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Effect of Presentation of Target on the Physical Performance in Healthy Subjects: A Preliminary Study

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Abstract

Purpose: This study investigates the effect of presenting the target as an intrinsic reward on the physical performance of healthy subjects.

Methods: Fifteen healthy people (62.9 ± 11.6 years old, mean ± standard deviation; 6 females and 9 males) were enrolled in this study. The task for physical performance was the Functional Reach Test, and participants performed the pre- and post-test. Participants were assigned randomly to a Control group, a High Target group (HT group) or Low Target group (LT group). In the control group, participants received feedback about each result and encouragement. In the HT group, participants received feedback about each result and were presented a target score that increased the result by 20%. In the LT group, participants received feedback about each result and were presented the target score that decreased the result by 20%.

Results: The main effect of group was no significance (p=0.88). The main effect of time was significant (p=0.011). The group × time interaction was no significance (p=0.13). However, distance of reach had a tendency to more increase at post-test in HT group as compared with other groups.

Conclusion: The results of this preliminary study indicate that physical performance in healthy people improved by presenting a set target, as well as feedback of the result. In particular, the results showed that a high target slightly beyond each result was more desirable than a low target. Together, our results suggest that the presentation of a set target as an intrinsic reward may improve physical performance and motivation.

Keywords: Extrinsic reward; Intrinsic reward; Physical performance; motivation

Introduction

Reward is important in the rehabilitation process. The integration of reward into behavior occurs where reward-related neural signals meet circuits concerned with motor performance. Several neuroimaging studies [1-4] have demonstrated that cortico-basal ganglia (striatum and putamen) circuits play a critical role in motor performance and learning. In the basal ganglia, cortical signals are integrated with reward error signals carried by Dopamine neurons in striatal projection neurons [5,6]. The striatum receives inputs from all regions of the cerebral cortex and parts of the thalamus. These excitatory glutamatergic inputs converge with dopamine inputs from the substantia nigra in the striatum. The output of the striatum influences other basal ganglia nuclei, which through direct and indirect pathways; reach the thalamus and thus, the motor regions of the cerebral cortex. Based on these studies, reinforcement of learning by reward was reported [7,8].

The results of several recent human studies [6,9,10] using neuroimaging devices have suggested that cortico-basal ganglia circuits are activated by extrinsic reward (monetary reward), similar to animal studies. Furthermore, some studies [11-13] have investigated whether monetary reward enhances learning, and reported that monetary reward provides benefits for cognitive and motor learning. However, some studies [14,15] have shown that extrinsic reward can undermine a person's intrinsic motivation to engage in a task ("undermining effect"). Furthermore, by neuroimaging research, hypoactivity of the basal ganglia has been reported in the undermining effect [16].

On the other hand, intrinsic reward through an interest in the task and a sense of accomplishment to a set target is important in motor learning for humans. Several studies [17,18] reported that the brain regions activated by feedback concerning the degree of achievement to the target or comparison of the result and target as a intrinsic reward was similar to activation by extrinsic reward. Reward is needed to improve the motivation of patients in the rehabilitation process. Particularly, intrinsic reward, which does not generate "undermining effect", is important. However, there is little data in the literature to suggest that presenting a set target as an intrinsic reward improves motivation.

In this paper, we examine the effects of presenting a target as an intrinsic reward on physical performance and motivation in healthy subjects.

Methods

Participants

Fifteen healthy people (62.9 ± 11.6 years, mean ± standard deviation, 6 females, 9 males) were enrolled in this study. The study protocol was explained to each participant who then provided informed consent. Participants were randomly assigned to a Control group (n=5, 3 females, 2 males), a High Target group (HT group: n=5,

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2 females, 3 males) or a Low Target group (LT group: n=5, 1 female, 4 males).

Task and procedure

The task of physical performance was the Functional Reach Test (FR test), which measures static balance. Participants stood with their feet a comfortable distance apart and their dominant arm raised to 90° shoulder flexion. They were asked to reach as far forward as possible without overbalancing. Overbalancing was defined as needing to take a step or requiring hands-on assistance to maintain balance. They were allowed to lift their heels during reaching forward. The distance of additional reach was recorded.

