

# The use of visual reality (VR) in therapy and its effectiveness

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## Introduction

Visual reality is a newly emerging advancement of technology that creates opportunities in different fields of science. The unique experience of isolation created by visual reality not only allow high concentration on the task but also results in higher brain activity. Recent research with patients after stroke shows a positive and beneficial effect of using visual reality for after-stroke rehabilitation (Choy, C et al, 2023). The effectiveness was reflected in the higher activity of the motor cortex while performing the mental task of throwing a basketball ball into the basket simultaneously with using the VR compared to the patients with no VR or those who performed the mental task after using the VR (Choy, C et al, 2023). Physical rehabilitation is certainly not the only field that has been intrigued by VR and many psychologists and clinicians have also started exploiting the new tool with their patients. A meta-analysis of more than 15 research papers has concluded an improved short-term memory and attention for people with ADHD as a result of VR usage (Gao et al, 2021). Similarly, the meta-analysis of 18 studies has shown a positive correlation between anxiety reduction and VR-projected natural settings (Riches, et al, 2023). The point was also supported in another meta-analysis which demonstrated similar benefits of the VR on short-term attention and memory improvement as well as short-term anxiety reduction in individuals with and without ADHD (Corrigan, N., et al., 2023).

This paper will primarily focus on the effect of visual reality in treating short-term anxiety as well as short-term memory and attention improvement in children and teenagers with ADHD and anxiety disorder. The following definitions and symptoms will be given to deepen the understanding of the problems we are attempting to tackle. ADHD is an abbreviation for attention disorder and hyperactivity deficit and can be expressed in two distinct ways. First is the hyperactive type which is marked by symptoms such as fidgety, playing with their hands or feet or squirming in the seat, being on the go or in constant motion, excessive talkativeness, interrupting others, and difficulty waiting for a turn and others (Attention-Deficit / Hyperactivity Disorder (ADHD), 2022). Second, is a lack of attention to detail or a tendency to make careless mistakes in school, not listening when spoken to, the tendency to lose things, avoiding or disliking tasks that demand mental focus, being easily distracted, etc (Attention-Deficit / Hyperactivity Disorder (ADHD), 2022). Additionally, anxiety is characterized by the following symptoms: excessive worrying about current or future events, fearfulness about the events or things (expressed in the form of phobias, society, or general worrying), avoidant behaviors as a result of anxiety (avoiding people, darkness), the experience of a panic attack(s), perfectionism, including some physical symptoms such as nausea, shaking, sweating, shortness of breath, sense of impending doom ("Anxiety disorder in children", 2023). In both cases disturbed memory and attention are observed and accompanied by anxiety as a consequence of both disorders. Based on the findings and background information, we also attempted to evaluate the effectiveness of the VR. For that, we experimented and hypothesized that VR-based sessions are effective in reducing anxiety symptoms as well as improving working memory and attention in the short-term.

## Methodology

The described study was conducted using an experimental approach with control and experimental groups. The independent variable was VR usage, and the dependent variable was the results of cognitive and emotional tasks prepared and provided in collaboration with neuropsychologist Elena Labkovsky at the AFG Guidance Center. A more in-depth description of the utilized manual and tasks can be found in **Appendix A**. All information was gathered under high confidentiality. The number of participants in the experimental and control groups was 9 and 13 respectively. Participants for the experimental group were obtained from the AFG Guidance Center diagnosed with either ADHD or anxiety and for the control group the participants were Lake Forest College students with no mentioned mental disorders. The

participants in each group followed the same steps found in **Appendix C**.

Other factors such as gender, sex assigned at birth, country of origin, or age were not taken into consideration when conducting the research. The assignment given to the participants consisted of several parts, the first part included physical measurements such as heart rate and stress index, the second part contained 5 cognitive tasks, and the third one asked to rate (from 1 to 10) the listed emotions in that specific moment. Time spent on completing the cognitive tasks was recorded in step 1 and step 3 as well as the ratings for experienced emotions. An example of the blank form can be found in **Appendix B**.

The data gathered from all the participants in both groups before the manipulation was subtracted from the after-manipulation results.

## Results

A within-subject T-test analysis was performed on SPSS to determine whether a meaningful connection exists between the results of the control group and experimental group before and after being exposed to the mentioned manipulations in step 2. An average was obtained for each group in each task and measurement, next results for the control group were subtracted from the experimental group. We expect to see positive and negative results in the calculator of the mean difference depending on the task.

Paired Samples Test										
		Mean		Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
						Lower	Upper			
Pair 1	Stress - stress2	-8.46154	12.48743	3.46339	-16.00762	-91546	-2.443	12	.031	
Pair 2	HR - hr2	4.92308	18.16802	5.03890	-6.05575	15.90190	.977	12	.348	

**Figure 1.** Differences in physical measurements before and after manipulations were compared between the control and experimental groups.

A paired T-test was conducted to examine the differences between the heart rate (M=4.92, SD=18.7) and stress index (M=-8.46, SD=12.5) difference between the control and experimental groups. The results revealed a significant t-value (t = 2.44, df = 12, p = 0.03), indicating a significant difference between the means. No other significant relationships were found.

