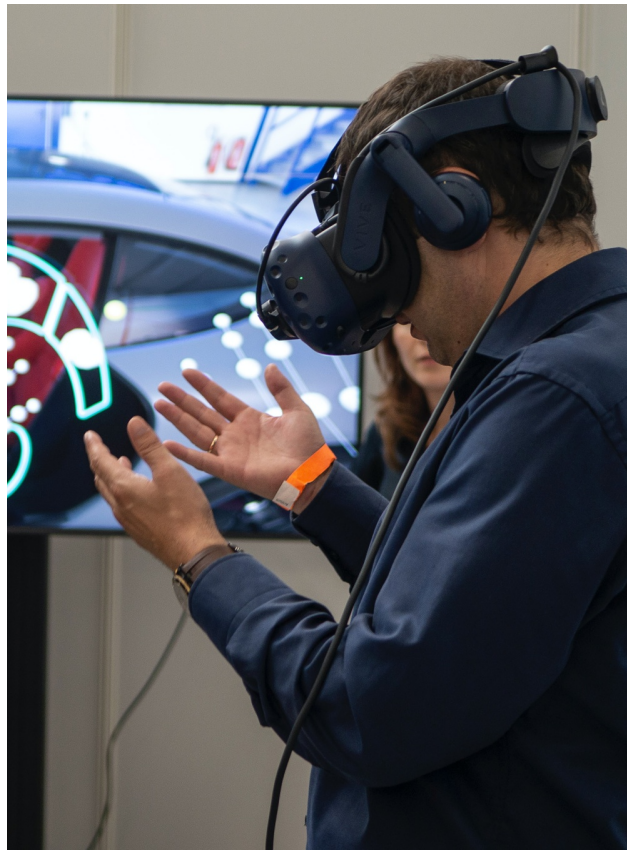
Head-mounted display (HMD) virtual reality (VR) as an **attention retention** and **anti-distraction** tool.

Head-mounted display (HMD) virtual reality (VR) has been widely used in entertainment, for example, in gaming and video streaming, and as an innovative productivity tool, for example, in 3D design and modelling.

There are limited numbers of built-in functions as well as software in VR that allow for conventional workflows such as typing and document editing, and it is important to understand the impact of using HMD VR when completing such tasks.

Could VR be used as a productivity tool by enhancing people's attention? How does it influence cognitive behaviour? What are the key factors that should be focused on in the future development of productivity VR? This study aims to investigate the effectiveness of HMD VR on attention retention by asking university students to perform memory-recall writing tasks on a computer and on HMD VR.



Theoretical Background

#1 VR AND ATTENTION

Research has suggested that there are opportunities for using VR in the rehabilitation of children with attention deficit hyperactivity disorder (ADHD)(Bashiri et al., 2017)

#2 HUMAN INFORMATION PROCESSING

Attentional resources are occupied to monitor environment, despite sensory register. (Wickens et al., 2004).

#3 ATTENTION AND DISTRACTION

Distraction is unexpected or undesired perception(Sharit, J., 2012).

#4 PRODUCTIVITY AND DISTRACTION

The capacity to retain attention varies, but an office worker would be able to increase their performance through controlled processing that uses temporary goals as anti- distraction strategies (Engle et al., 1999).

#5 VISUAL DISTRACTION

Avoiding being distracted by conspicuous but irrelevant stimuli is critical to accomplishing daily tasks(Cosman, J.D. et al., 2018).

#6 AUDITORY DISTRACTION

Auditory distraction should be considered as having a significant impact on worker productivity (Mak, C.M. and Lui, Y.P., 2012).

Methods

Experiment One

This study consists of two experiments. The second experiment was conducted to examine the effect of peripheral vision blocking.

1 PARTICIPANT

The experimental group consisted of 10 participants (four females and six males) aged 22–38 (M = 25.5 years old).

