Brief Communication

Effect of cognitive function and physical activity on the ability to learn and reproduce physiotherapy exercises in healthy subjects

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The aim of the study was to examine the effect of physical activity level and cognitive function on the ability of healthy subjects to learn and reproduce exercises taught to them by a physiotherapist. Thirty-one healthy individuals working in different positions in the university hospital participated in our study. Of them, 14 women and 17 men (mean age, 33.96 ± 6.60 years, range: 23-46) were included in the study (**Table 1**). This prospective study was performed in the School of Physical Therapy of Dokuz Eylul University, Izmir, Turkey, between May, and September 2009. All participants were taught the same 5 exercises to increase the range of motion (ROM) of the lower and upper limbs. These included shoulder flexion, elbow flexion, hip flexion, knee extension, and ankle dorsi-flexion exercises, with no weight used. All exercises were repeated 5 times in a seated position. These exercises were chosen because they are relatively simple, involving only one body part moving in a single plane. The subject's exercise recall was assessed using an exercise assessment scale, which included starting position, plane of movement, ROM, compensation, duration/speed of movement, repetition, and frequency of each exercise. Receiving high grades from exercise assessment shows that scores are good (**Appendix**). We used the Baecke's physical activity questionnaire, which consists of 16 items examining 3 types of habitual physical activity over the previous 12 questions), and leisure and locomotion activities (4 questions). The total score for habitual physical activity was obtained by adding these scores together. Three methods were used to assess cognitive functions, which were assessed by the Wechsler Memory Scale, the Stroop color-word test, and the verbal test of memory processes. The participants were asked to perform the tests 60 minutes later for standardization, and the participants were divided into 2 groups: Group one those who performed the Stroop test in less than 30 seconds, and group 2 those who performed the Stroop test in more than 30 seconds. After the cognitive assessment the participants were instructed through a verbal description and physical demonstration of each exercise by the physiotherapist. Each participant then practiced the exercises under supervision until he or she was able to reproduce all 5 exercises correctly and consecutively without prompting, and to recall the prescribed number of repetitions and the frequency of the exercise (namely, until they received a perfect score on the exercise assessment scale). The frequency of the exercise, and the number of repetitions were tailored to each patient and noted on an assessment sheet. The speed of the movement was assessed if the exercise were correctly performed during the total period. Participants were not told beforehand that they would be reassessed. Sixty minutes later, a different physiotherapist evaluated the participants again. Exercise memory was assessed twice: right after the patient said he or she learned it and 60 minutes after that. Physiotherapists were blinded to each other's assessment, and physical and cognitive assessors were also blinded to each other's results. Ethics Committee consent, and written informed consent were obtained from the patients before inclusion (Ethical Committee for Human Research, University Hospital Protocol Number 2010/12). We calculated frequency distributions for categorical variables (gender and education level), and the mean ± standard deviation (SD) for continuous variables (age and body mass index [BMI: kg/m^2]). Chi-square test with Fisher exact was used for analyzing relationships between gender and clinical data. One-way ANOVA test was used to assess the age, BMI, physical activity level, cognitive tests, and exercise memory. For the assessment of correlation, Pearson correlation test was used. All statistical analyses were performed using the Statistical Package for Social Sciences (SPSS Inc, Chicago, IL, USA), version 15.0, and $p<0.05$ was considered significant.

The participants were first grouped into those who completed the Stroop test in <30 seconds and those who required >30 seconds. Demographic data are shown in **Table 1.** When dividing the participants on the basis of Stroop performance (namely time required to complete the test) there was no difference between the 2 groups in terms of gender, education, age, and BMI, and the groups were considered homogenous. The groups did not statistically differ in their ability to learn and reproduce the prescribed exercises, either immediately or 60 minutes after the training according to the exercise assessment scale (**Table 1**). In the evaluation of 5 different exercises, regarding the ability to reproduce the prescribed exercises after 60 minutes, there were significant differences in the activity plane and speed of the hip flexion exercise, and in the starting position of the ankle dorsi-flexion exercise. There was no statistically significant difference between the groups in terms of the Wechsler Memory Scale, and the verbal test of memory processes (**Table 1**). When the groups were evaluated regarding their physical activities, there were significant differences and positive correlations, especially in their leisure time and locomotion activities, and total physical activity assessments.

Table 1 - Demographic data, physical activity, and cognitive functioning of 31 healthy subjects.

