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The effect of cognitive dance therapy as dementia prevention

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Abstract

Background: Regarding dementia prevention, as it has been reported that the volume of the hippocampus increases with continuous dancing and that dancers' gray matter increases, dancing and recognition tasks have been combined and developed into brain training. We equipped a robot with dance therapy and a cognitive evaluation scale, the results of which we will exam as the focus of this study.

Methods: Comparison of the results of cognitive evaluation tests before and after seven weeks of continuous cognitive dance therapy once a week. The cognitive evaluation test utilized was the cognitive test used by the National Police Agency for the renewal of elderly person's licenses. Moreover, we surveyed the psychological condition of participants after robot therapy.

Results: Of the 72 registrants, with no missing values data of 53 people was analyzed with paired t-test. The mean age was 70.7±5.9 years old, the average score for the cognitive test prior to intervention was 87.3 points. After seven weeks of intervention, the average score was 94.3 points, a significant increase (p<0.01). Next, the average score of the robot therapy satisfaction level was as high as 4.73 out of 5 points. In the comments section, there were in descending order comments such as being happy, healing, clarity of the mind, facilitation of social interactions, et cetera.

Conclusion: Cognitive dance therapy improves cognitive ability. Remembering songs and choreography together with music is indeed easy and effective. Additionally, with the combined effects of the results from robot psychological healing, it was shown that both the mind and body of older people are revitalized.

Keywords: dance, cognitive function, psychological factors, therapy

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Introduction

With regards to the prevention of dementia, the effects of aerobic exercise are well known [1,2], but a lot of motivation is necessary to continually do aerobic exercise every day [3,4]. For that reason, we surveyed the possibility of continuously doing various aerobic exercises, selected dance for its continuity [5,6]. Dance does not only improve one's physical ability in terms of one's ability to move or walk [7,8], it improves one's mental health and prevents stress [5,9].

Furthermore, regarding the effects of dance on the brain, dancers have an amount of gray matter and with continued dancing, the volume of hippocampus increases [10,11], with six weeks of balance training, there is evidence of increased gray matter [12]. For this reason, we developed brain training which combines dance with cognitive recognition tasks. For the pre-test, we compared a group that danced with a group that did not dance and found that cognitive ability improved and stress decreased [5,6]. Additionally, we equipped a robot with dance therapy, making it possible to assign dance and cognitive tasks.

The background for this request is the aging of populations has continued on a global scale, and there has been an insufficient supply of nursing professionals as a result. Robots have the potential to respond to this demand by fulfilling ever-important roles in the field of nursing [13]. While the field of nursing and caregiver robots has seen advances at a rapid pace, there has been insufficient research as to the psychological effects of robot therapy. What we expect from robot therapy goes beyond satisfying the demand for the caregiver. Robots can be used to mitigate stress [14], deter dementia and depression and aid in therapeutic exercises, thus providing large benefits to the elderly, their family and health-care providers.

Furthermore, in preliminary testing, we examined delayed playback task and the validity of dual-task [15,16], and developed cognitive-dance therapy to add delayed playback task and dual task as part of brain training [5]. If robots are able to perform health-care functions as outlined above, the societal benefits would be enormous. We thus equipped robots with brain training functions such as cognitive dance therapy. Furthermore, to measure dementia we built in the Revised Hasegawa Dementia Scale (HDS-R) [17], and to measure mild cognitive impairment we added a cognitive evaluation scale for driver's licenses [18], allowing the robot to detect the results of treatment and continuously understand changes in cognitive function. The primary objectives of this research are verification of cognitive dance therapy, and understanding how robot therapy affects treatment recipients.

Methods

Method of participant recruitment

Applicants were registered by public offering. Not having dementia, and being able to take a test on their own without assistance. The implementation period was between October 2018 – February 2019.

Ethical consideration

The outline of the research, voluntary nature of participation, anonymity, and agreement regarding the publication of the document were explained to prospective participants both in writing and verbally, and their consent was subsequently obtained. This study was conducted in accordance with the Declaration of Helsinki and the study protocol was approved by the ethical review board of Nara Medical University.

Comparison of the before and after effects of cognitive dance therapy in order to program the robot. Method of cognitive dance therapy: 1. memorize ten words; 2. practice a choreography assignment; 3. reproduce ten words; 4. reproduce the choreography assignment; 5. sing while dancing; 6. reproduce remembered lyrics.

In this way, we alternatingly repeat memory assignments and dancing, with all participants supporting each other as they reproduce memory assignments.

Cognitive dance therapy is practiced once a week for 90 minutes, administering a cognitive test before and after seven weeks of therapy, comparing them by the paired t-test.

For the cognitive test, the cognitive evaluation scale for the National Police Agency of driver's licenses was used. The test used the following three tasks to decide test subjects' memory and cognitive ability.

