

Psychological Effects of an Art Program with Feed Back Systems Reflecting Achievement Levels in Rehabilitation Exercises

- Development of a VR Device Encouraging Squatting Movements -

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Abstract

We developed an art program that connects rehabilitation exercises with the creation of art. The quality and level of rehabilitation exercise achieved in the outcome of the resulting artwork is reflected as feedback to encourage patients to perform their rehabilitation exercises. The art program is called “Let’s stand up and draw art in the sky!” and utilizes a virtual reality (VR) head-mounted display device to create a landscape image in the device’s display area, through the movements of sitting down and standing up. To replicate the rehabilitation movement of standing then sitting on a chair, a squat exercise experiment was conducted with and without the art program, using university student subjects, and the results were compared between the two trials. When the subjects used the program they reported a significant increase in the "Level of Vitality" and the "Level of Pleasure", compared to when they performed the exercises without the art program.

Keywords: Virtual Reality, Rehabilitation, Art Program, Feed Back, Psychological Effect, Active Art

Sustaining patient motivation to perform simple and repetitive exercises is a problem in rehabilitation aimed at the recovery of physical function [Note 1]. In recent years, game-based rehabilitation devices have become available, but they merely give movement instructions or display the number of movements performed [Note 2, 3]. In this research, to encourage patients to perform their rehabilitation exercises, we developed a collection of art programs, generally referred to as the “Active art rehabilitation program” (patent pending), that connects rehabilitation exercises with the creation of art and reflects the quality and level of rehabilitation exercise achieved in the outcome of the resulting artwork as feedback.

Literature Review

Previous studies of "Active Art" programs that make art works by touching a computer touch panel and squeezing a rubber air pump showed effects of improved mood and rehabilitation assistance [Note 4-6]. These previous programs are expected to help maintain patients' motivation towards performing simple and repetitive rehabilitation exercises through the psychological effects of art, which occur when patients interact with art and the human senses are stimulated as a result of the interaction, and through the creative work of art making.

In this research, an art program called "Let's stand up and draw art in the sky!," which included sitting-down and standing-up movements, was developed to create a rehabilitation device. The purpose of this research was to maintain patients' enthusiasm and motivation towards performing simple and repetitive rehabilitation exercises and to promote the recovery of the patients' physical functions.

Importance of Sitting Down and Standing Up Movements

Sitting down and standing up are extremely important locomotive movements related to standing and walking in everyday life. In rehabilitation exercises, these training movements are used to strengthen a patient's lower limb muscles and are used in balance training. They are used in various rehabilitation programs intended to improve functional impairment caused, for example, by post-stroke motor paralysis. The program can also be used in squat exercises to prevent the need for care in the elderly [Note 7].

The "Let's stand up and draw art in the sky!" program

A virtual reality head-mounted display device (Oculus Rift) was used to execute the "Let's stand up and draw art in the sky!" program and to create a landscape image in the device's display area through the movements of sitting down in a chair and standing up.

Program Design

(1) Evaluation of Achievement Levels and Feedback

The maximum amount of exercise (target number of sitting-down and standing-up movements) to be performed by the patient was chosen as the evaluation criterion. The amount of exercise (number of sitting-down and standing-up movements) performed by the

patient during the program was evaluated by using the evaluation criterion, and the level of achievement was reflected in the outcome of the resulting artwork as feedback. In this program, the patient was required to finish a piece of artwork after 30 or 50 standing-up movements. Achievement was evaluated in three levels in the program of 30 standing-up movements and in five levels in the program of 50 standing-up movements.

(2) Projected Images

The wearer of the virtual reality head-mounted display device was shown underwater scenes when sitting down and scenes from above the water when standing up. In the case of the above-water scenes, puzzle image pieces of scenes—for example, of World Heritage Sites—were added to the device’s display area in an orderly manner or the content (number of pixels and colors) of each puzzle piece was changed when the wearer of the device stood up (Figures 1 & 2). The program also involved a creative element: the scenic image created in relation to the level of rehabilitation exercise achieved by the patient could be printed out on a postcard sized artwork and taken home as a reward of the rehabilitation exercises performed. At the beginning of the program, the patient was able to choose, from among five types, the theme of the scenic image they wished to create.

