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Original Article

Specialization in interlimb transfer between dominant and non-dominant hand skills

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Abstract. [Purpose] This study aimed to confirm the specialization of interlimb transfer in occupationally embedded tasks between dominant and non-dominant hands. [Subjects] Twelve neurologically intact participants were recruited. [Methods] The participants were divided into two training groups and performed training with their dominant or non-dominant hand. Three subtests of the Jebsen-Taylor Hand Function Test were used to practice interlimb transfer training in each group. All Jebsen-Taylor Hand Function Test subtests were evaluated using the untrained hand before and after 5 days of training. [Results] The dominant hand group showed significant differences after training when using the untrained hand in the simulated feeding and lifting large heavy objects subtests. Meanwhile, the non-dominant hand group showed significant differences after training when using the untrained hand in the turning cards, simulated feeding, stacking checkers, and lifting large heavy objects subtests. [Conclusion] When performing occupationally embedded tasks, the dominant hand has interlimb transfer advantages with respect to predictable dynamic movements, while the non-dominant hand has interlimb transfer advantages in stabilization.

Key words: Dominant arm, Interlimb transfer, Specialization

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INTRODUCTION

"Interlimb transfer" is an interesting phenomenon in stroke rehabilitation in which the untrained hand benefits from practice with the opposite hand[1]. Thus, interlimb transfer learning could be applied as a paradigm for the recovery of related functional lateralization. This phenomenon demonstrates that the corpus callosum plays a role in connecting neural pathways between brain hemispheres through interhemispheric communication. However, the major changes in motor output systems after unilateral motor practice remain unclear[2, 3]. Wang and Sainburg (2007) demonstrate that the non-dominant arm can be conditioned for the final position of arm reaching movement4). Conversely, the dominant arm can be trained for trajectory accuracy in the acceleration phase of reaching motion. Thus, the advantages of dominant and non-dominant arm performance in daily tasks can be evaluated. Each side of the body attains different amplitudes of movements in targeted single-joint tasks, such as speed, accuracy, and acceleration parameters; this also demonstrates the lateralization of this phenomenon[4, 5]. Individuals afflicted by unilateral impairment are treated by occupational therapists, whose main goal is to train and retrain patients to perform motor tasks in order to enhance their functional abilities in daily life[6]. The ultimate aim of stroke rehabilitation is to enable independent functioning in daily life. Accordingly, a previous study compared to the interlimb transfer specialization during a simple reaching movement[7]. Thus, the present study aimed to confirm interlimb transfer specialization of occupationally embedded tasks between dominant and non-dominant hands.

SUBJECTS AND METHODS

Twelve neurologically intact subjects (mean age: 20.61 ± 0.77 years) were recruited. They received an explanation about the purpose and methods of the study and provided informed consent prior to participation in accordance with the ethical principles of the Declaration of Helsinki. The participants had no orthopedic diseases, and the right hand was determined to be dominant through interviews. Participants practiced training conditions with their dominant and non-dominant hands and were randomly divided into the dominant or non-dominant training group (n = 6 each); the evaluator was not blinded to the experiment. We used three subtests of the Jebsen-Taylor Hand Function Test (JHFT) to practice interlimb transfer in each group: lifting small objects, simulated feeding, and lifting large heavy objects. After the baseline evaluation, each group practiced the three subtest tasks using one hand. After 30-minute training sessions for 5 days, all JHFT subtests were performed using the opposite hand. This evaluation tool was used as a primary measure of the untrained hand. The JHFT is generally used for hand and dexterity assessment in the performance of everyday skills; it has good validity and reliability, and

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Table 1. Interlimb transfer in the dominant hand training group (*n* = 6) (Units: seconds)

JHFT Subtests	Non-dominant hand (mean ± SD)	
	Pre-training	Post-training
Writing a letter	16.63 ± 6.29	14.52 ± 1.66
Turning a card	3.54 ± 0.91	2.82 ± 0.33
Lifting small objects	6.34 ± 0.84	5.15 ± 1.04
Stacking checkers	1.82 ± 0.46	1.56 ± 0.45
Simulated feeding	8.46 ± 2.29	5.58 ± 0.55*
Lifting large light objects	3.25 ± 0.44	2.79 ± 0.30
Lifting large heavy objects	3.41 ± 0.34	2.67 ± 0.18*

*: $p < 0.05$

Table 2. Interlimb transfer in the non-dominant hand training group (*n* = 6) (Units: seconds)