2 EQUIPMENT AND PREPARATION

Participants used Oculus Quest2, and Macbook Pro 13' for each section of the experiment.

3 MEMORY RECALL WRITING TASK

All participants were given the same writing task. The task consisted of two 10-minute sections. For each section they used VR or laptop.

4 WRITING TASK

The writing task was: 'Describe your day with creative writing'. A short guide was referenced from a creative writing guidance article by B.R. Pope (2019).

5 ANTI-DISTRACTION TEST

An audio-visual distraction with LI and an auditory distraction with HI were introduced during each section of both experiments.

6 INTERVIEW

An interview was conducted after the second section of each experiment.

Methods

Experiment Two

The experiment two duplicated the first experiment, but with **HMD VR replaced by peripheral blocking mask.**

1 PARTICIPANT

The experimental group consisted of four participants (two females and two males) aged 24–26 (M = 24.6 years old).

2 EQUIPMENT AND PREPARATION

Participants used modified peripheral blocking mask, and Macbook Pro 13' for the experiment.

3 MEMORY RECALL WRITING TASK

All participants were given the same writing task. The task consisted of two 10-minute sections. For each section they used mask+laptop or laptop alone.

4 WRITING TASK

The writing task was: 'Describe your day with creative writing'. A short guide was referenced from a creative writing guidance article by B.R. Pope (2019).

5 ANTI-DISTRACTION TEST

An audio-visual distraction with LI and an auditory distraction with HI were introduced during each section of both experiments.

6 INTERVIEW

An interview was conducted after the second section of each experiment.