(3) Design Factors Related to Motivation

Because the image appearing on the display area changed with the patient’s sitting-down and standing-up movements, the patient was able to visually acknowledge their movements. After each 10th standing-up movement, the patient heard a cheering voice telling them to “Keep up the good work!” The level of rehabilitation exercise achieved was reflected in the outcome of the resulting artwork as feedback.

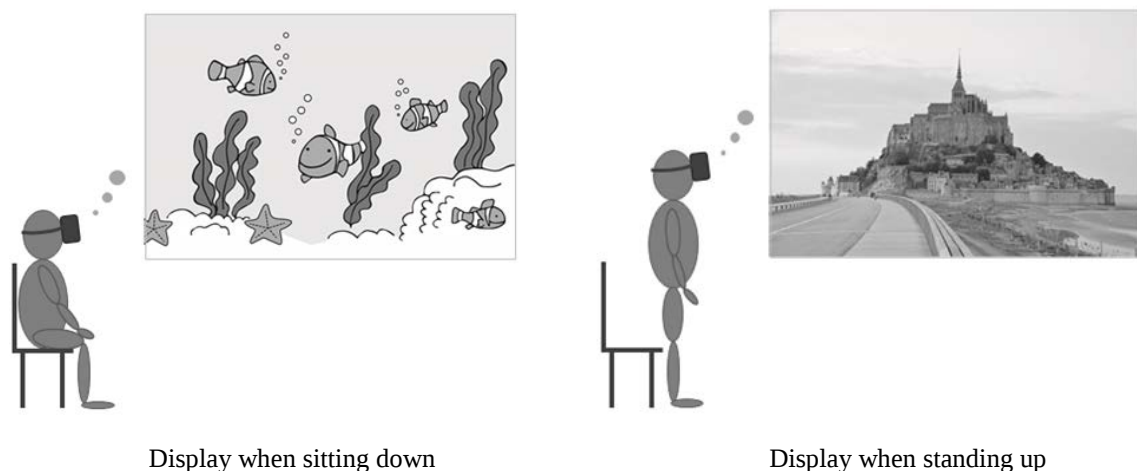
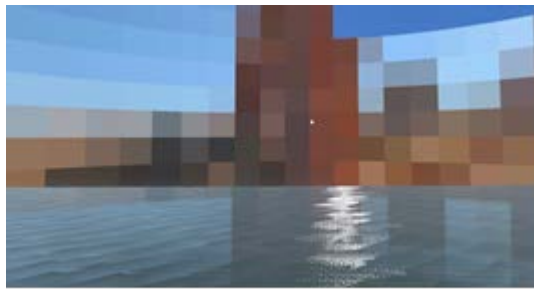
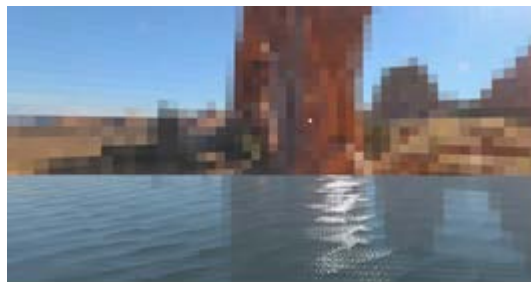


Fig. 1 “Let’s stand up and draw art in the sky!” Program



Movements 1 to 10, of a 30 Movement Program:
Addition of part images with coarse mosaics whenever subject stands up



Movements 11 to 20, of a 30 Movement Program:
Change to detailed images of fine mosaics whenever subject stands up



Movements 21 to 30, of a 30 Movement Program:
Change to part of the images seen clearly without mosaics whenever subject stands up

Fig. 2 Images of Feedback Reflecting Achievement Levels in Rehabilitation Exercises

Psychological Evaluation of the “Let’s stand up and draw art in the sky!” Program

Methods

Participants were twelve healthy university students (Ages: 18 to 28 years; male, 3, female, 9.) A set of 30 squats with the art program and a set of 30 squats without the art program were

performed in random order with a few days break between set. A psychological evaluation using the two-dimensional mood scale – short term (TDMS-ST) was performed before and after each set of squat exercises [Note 8].