Paired Samples Test										
		Mean		Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
						Lower	Upper			
Pair 1	IQ1 - IQ1.2	-9.46923	39.00635	10.81842	-33.04053	14.10207	-8.75	12	.399	
Pair 2	IQ2 - IQ2.2	10.07692	13.04135	3.61702	2.19611	17.95773	2.786	12	.016	
Pair 3	IQ4 - IQ4.2	-11.84615	8.54250	2.36926	-17.00834	-6.68397	-5.000	12	.000	
Pair 4	HANDEYE - HANDEYE2	12.07692	8.87376	2.46114	6.71456	17.43928	4.907	12	.000	
Pair 5	SCHULTE - SCHULTE2	-41.92308	7.27394	2.01743	-46.31868	-37.52748	-20.780	12	.000	

**Figure 2.** Differences in cognitive task results before and after manipulations compared between the control and experimental groups.

A paired T-test was conducted to examine the differences between the cognitive tasks difference between the control and experimental groups. The results revealed a significant t-value in task 1 (M=-9.47, SD=39.0) (t =2.79, df = 12, p = 0.02), indicating a significant difference between the means. Additionally, a significant difference between the means for the two groups in the cognitive tasks pair 3(M=-11.8, SD=8.54), pair 4 (M=12.1, SD=8.9), pair 5(M=-41.92, SD=7.3) were found, (t=5.00, df = 12, p <0.001); (t=4.91, df = 12, p <0.001); (t=20.78, df = 12, p <0.001), respectively. No other significant relationships were found.

Paired Samples Test										
		Mean		Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
						Lower	Upper			
Pair 1	upset - upset2	-14.84615	5.63983	1.56421	-18.25427	-11.43804	-9.491	12	.000	
Pair 2	restless - restless2	.92308	3.20056	.88768	-1.01100	2.85716	1.040	12	.319	
Pair 3	happy - happy2	1.96538	3.86961	1.07324	-3.73000	4.30377	1.831	12	.092	
Pair 4	depressed - depressed2	-3.50000	3.47611	0.96410	-5.00059	-1.39941	-6.330	12	.003	
Pair 5	relaxed - relaxed2	1.92308	2.39658	0.66409	4.74884	3.37131	2.893	12	.013	
Pair 6	bored - bored2	2.07692	3.06761	0.85080	2.2318	3.93066	2.441	12	.031	
Pair 7	calm - calm2	-.38462	2.46774	0.68443	-1.87586	1.10663	-.562	12	.584	
Pair 8	sad - sad2	-2.53846	3.59665	.99753	-4.71190	-3.6503	-2.545	12	.026	
Pair 9	worried - worried2	2.00000	3.39116	0.94054	-0.04926	4.04926	2.126	12	.055	
Pair 10	tense - tense2	2.00000	2.64575	.73380	4.0119	3.59881	2.726	12	.018	
Pair 11	focused - focused2	.92308	2.87117	.79632	-8.1195	2.65810	1.159	12	.269	
Pair 12	distracted - distracted2	-.69231	4.00800	1.11162	-3.11432	1.72971	-.623	12	.545	
Pair 13	anxious - anxious2	-.53846	3.84308	1.06588	-2.86081	1.78389	-.505	12	.623	
Pair 14	tired - tired2	4.03846	3.74423	1.03846	1.77585	6.30107	3.889	12	.002	
Pair 15	angry - angry2	-3.84615	4.35596	1.20813	-6.47843	-1.21388	-3.184	12	.008	
Pair 16	annoyed - annoyed2	1.84615	2.57702	.71474	2.8888	3.40343	2.583	12	.024	

**Figure 3.** Differences in ratings of emotional states before and after manipulations were compared between the control and experimental groups.

A paired T-test was conducted to examine the differences between the emotional state difference between control and experimental groups. The results revealed a significant t-value of difference in sadness ratings ( $t = 9.50$ ,  $df = 12$ ,  $p < 0.001$ ), indicating a significant difference between the means of the two groups. Additionally, a significant difference between the means for the two groups in ratings of depression ( $M = -3.5$ ,  $SD = 3.5$ ), relaxation ( $M = 1.9$ ,  $SD = 2.40$ ), boredom ( $M = 2.1$ ,  $SD = 3.1$ ), sadness ( $M = -2.5$ ,  $SD = 3.6$ ), tenseness ( $M = 2.0$ ,  $SD = 2.6$ ), tiredness ( $M = 4.0$ ,  $SD = 3.7$ ), anger ( $M = -3.8$ ,  $SD = 4.3$ ), and annoyance ( $M = 1.8$ ,  $SD = 2.6$ ) were found, ( $t = 3.63$ ,  $df = 12$ ,  $p = 0.003$ ); ( $t = 2.89$ ,  $df = 12$ ,  $p < 0.013$ ); ( $t = 2.44$ ,  $df = 12$ ,  $p = 0.03$ ), ( $t = 2.54$ ,  $df = 12$ ,  $p = 0.03$ ), ( $t = 2.73$ ,  $df = 12$ ,  $p = 0.02$ ), ( $t = 3.89$ ,  $df = 12$ ,  $p = 0.002$ ), ( $t = 3.18$ ,  $df = 12$ ,  $p = 0.008$ ), ( $t = 2.58$ ,  $df = 12$ ,  $p = 0.02$ ), respectively. No other significant relationships were found.