Results Experiment One

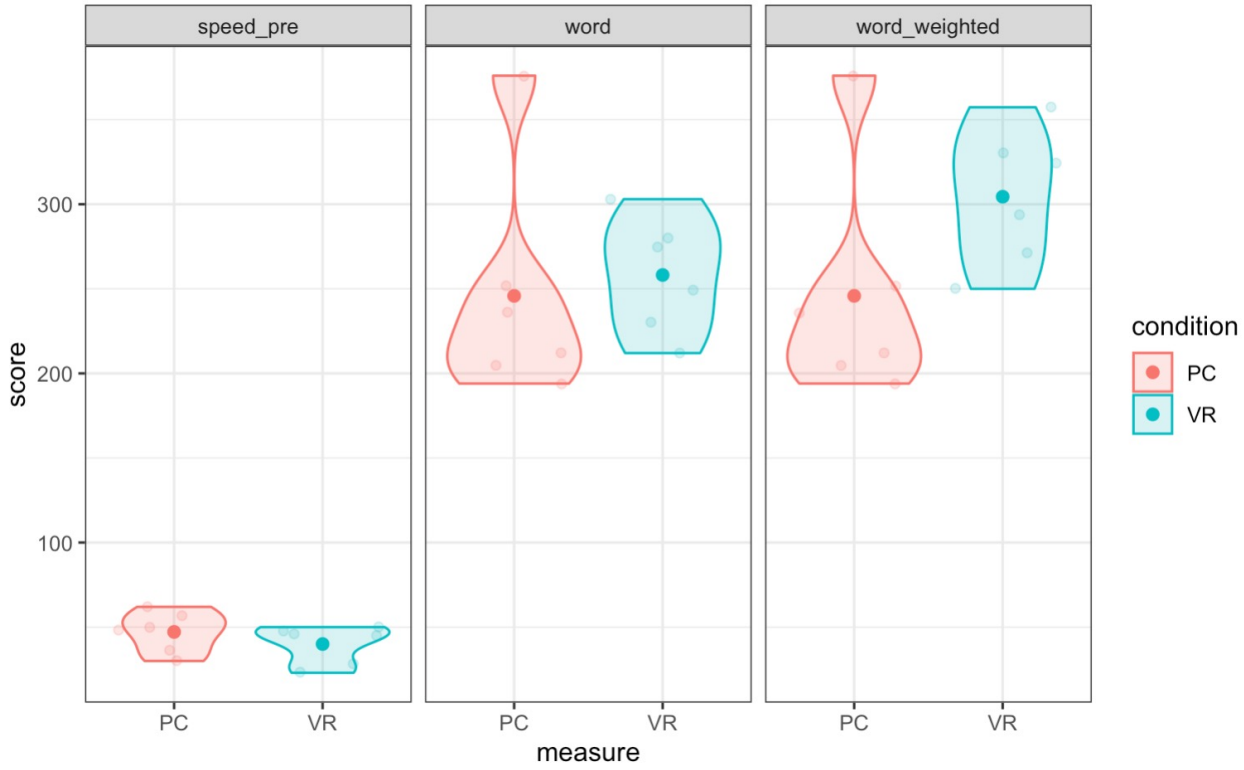
Quantitative Analysis

1 VALID RESULTS

All 10 participants completed the study. Four participants experienced serious glitches while using the VR headset, and they were required to recenter the screen multiple times (average >6 times) and self-reported to have been severely distracted. Therefore, only six results are considered valid.

2 DATA

All six participants with valid results typed faster on the laptop(M = 47.166 WPM, SD = 12.20) than on VR(M = 40 WPM, SD = 11.47). However, five out of the six participants wrote more on VR(M = 258.166 words, SD = 33.99) than on the laptop(M = 240.833 words, SD = 67.19).



Results Experiment One

Quantitative Analysis

1 WELCH PAIRED SAMPLE T-TEST

Welch paired sample t-test was performed, t (63.61) = 2.69, p = 0.04, d= 1.10, 95% CI [2.82 124.39], showing a large effect size and significant statistically difference in mean map scores between the two conditions(Figure 10).

2 IT IS SHOWN...

1. HMD VR had a positive impact on performance during the memory-recall writing task. The participants typed more when using HMD VR, even when their limit typing speeds were lower. The weighted performance is largely significant.

2. HMD VR may have some impact on an individual's ability to recover from LI and HI auditory distractions, but further investigation is required.

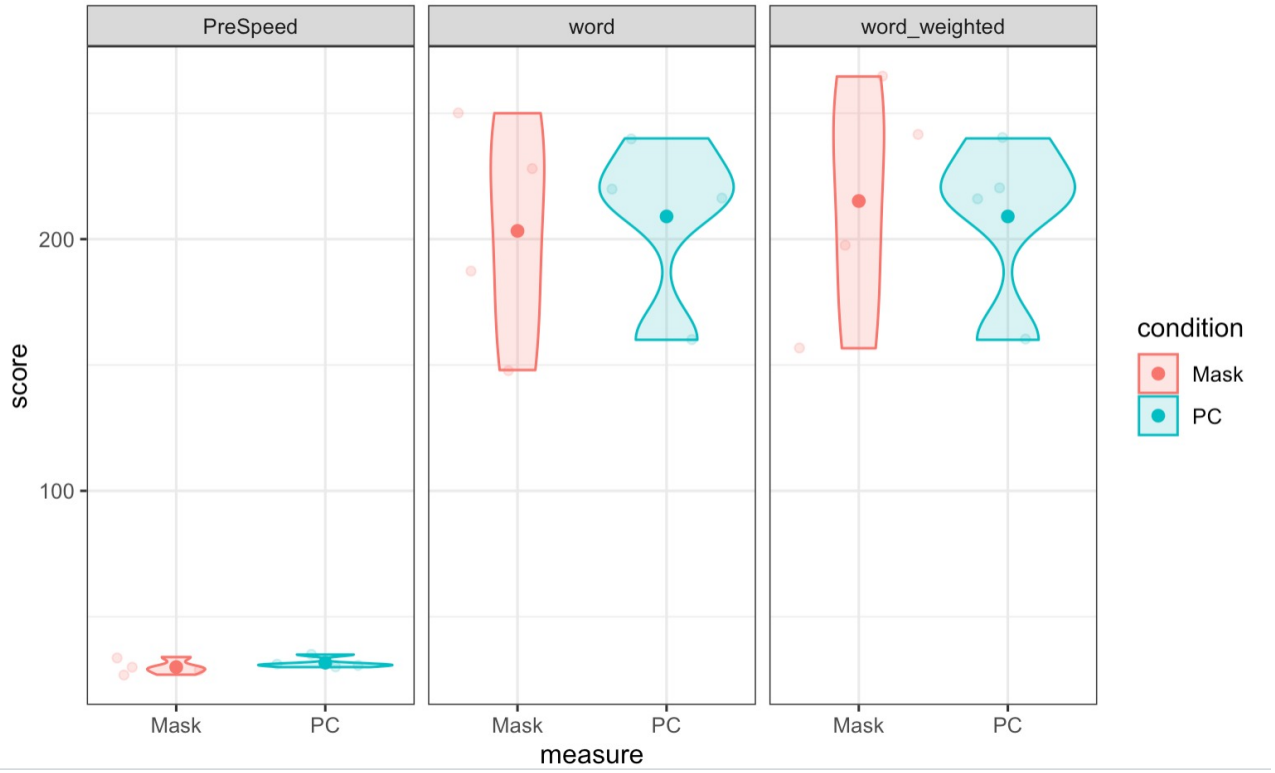
measure	estimate	statistic	p.value	conf.low	conf.high	method
Tested typing speed (WPM)	-7.16	-4.31	0.007	-11.43	-2.89	Paired t-test
Actual word typed	17.33	0.74	0.49	-43.17	77.84	
Weighted Performance	63.60	2.70	0.04	2.82	124.39	