JHFT Subtests	Dominant hand (mean ± SD)	
	Pre-training	Post-training
Writing a letter	7.37 ± 0.87	7.35 ± 0.63
Turning a card	2.97 ± 0.44	2.66 ± 0.29*
Lifting small objects	5.80 ± 0.68	5.73 ± 1.34
Stacking checkers	2.10 ± 0.74	1.52 ± 0.53*
Simulated feeding	7.98 ± 2.31	4.92 ± 0.68*
Lifting large light objects	3.16 ± 0.55	2.61 ± 0.26
Lifting large heavy objects	3.07 ± 0.51	2.59 ± 0.19*

*: $p < 0.05$

very few learning effects (subtests; writing a letter, turning a card, lifting small objects, stacking checkers, simulated feeding, lifting large light objects, and lifting large heavy objects)[7]. Participants were divided into two groups according to which hand was used for training. The dominant hand group performed the three subtests using their non-dominant hand and vice versa to simulate activities of daily living. The training tools were placed at the midline of the body. Each training session was 30 min long. The participants practiced for 5 days over a 1-week period. Parametric analysis was used to summarize individual JHFT ordinal scores. Each JHFT subtest was performed three times, and the best two scores were used to calculate the average pre- and post-training scores. All testing processes were evaluated at the beginning and end of each training session. SPSS version 22.0 (SPSS Inc., Chicago, IL, USA) was used to analyze the interlimb transfer effect between the dominant and non-dominant hands. Because the data were not normally distributed, the non-parametric Wilcoxon signed-rank test was used for intra-group comparisons. The level of significance for all tests was set at $p < 0.05$.

RESULTS

Interlimb transfer during basic tasks was compared between the dominant and non-dominant hand groups. The dominant hand group showed significant differences after training in the simulated feeding and lifting large heavy objects tasks with the untrained hand ($p < 0.05$; Table 1). However, there were no differences in the performance of other tasks (writing a letter, turning cards, lifting small objects, stacking checkers, simulated feeding, and lifting large heavy objects) after training ($p > 0.05$). Meanwhile, the non-dominant hand group showed significant differences after training in turning cards, simulated feeding, stacking checkers, and lifting large heavy objects with the untrained hand ($p < 0.05$; Table 2). However, there were no significant differences in other tasks (writing a letter, lifting small objects, and lifting large heavy objects) after training ($p > 0.05$).

DISCUSSION

According to the interlimb transfer phenomenon, the performance of a required hand skill is likely to be learned by the opposite hand[5, 6]. The present study differed from previous works, which utilized occupationally embedded task training. We performed dominant and non-dominant hand training tests for interlimb transfer specialization and compared the results. The dominant hand generally has superior skills compared to the non-dominant hand. Previous reports indicate the dominant hand utilizes trajectory accuracy control for adaptation to movement. Meanwhile, the non-dominant hand is used for endpoint control to achieve a steady posture. For example, the dominant hand can better perform dynamic tasks such as combing and cutting, while the non-dominant hand is superior for performing stabilizing activities[8–10]. The present study utilized the JHFT, which is frequently used in neuropsychological evaluations of various motor functions. Longer performance times during the task activity indicate awkward and slower movement. The present results support the possibility of specialization in interlimb transfer for each hemisphere after training for occupationally embedded tasks[9, 11]. Task learning transfer is an important aspect of learning theory, and activity generalization is an important aspect of rehabilitation recovery. The goal of rehabilitation in occupational therapy is positive occupation transfer at home and work. In the present study, the results of the dominant hand group in the simulated feeding and lifting large heavy objects subtests differed significantly after training. Meanwhile, the non-dominant hand group showed significant differences in the turning cards, simulated feeding, stacking checkers, and lifting large heavy objects subtests after training. Thus, the present results support the possibility of specialization in interlimb transfer for each hemisphere after training for occupationally embedded tasks[12, 13]. This study has several limitations. Individuals were generally right-handed and were not supervised by a professional therapist. Meanwhile, approximately 60% of stroke patients have left hemisphere damage with ideomotor limb apraxia; therefore, when experiencing moderate-to-severe hemiplegia, they usually use a lead controller for occupationally embedded tasks[14, 15]. Thus, further research aiming to develop novel rehabilitation treatments for patients with hemisphere damage should take these diagnostic variables into consideration.

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