Results

Scores for “Level of Vitality,” “Level of Stability,” “Level of Pleasure,” and “Level of Arousal” with and without the art program, and before and after the squat exercises were tested by using a two-factor two-level analysis of variance. For “Level of Vitality”, a significant difference was found between with and without the art program ($F(1, 11)=5.77$, $p<0.04$) and before and after the squat exercises ($F(1, 11)=12.92$, $p<0.004$; Figure 3). For “Level of Pleasure”, a significant difference was found between with and without the art program ($F(1, 11)=4.97$, $p<0.05$; Figure 5). For “Level of Arousal”, a significant difference was found between before and after the squat exercises ($F(1, 11)=9.59$, $p<0.01$; Figure 6).

The results showed an increase in the scores for “Level of Vitality” and “Level of Arousal” after the squat exercises. In addition, when the squat exercises were performed with the art program, the scores for “Level of Vitality” and “Level of Pleasure” were higher than the scores for the squat exercises performed without the art program.

“Level of Pleasure” showed an interaction effect ($F(1, 11)=5.82$, $p<0.03$), and the simple main effect test found a significant difference ($F(1, 11)=10.58$, $p<0.004$) between the evaluation done after the squat exercises with the art program and the one done after the squat exercises without the art program.

Analysis of the participants’ mood after squat exercises performed with and without the art program revealed a higher score for “Level of Pleasure” when they exercised with the art program.

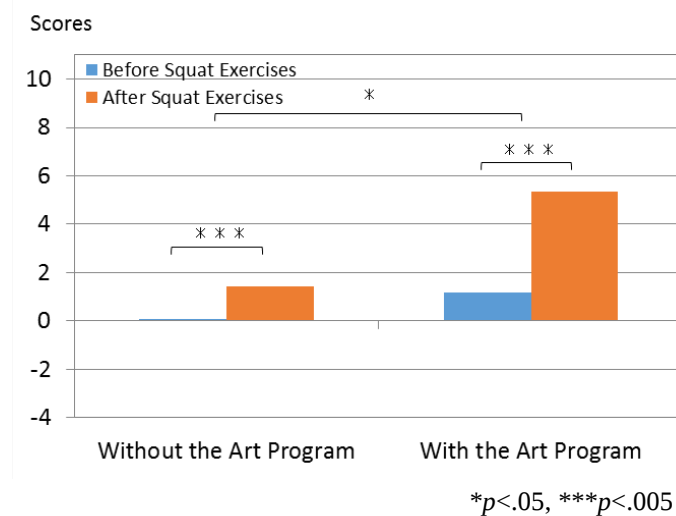


Fig. 3 Comparison of scores for “Level of Vitality”

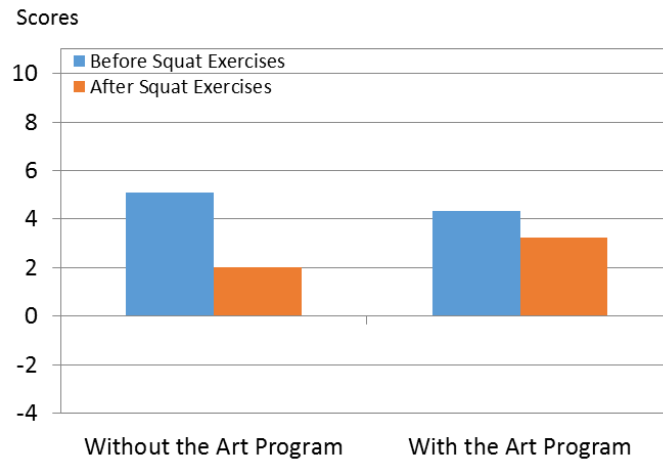


Fig. 4 Comparison of scores for “Level of Stability”