All participants performed the FR test 3 times as a pre-test. After the pre-test, participants performed the FR test 3 times as a post-test. Before the post-test, all participants received feedback concerning the distance of reach that they performed in the pre-test, and each group received different targets and encouragement. In the control group, participants were given only encouragement ("Please make the effort to exceed your results of the pre-test") from the therapist. In the HT group, participants were presented with a high target score that was increased by 20% over the average result of the pre-test. Participants in the HT group were also provided encouragement ("Please make the effort to exceed the target score") from the therapist. In the LT group, participants were presented with a low target score that was decreased by 20% from the average result of the pre-test. Participants in the LT group were also given encouragement ("Please make more effort") from the therapist. A high or low target score was presented as an average score of people of same age in each participant

Statistical analysis

A repeated-measure 2 way ANOVA with factors group (control/HT/LT) and time (pre/post) on distance of reach was performed. A p value less than 5% was considered statistically significant.

Results

At pre-test, the mean (mean ± standard deviation) distance of reach was 31.43 ± 4.80 cm in the Control group, 33.37 ± 5.18 cm in the HT group, and 33.73 ± 9.13 cm in the LT group. At post-test, distance of reach was 33.70 ± 4.73 cm in the Control group, 36.83 ± 5.75 cm in the HT group, and 34.23 ± 9.62 cm in the LT group (Figure 1).

The main effect of group was not significant (p=0.88). The main effect of time was significant (p=.011). The group × time interaction was not significant (p=0.13). However, distance of reach had a tendency to more increase at post-test in HT group as compared with other groups.

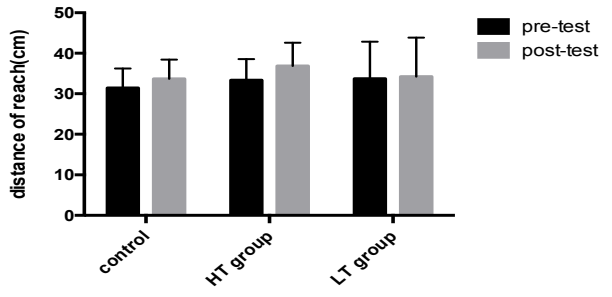

Figure 1: Effect of FR test on each group
※ HT group: High Target group, LT group: Low Target group
※ Error bar: Standard Deviation

Discussion

The results of this preliminary study indicate that physical performance in healthy subjects improved by presenting a set target, as well as feedback. In particular, it was found that a high target slightly greater than each result was more effective than a low target.

A previous study by Dobkin et al. [19] demonstrated that feedback of each result and encouragement from the therapist for daily walking training improves the walking speed in stroke patients. From this finding, the feedback of result and encouragement is thought to be able to substitute for monetary reward as a reinforcement factor to improve physical performance. Actually, Izuma et al. [20] reported that an activation of the basal ganglia was obtained by social reward such as the trust from others, and this was similar to the activation obtained by monetary reward. Furthermore, in the present study, we presented a set target only without the feedback and encouragement. In the psychological classical [21,22] and recent research [23], it is found that feedback has an influence on the physical performance and motor learning. Our study indicates that setting a target as compared with the people of same age improves the intrinsic motivation more than feedback. We believe that this improvement was mediated by reinforcement through the activation of the cortico-basal ganglia circuits.

However, Lewthwaite et al. [24] investigated the effect of presenting a high and low target of each result in balance learning in the young adults. They reported that the group presented the low target showed significant learning effect over that of the group presented the high target. The discrepancy between their results and ours may be due to the difference in age of the participants between the studies.

Recently, external reward has been shown to influence motor performance and learning based on results of animal and human studies. However, from classic psychological [14] and neuroimaging research [15,16], the motivation improvement by external reward initiates the undermining effect. Although improvement of the motivation of patients is important for effective rehabilitation, it is insufficient using external reward only. Together, our results suggest that presenting a set target as an intrinsic reward is necessary for the improvement of physical performance and motivation. However, this study examines a small sample size and healthy participants. Future studies should solve these limitations and advance investigation using brain imaging devices.

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