1. Date, day, and time-oriented tasks

2. Delayed playback tasks

3. Clock-drawing tasks

The standard values for test scores were determined based on the following:

1. Normal: 76 points or more

2. Mild cognitive decline: above 49 points, up to 76 points

3. Cognitive decline: up to and below 49 points

The robots were communication robots and primarily intervened through conversation and cognitive dance therapy (Figure 1). We performed a questionnaire of elderly people who have undergone robot therapy. The satisfaction was measured using a 5-point Likert scale and included a free-form qualitative section.

From now on, remember the brain training task I

Figure 1. Conversation and cognitive dance therapy by robots.

Results

Of the 72 registrants, with no missing values, the data of 53 people was analyzed with the paired t-test. The mean age was 70.7±5.9 years old, 4 of whom were men, 49 of whom were women. Regarding cognitive test results, total test scores surpassed the cutoff of 76 points even prior to intervention, with the average score being 87.3 points. After seven weeks of intervention, the average score was 94.3 points, a substantial increase (p<0.01). In regards to before and after comparisons of scores for each test subject, delayed playback task (p<0.01) and clock-drawing (p<0.05) improved substantially (Table 1).

Table 1. Cognitive test scores

	Cognitive test tasks			
	Orientation tasks	Delayed playback tasks	Clock-drawing tasks	Total test scores
Before intervention	17.1	49.5	20.3	86.9
After intervention	17.2	56.2	20.7	94.1
p*	0.709	0.000	0.031	0.000

*Paired sample t-test

Next, we analyzed satisfaction levels before and after robot therapy based on the data of 43 people with no missing values. The average score of the robot therapy satisfaction level is as high as 4.73 out of 5 points. In the free-form qualitative section, 43 people write that they are feeling pleasure, 42 write that it is good for brain activation, psychologically healing (41), promotes interactions (32), feeling excited (21), eases the atmosphere (17), in multiple answers (Figure 2).
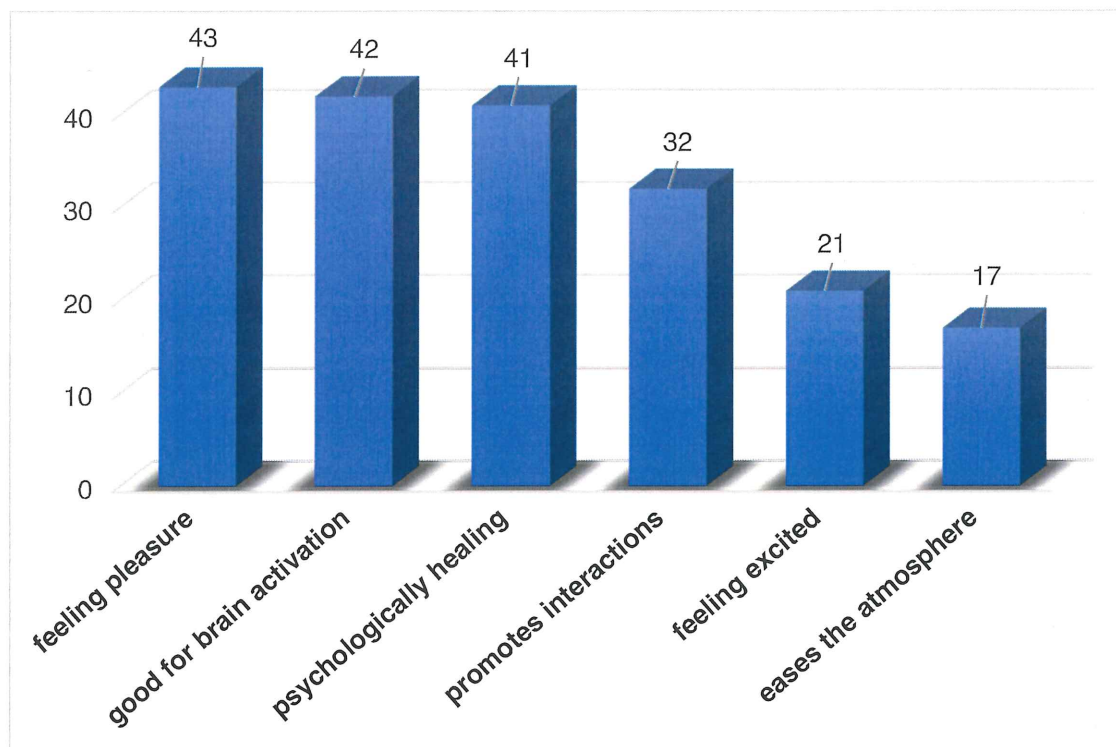

Figure 2. Content of the free-form questionnaire.

Discussion

As a method of cognitive training to maintain the cognitive ability is verified that dual-task (practicing two tasks simultaneously) [20,21] and n-back task (to delay recall the nth time task) [22] is efficient. About the dual-task, in order to achieve the two tasks at the same time, it is necessary for the function of the frontal lobe that has prefrontal cortex as the center [23], and this thought that this leads to the training of the frontal lobe. In fact, it is verified from the examination that used the brain wave or the near-infrared spectroscopy that the frontal lobe became activated [24,25]. As for the n-back subject, the fact that was introduced by Wayne Kirchner in 1958, which states that even though it is a test of temporary memory, not only as an assessment test [26], but also it became clear that there is an effect of improvement in memorization and began to be used as a method for cognitive training. Facts such as the improvement of fluid intelligence [27], the increase in the density of dopamine [28], and according to the meta-analysis, the frontal lobe and the activation of the area of the parietal cortex have been verified [22].