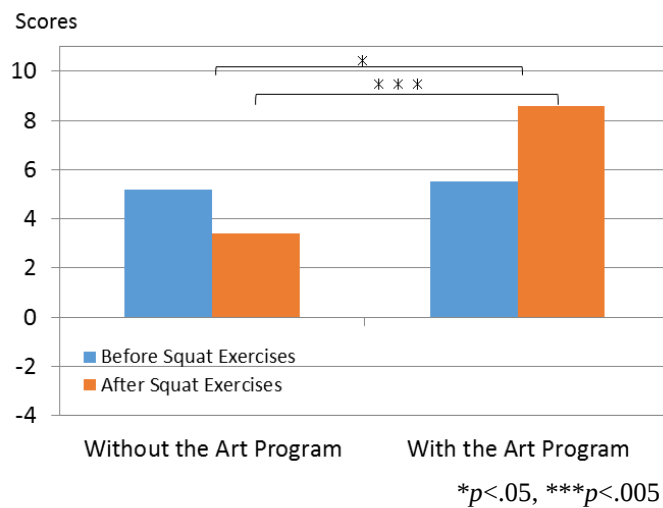


Fig. 5 Comparison of scores for “Level of Pleasure”

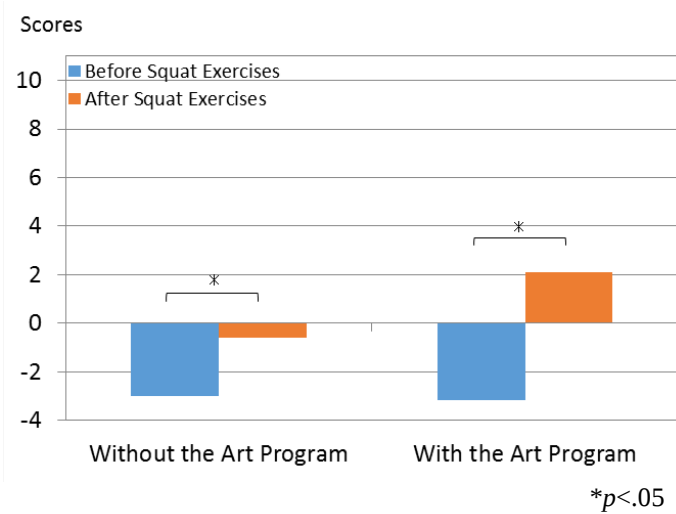


Fig. 6 Comparison of scores for “Level of Arousal”

Discussion

We conducted a psychological evaluation of the performance of squat exercises with and without using the “Let’s stand up and draw art in the sky!” art program. We found that “Level of Vitality” and “Level of Pleasure” were increased by using the art program, compared with not using it. We confirmed that simple and repetitive squat exercises can be performed with excitement and liveliness in a positive and comfortable mood by using the program. Moreover, the “Level of Pleasure” was increased significantly and participants gained a comfortable and positive feeling by performing squat exercises with the program.

Conclusion

We developed an art program called “Let’s stand up and draw art in the sky!” which gives feedback on the levels of rehabilitation exercise achieved by patients. When the squat exercises were performed with the art program, the scores for “Level of Vitality” and “Level of Pleasure” were higher than the scores for the squat exercises performed without the art program. The participants’ “Level of Pleasure” increased significantly when the program was used with the performance of squat exercises. Presently, the program is being implemented and evaluated in a recovery-phase rehabilitation hospital. The program is expected to help patients to maintain their motivation and to become actively involved in performing simple and repetitive rehabilitation exercises.

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Author Biography

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Kiyomi YOSHIOKA received a PhD of Design Science from the University of Tsukuba. She has been an associate professor of the Department of Design, Meisei University from 2014. Her research areas are Affective Design, Design Thinking, Medical and Welfare Design, and Implementation of Art & Design Workshop. Medical Welfare Design helps maintain motivation for rehabilitation. The Art & Design Work Shop Program aims to improve patients' rehabilitation and quality of life (QOL). She is engaged in research of 'Active Art Rehabilitation Programs', and is a member of the International Association for Universal Design, the Japanese Society for the Science of Design (JSSD), and the Japan Society of Kansei Engineering (JSKE).