Results Experiment Two

Quantitative Analysis

1 DATA

2 out of 4 participants wrote less while using peripheral blocking mask. On average, 4 participants had average typing speed 1.5% slower while wearing peripheral blocking masks(PC M = 31.75, SD = 2.21; MASK M = 30, SD = 2.94). They wrote slightly less on VR(M = 203.25, SD = 45.15) compare to writing in laptop (M = 209, SD = 34.31).



Results Experiment Two

Quantitative Analysis

1 WELCH PAIRED SAMPLE T-TEST

Welch paired sample t-test was performed, t (-6.12) = -0.53, p = 0.63, d= 0,266, 95% CI [-42.82 30.57], showing a small effect size and no statistically significant difference in mean map scores between the two conditions(Figure 13).

2 IT IS SHOWN...

1. The peripheral mask in itself did not have a significant impact on the participants' performance during the memory-recall typing task.

2. HMD VR has a positive attentional impact on users other than peripheral blocking.

measure	estimate	statistic	p.value	conf.low	conf.high	method
Tested typing speed (WPM)	1.75	2.05	0.133	-0.96	4.47	Paired t-test
Actual word typed	5.75	0.54	0.62	-27.94	39.43	
Weighted Performance	-6.12	-0.53	0.63	-42.82	30.57	

Results
Experiment One

Qualitative Analysis

1 INTERVIEW

From the interview, all participants were more concentrated on the task when using HMD VR, subjectively.

2 DISTRACTION

Half of the participants recalled they had glanced at the surroundings when thinking about what to write, and two of these participants reported that they had noticed that they were being momentarily distracted.

3 OBSERVATION

Only one participant turned their head to the researcher during the first distraction.

4 REACTION

The participants had different reactions to the distractions. Two participants noted they were unable to concentrate, stopped typing for a few seconds, attempted to process the HI distractor and then resumed typing during the second distractions.

Results
Experiment Two

Qualitative Analysis

1 INTERVIEW

Two participants felt they were slightly more concentrated on the task. Two other participants felt there was no obvious anti-distraction. The only participant who looked at the researcher during the first distraction when using the laptop was the only one severely distracted by the name-calling event. He looked at the researcher and stopped typing. It also took ~4 seconds before he started typing again.