**Conclusion:**

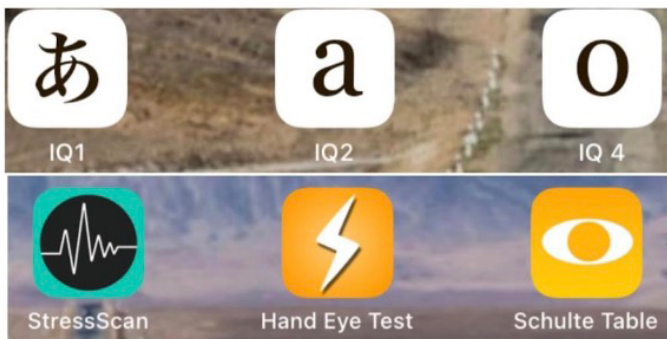
The significance of the results provided does not necessarily support our hypothesis that VR is effective in reducing short-term anxiety and enhancing short-term attention and memory. While the majority of calculations have shown significance, in cases such as stress levels, VR had a positive effect on participants by reducing their stress levels, as opposed to the control groups, which exhibited higher stress levels than expected. However, cognitive task 5 (Schulte test) demonstrated a distinct pattern, with higher scores in the control group than in the experimental group, which does not support our hypothesis. In other words, the present data is insufficient to draw substantial conclusions about the effectiveness of VR in therapy, and further research is warranted.

One potential means of improving the quality of the research is to increase the number of participants, as the disparity in the current number of participants between the control and experimental groups is one of the main weaknesses of this paper. Additionally, the differences in the environments where the tests and measurements were conducted for both groups significantly lower the internal validity. The duration of the experiment is another potential weakness that could have led to reduced participant interest and motivation, resulting in less effort invested in completing the tasks.

On the other hand, one of the strengths of this research lies in its multifaceted approach. Evaluating the cognitive, emotional, and physical states of individuals expands our understanding of the overall impact of VR manipulations. While participants may potentially provide inaccurate responses regarding their emotional states, the physical and cognitive states cannot be falsified. However, redundancy in the questioning is a drawback since participants completed the cognitive tests twice, and improvements in results were somewhat expected. External validity of the research may be problematic due to the limited pool of participants, which does not adequately represent the U.S. population. For future research, recruiting more participants from diverse regions within a country or multiple countries and conducting experiments in a more controlled environment will significantly enhance result quality. Moreover, selecting participants of a relatively similar age could be beneficial for further generalizing the findings

**Appendices**

**Appendix A:**



The three top applications: IQ1, IQ2, and IQ 4, and bottom right: Hand Eye Test and Schulte Table were used for cognitive tasks as they require memory and reaction time. The left bottom application "Stress scan" was used for measuring the physical char-

acteristics such as heart rate and stress level of the participants.

**Appendix B:**

This image depicts the final version of the forms used for recording the data for the experiment.

**Appendix C:**

Control Group	Experimental Group
<p><b>Step 1:</b> Tasks and measurements mentioned earlier</p> <p><b>Step 2:</b> 15-20 minute talking or neutral task execution</p> <p><b>Step 3:</b> Measurements conducted again as well as the cognitive tasks</p>	<p><b>Step 1:</b> Tasks and measurements mentioned earlier</p> <p><b>Step 2:</b> 15-20 minute VR</p> <p><b>Step 3:</b> Measurements conducted again as well as the cognitive tasks</p>

**References**

"Attention-Deficit / Hyperactivity Disorder (ADHD): Symptoms and Diagnostics of ADHD." Center of Disease Control and Prevention, National Center on Birth Defects and Developmental Disabilities, 2022, <https://www.cdc.gov/ncbddd/adhd/diagnosis.html#:~:text=Often%20has%20trouble%20holding%20attention,trouble%20organizing%20tasks%20and%20activities.>

"Anxiety disorder in children." NHS Inform, 2023, <https://www.nhsinform.scot/illnesses-and-conditions/mental-health/anxiety-disorders-in-children>

Choy, Chi S., et al. "Virtual Reality and Motor Imagery for Early Post-Stroke Rehabilitation." BioMedical Engineering OnLine, vol. 22, no. 1, July 2023, pp. 1–18. EBSCOhost, <https://doi.org/10.1186/s12938-023-01124-9>.

Corrigan, N., et al. "Immersive Virtual Reality for Improving Cognitive Deficits in Children with ADHD: A Systematic Review and Meta-Analysis." 2023, doi:<https://doi.org/10.1007/s10055-023-00768-1>.

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