Can Virtual Reality Create Muscle Memory?

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Abstract

Are we capable of forming new muscle memory in Virtual Reality? If practice with real objects informs our usage of similar objects in VR, perhaps lessons gleaned in VR could have real-world implications.

1 Introduction

The history of tool use is tantamount to human history. Our daily lives are predicated on using tools to complete tasks. The "most studied human research subject of all time", Henry Molaison, was able to form *and retain* new motor skills, even though he couldn't commit them to explicit memory.[1] If *Patient H.M.* was able to do crosswords without a prefrontal cortex, it's feasible that performing a task in VR could boost aptitude in real life.

Another metric that comes to mind is the notion of "deliberate practice", which was thought to be a critical factor in professional proficiency, providing the basis for Malcolm Gladwell's "10,000 Hour Rule". It has more recently been claimed to be a rather poor correlate of proficiency, showing $> 1\%$ of the performance variance for professions.[2] Even so, 26% of the variance in games is still correlated with practice, with similar figures for musical performance (21%) and sports (18%). It stands to reason that a person's proficiency with tasks that rely heavily on motor skill to performcould be improved by "practice". We aim to determine if a VR simulation can supplant real-world experience.

2 Methods

In order to determine if people are more capable of forming muscle memory, subjects will be timed as they perform common tests of dexterity.

Control The control group will perform the tasks with no other preparation, providing a baseline measurement for the difficulty of the tasks. specifically, we will measure how long it takes them to complete the tasks. They will then be given the same test a second time, which will determine a baseline for their improvement after a second run.

Experiment The experiment group will be tested in a VR simulation of each task first, which should be designed to match the difficulty of the base tests. The results of this first test should be proportional to that of the control. They will then have the same opportunity to perform the tasks as the control.

2.1 Racquetball (Spatial Awareness)

Participants will be tested on their ability to judge the path of a ball, and on how closely they can hit said ball towards a specific target, intending to measure reaction time and awareness, but not mobility. Racquetball in particular requires a high level of spatial awareness. This test will determine spatial awareness gained in VR is evident in reality.

2.2 Welding (Mechanical Dexterity)

This task will judge users on the basis of how steadily they can trace a sequence of increasingly complex lines and shapes, simulating welding. When welding, it is important to not move too slowly or too quickly, so in this case we also have a qualitative measurement of ability. This test will establish if motor dexterity carries over into reality. (While we maybe don't want to let participants loose with welding equipment, a hot-glue gun would probably be a perfectly reasonable facsimile).

3 Materials

This will require a room-scale VR system with tracked hand controllers. The HTC Vive matches this description, though there are alternatives. The experiment also requires an ordinary smartphone / whatever else, to time participants, and record videos of their performance for analysis. Additionally, a large number of VR-naive participants will be required.

It may also be interesting to run this experiment on people who have significant real-world experience with the manual tasks we're testing. We could compare their scores to that of the unskilled participants, which could be evidence of a correlation between adeptness in life and in VR.

3.1 Roles

3D Artist The models we use in our simulations must be reasonably realistic, such that participants accept them as replacements for what they represent. It will fall on the team's 3D artist to achieve this.

UI/UX Designers The designers must ensure the experience correlates to the real trials, and must also guide some of the programmer's / 3D artist's decisions, such that people don't... *become biased* by poorly thought out features. They will also be tasked with conducting tests on the participants.

Programmer The simulations need to behave similarly to their real-world counterparts. The programmer will be tasked with creating believable in-game interactions. Also, they may find some helpful in-game data gathering methods along the way.

4 Questions to Explore

1. Does experience using tools in VR correlate to real-world aptitude?
2. Can we establish new reactions to ordinary, real world events in VR, and would these responses be evident or even involuntary in real life?
3. Could unwanted effects persist even after ceasing to use VR?

Figure 1: adverse effects of virtual reality

5 Definition of Success

The "success" of a particular simulation could be gleaned from the results. If we find that only two of the trials produce any kind of performance gain, the trial that didn't improve performance could be considered a "failure".

However, the direct findings of our study could be a better metric of success. We might find that even extensive practice in VR makes no difference, or it might only provide a slight advantage over the control's results. Maybe time in VR will worsen aptitude in real life (Figure 1), or we may find that VR preparation exceeds the gains of firsthand experience! It's also possible that neither of these is a good indicator of success. The best way to find out is to start, right away. One good test is worth a thousand expert opinions.

References

[1] William Beecher Scoville and Brenda Milner, *Loss of recent memory after bilateral hippocampal lesions*, Journal of Neurology, Neurosurgery and Psychiatry, 1957.

[2] Brooke N. Macnamara *et al*, *Deliberate Practice and Performance in Music, Games, Sports, Education, and Professions*, Department of Psychology, Princeton University, 2014.