Discussion

Attention, distraction, and HMD VR

This study focused on the **effectiveness** of using HMD VR for **attention retention** in memory-recall writing tasks and for anti-distraction purposes.

The results show that **HMD VR** has a **positive impact** on **memory recall writing tasks**; the participants were able to **type more during the task** while they had slower tested type speed in VR .

Various factors might explain this result. However, the **blocking of peripheral vision was the most likely factor**.

A **further experiment** using a peripheral blocking mask instead of HMD VR was **conducted**.

The results showed that the **impact** of a **peripheral blocking mask** is **minimum**, which suggested that HMD VR affected participants in other ways as well.

Discussion

Attention, distraction, and HMD VR

Previous research has shown that **attention** on the task is known to be **determinate** for **memory- recall-related tasks**. While it is known that HMD VR can help **improve performance** during a memory-recall task, and it wasn't because of simple peripheral blocking, it could be suggested that HMD VR could help individuals **retain attention** on certain tasks.

When a user is using **HMD VR**, they are **cognitively isolated** from the outer environment, and the **attentional resources** used for **monitoring** the environment are now **freed** to process the task.

Because HMD VR offered less sensory input from the surrounding environment, the participants were able to both **occupy fewer** attentional resources on the **sensory register** and **allow more** attentional resources on the task itself.

Discussion

Cost to Quit effect

This study would like to note an effect from the current investigation.

The cognitive cost to quit using HMD VR to observe distractors is significantly higher compared with using a laptop. This is because when an individual is distracted by any conspicuous distractor, the cost to look at the source of the distractor (e.g. a ringing phone or a speaking person) is very low (a glance). Glancing at various distractors may increase the chance of becoming severely distracted. However, the cost to quit using HMD VR is significantly higher (take off and put back on the HMD VR). It is possible that this 'cost to quit' effect can be used as a practical anti-distraction strategy in certain workflows. Individuals may wish to use this higher 'cost to quit' as a self-monitoring strategy. Such a strategy is commonly applied by students, who may study in a library instead of at home.

Discussion

Real World Application

Oculus Quest 2 is designed to fully block peripheral vision apart from a small section on top of the nose for comfort. This design feature enables the product's anti-distraction ability. However, numerous newer models of HMD VR glasses have open designs with far peripherals no longer being blocked (e.g. Oculus quest Pro and Lynx). This newer design could potentially lead to unwanted sensory input and cause conspicuous visual distraction.

The 'cost to quit' effect, if further recognised, might guide the future design of HMD VR for conventional work users. While accessibility is critically important, specific functions could be introduced to maintain a high 'cost to quit' while also keeping accessibility high.

Discussion

Limitation

The limitation of the study is its small sample group. Participants' personalities and working habits were not investigated beforehand. The first hypothesis needs to investigate other factors of HMD VR. The 'cost to quit' hypothesis needs further investigation and brain activity monitoring for further study.

The result of this study was considered based on weighted performance. The weight was added because previous studies have shown participants should be able to type on VR as fast as on PC. For the soundness of evaluation of writing performance, weight was calculated by the mean of tested typing speed. However, it is possible participants’ ability to type on VR was keep elevating during the experiment. Future experiment should consider how to avoid this potential problem.

Conclusion

The study results suggest that in memory-recall writing tasks, HMD VR has a positive impact on attention retention.

It is suggested less attentional resources are occupied for sensory register and environment monitoring, and more attentional resources can be used for working memory and memory-recall.

Acknowledgements

I would like to thank my supervisor, **Dr.Mick Grierson** for his full support in my work. Special thanks to **Miss Siyu Wang** from UCL psychology department for her contribution to the data analysis of this study. I would also like to show my gratitude to all the participants of this study.

Analysed data and **R script** can be found at:
https://github.com/SimonS98/HMDVR_Attention_Research