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Poster

Development of Attention Overload Virtual Reality Training System to Extend Effective Attention Resources

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Abstract

In recent years, various proposals have been made for body extensions, such as the [third arm] and other extended limbs. These extended limbs overcome physical limitations in multitasking, but they place a heavy burden on human cognition because they require attention to multiple positions. In this study, we developed VR training that applies a moderate attentional load and raises it step by step with the aim of improving multitasking ability by extending human effective attentional resources. The results of the validation test showed a 10 20% improvement in test task performance , confirming that the amount of tasks that can be handled and the speed of response to tasks increased. In addition, it was confirmed that switching of attention became more efficient, reducing the amount of attentional resources that were being wasted.

CCS Concepts

• ***Human-centered computing*** → ***Empirical studies in HCI; Virtual reality;***

1. Introduction

In recent years, research in the field of body augmentation has progressed, with the development of extended limbs that use robotics and other technologies to add new parts to the human body and improve physical functions. For example, there is a "third arm" [IWI16]. However, when multitasking with the human innate body and the extended body, it is necessary to pay attention to both of them, and the number of objects to which attention is directed increases, resulting in a significant cognitive load. Furthermore, because of the limitations of human attentional resources that are inherent in humans and are consumed when attention is directed to something [Cow01] [KAH73], it is difficult to give sufficient attention to both the innate body and the extended limb, which rather leads to a decrease in work efficiency.

To solve this problem, this study developed VR training system (Figure 1) aimed at extending the effective attentional resources that are usable area of user's attentional resources. The research conducted by Nass and colleagues at Stanford University suggested that excessive attentional load caused by heavy multitasking has a negative cognitive impact [ONW09]. In contrast, we hypothesized that moderate-intensity training, like muscle training, would improve effective attentional resources.

2. Experiment

In this study, we constructed a training stage to extend effective attentional resources using graded attentional load and a test stage to evaluate the amount of effective attentional resources.

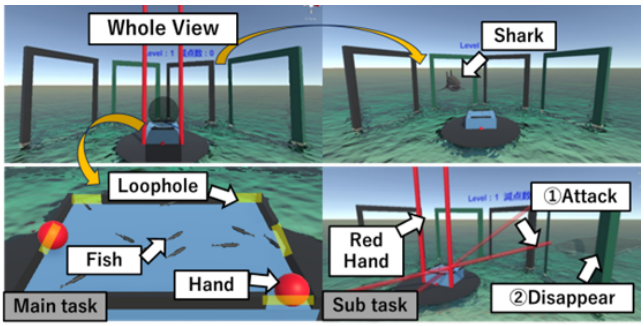

Figure 1: *Overview of training stage*

2.1. Setup

10 participants took part in this study with VR experience ranged from 0 to 3 years. In this experiment, subjects are required to wear VR headset and sit in the chair(Figure 1). Subjects will do 2-minute training stage six times and test stage before and after training stage.

2.2. Training stage

In this stage, we aim to extend the effective attentional resources by applying an appropriate attentional load commensurate with the subject's attentional capacity and then gradually increasing that load. This stage was composed of a main task that requires a certain

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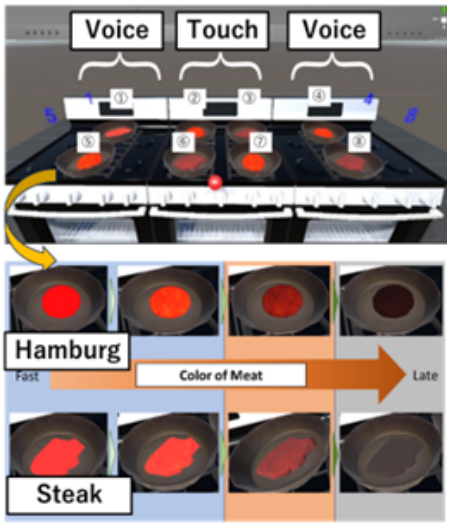

Figure 2: *Overview of test stage*

amount of attention at a certain difficulty level and a subtask that increases in difficulty and requires an increasing amount of attention (Figure 1). The main task was to monitor 10 small fish moving randomly around in a cage, and to prevent them from escaping by closing the six gaps in the cage with their own hands. The subtask is to fight off sharks that attack through the four windows at the back of the room. In this system, sharks attack from random windows at random times. Subjects must defeat these sharks by manipulating a red rod mounted on their shoulders in the VR space. The additional arm is manipulated by simply instructing the subject with a voice to position the shark and the action of knocking it down, which causes the additional arm to fall toward the window and repel the shark. The difficulty level of this subtask increases as the location and frequency of shark attacks increase.

2.3. Test Stage

In this stage, the amount of effective attentional resources of a subject is evaluated indirectly by calculating the number of tasks that the subject could not handle when a large number of tasks that the subject could not handle were imposed on the subject and by comparing these results. The task in this stage was to monitor hamburgers placed in eight locations and flip them over when they turned the appropriate color (Figure 2). The color of the hamburger gradually changes from bright red to black over time. The subject must notice the color of the hamburger as soon as it reaches the third stage and flip it over to return it to the color of the first stage. The method of flipping the hamburgers is simple: the four hamburgers in the front are touched by hand, and the four hamburgers on the outside are instructed by voice, as in "flip the number -".

3. Result and Discussion

Figure 3 shows the change in the error time, which represents the number of tasks that the subject could not handle, for the 10 subjects before and after the training. Comparing the error time before and after training, the error time before training was 160.4 [s] and after training was 138.1 [s], showing a significant decrease of approximately 14%. Even the person with the smallest decrease showed a decrease of approximately 10%, indicating a decrease in all participants. this result suggests that the training developed in this study increased the number of tasks that can be handled, i.e., extended the effective attention resources.

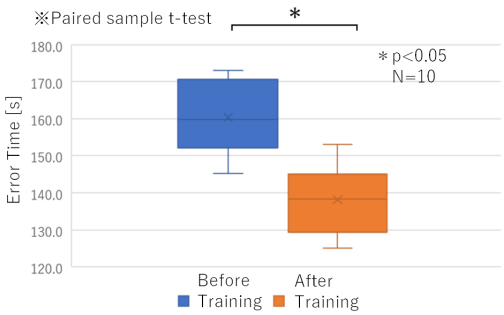

Figure 3: *Changes in error time*

And we could see the changes in the numeber of facial movement in some subject. The entire task cannot be visible simultaneously in this stage. Therefore, the movement of the facial direction in this test indicates the number of times attention is switched in the left-right direction, and that changes might suggest that the training system devloped in this study can improve attention switching ability.

4. Conclusion

In this study, we developed an attentional overload training stage in which subjects are subjected to an appropriate attentional load, which is raised in stages, and a test stage to verify the effectiveness of the training stage. The results showed that the number of tasks that could not be handled was significantly reduced before and after the training, confirming that the training stage expanded the effective attentional resources, and suggested that training stage can improve attention switching ability. We will gather more subjects and analyze the factor of expansion of attentional resources.

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