In examining methods for effectively conducting cognitive training such as this, we can say that dance choreography is a natural dual task. Furthermore, we also incorporated remembering choreography and lyrics afterward. Additionally, in order to improve memorization ability, we added 10-word memory tasks. Looking at the before and after comparison for this study, we can see substantial improvement in cognitive scores. The big improvement regarding delayed playback task is especially significant. In our daily lives, we maintain memories temporarily, such as continuation of conversations, shopping and housework, and we act based on those.

This daily, essential temporary storage of memories is called a "Working memory" and research into improving this ability is advancing [28,29]. Language memory, visual-spatial recognition, et cetera are the foci of such training [30], which is also true of our methods. However, what can be particularly noted is that the ability to combine music with natural movement and be able to train effortlessly is a special feature of our training method.

The method is to repeat the short term of musical phrases and the choreography several times and make target people reconstruct their memories after the cognitive-dance. Moreover, we change the choreography during the music and after that, we conducted delayed recall. This has the characteristic that by memorizing along with the music, we can easily memorize and recall the phrases or the movements.

In fact, the relevance between music and memorization is known [31], that music encourages the recollection of memories [32-34], and moreover it promotes the maintenance of the memories [35-37]. Furthermore, music improves the encoding capability of people's memory, which is to recognize the lyrics [38]. Lyrics indicated by songs can be remembered much better than clauses indicated by speech [39].

Furthermore, for implementing these by robots, we were able to confirm a high degree of satisfaction with regards to health-care intervention by robots. As per our qualitative analysis, the biggest reason for this was those feelings such as "feeling pleasure", followed by "good for brain activation", "psychologically healing" improved. Our communication robot was originally built with the goal of having positive psychological effects, and by adding brain training functions we were able to achieve not only pleasant feelings but also the increase of recollection ability, which constitute significant results.

As the result of using a communication robot created for the purpose of psychological healing for brain training, not only memory ability is improved but also there is a significant effect which makes participants' feeling more comfortable. Because stress and cognitive performance were correlated in our pre-test, (p <0.05) [6], our objective was to conduct the brain training without making participants' feel stress, and we achieved this objective. Furthermore, since the effects of promoting exchanges among participants and easing the atmosphere were observed, the robot played an important role in creating a positive atmosphere.

In this type of intervention, it is important to create an appropriate atmosphere for things to go smoother. The fact that the robot can ease the atmosphere is found to be significant. Furthermore, since participants are gaining pleasure and excitement, the robots can be used for preventing depression or relieving stress for the future. Also, the brain activation effect is very significant, and it has been verified that such subjectivity has an effect on not developing dementia [40] or depression [41]. It has also been reported that subjective youthfulness can reduce the risk of developing dementia [42] and the improve ability to perform tasks [43]. We, therefore, aim to develop robot therapy while improving subjective sensations, such as brain activation and the feeling of excitement.

One of our goals was to confirm the psychological effects of robots, specifically the deterioration of stress as well as the uplifting of spirits, which was confirmed in this research. Furthermore, if robots are able to monitor cognitive ability, they will not only be able to detect decreases in cognitive ability early but also be able to respond and adopt preventative measures.

The cognitive screening test we installed was the cognitive evaluation scale for driver's licenses was a test that people over the age of 75 have to pass to renew their license, in which orientation tasks, delayed playback tasks, clock-drawing tasks are featured. Through assigning robots with such screening, it becomes easier to monitor the elderly's cognitive function in their home and facilities, allowing for a more systematic approach to dementia prevention. It would thus be ideal if robots can be used to mitigate stress and prevent depression through therapeutic exercises such as dance [5] and brain training [15,16]. Furthermore, we also found that intervention by robots fostered exchanges among participants and created a harmonious atmosphere. Interpersonal connections impact depression and stress [44], and interpersonal exchanges promote a daily sense of reassurance [45], contributing to the health and well-being of the elderly [46]. Furthermore, these senses of health and well-being have a significant impact on healthy longevity [47].

Following the above, to increase the positive psychological effects due to robot therapy to its highest possible level, the robots' appearance, facial expressions and patterns of speech can be further improved, making them more easily approachable and friendly. We will develop this technique so that robots facilitate interpersonal communication among the elderly and give life a pleasure and vibrancy.

Conclusion

Cognitive dance therapy improves cognitive abilities, among which the delayed playback task has been improved the most. Remembering songs and choreography together with music is easy and can be continued on a daily basis. With the combined effects of the results from robot psychological healing, it could be confirmed that both the mind and body of older people are revitalized.

Conflict of interest

All authors declare that they have no conflict of interest.

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