Variable	Group 1, n = 12 (<30 seconds)	Group 2, n = 19 (>30 seconds)	*P*-value
Age (years) mean ± SD	34.58±5.91	33.57±7.12	0.684
BMI (kg/m^2) mean ± SD	24.18±3.62	23.97±3.62	0.903
Gender n (%)			0.475
Female	6 (50)	8 (42.1)	
Male	6 (50)	11 (57.9)	
Education Level n (%)			0.968
Primary school	3 (25)	4 (21)	
High school	3 (25)	5 (26.3)	
University	6 (50)	10 (52.6)	
Exercise assessment scale			
After exercise	23.91±6.06	24.21±4.77	0.881
After 60 minutes	24.08±5.56	23.15±5.39	0.649
Baecke's physical activity questionnaire			
Occupational physical activity	3.31±1.01	3.66±0.73	0.272
Physical exercise in leisure	1.98±0.74	2.47±1.09	0.179
Leisure and locomotion activities	2.58±0.58	3.07±0.49	0.017
Total score	7.87±1.33	9.22±1.58	0.020
Verbal test of memory processes			
Immediate memory	6.08±1.08	5.31±1.52	0.142
Learning score	55.75±6.29	52.42±7.80	0.224
Maximum learning	9.66±0.65	9.21±1.08	0.200
Acquisition	8.66±1.61	8.42±1.80	0.704
Visual memory (Weshler Memory Scale)			
Short-term recall	11.75±2.13	10.31±3.90	0.254
Long-term recall	11.50±2.71	9.57±3.74	0.135

Adherence to exercise regimes is of the utmost importance for successful physiotherapy. Previous studies have investigated the impact of patient beliefs, patient-healthcare provider interaction, and the psychosocial elements of a chronic illness on adherence to exercise regimes.[1] In a study by Smith et al,[2] 18% of the subjects simply forgot to exercise. A previous research indicates that age affects the accurate recall of physiotherapy exercises, perhaps because of the increasing number of the exercises that are prescribed.[3] Smith et al[2] compared the ability to remember and reproduce physiotherapy exercises among younger and older adults in a laboratory setting. The subjects were taught 5 or 10 exercises and then asked to repeat the exercises after 30 seconds. Although no significant difference was observed between the groups when they learned the 5 exercises, participants over the age of 60 showed significantly poorer recollection than did younger patients when they were required to learn 10 exercises. Thus, poor memory is a factor when physiotherapy exercises are prescribed, particularly for elderly patients. In our study, subjects ranging in age from 23-46 years were taught how to perform 5 simple exercises for the lower and upper extremities and then asked to reproduce these movements 60 minutes later. However, despite the relative ease of the exercises, the subjects had problems regarding the activity level and the adjustment of activity speed. Cognitive tests were performed to evaluate attention, verbal and visual memory, and short- and long-term memory functions.[3] There was no statistically significant difference between the groups regarding their ability to learn and reproduce the prescribed exercises, either immediately or 60 minutes after the training according to the exercise assessment scale. However, although there was no difference in the assessment of upper extremity exercises, there was a significant difference between the onset and speed of ankle dorsi flexion and hip flexion exercises. This may relate to the lack of stability in the lower extremities, which are composed of more joints that weigh more compared to the upper extremities. There was no significant correlation between cognitive function and the ability to reproduce the prescribed exercises.[4,5] Cognitive test results did not affect the exercise memory. Previous studies have demonstrated that physical activity affects cognitive function, which may then affect the ability to remember prescribed exercises. However, although some studies support the hypothesis that increased levels of physical activity are associated with preserved cognitive function; several methodological considerations limit our ability to draw conclusions from these studies. However, neither physical activity level nor cognitive function affected the ability to perform the prescribed exercises.

In conclusion, despite some limitations such as the small size of the study group, our results indicated that physical activity level and cognitive function did not affect the learning and reproduction of exercises in healthy subjects. However, further studies are required to examine the effect of various instruction methods such as videotapes, figures, and written texts on the retention and reproduction of physiotherapy exercises.

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APPENDIX

Exercise assessment scale

Starting position	
Correct starting position	1
Incorrect starting position	0
Plane of movement	
Correct body part moving in correct plane	1
Body part moving in incorrect plane	0
Range of motion (ROM)	
Exercise performed using correct ROM for that patient	2
Exercise performed using partially correct ROM	1
Incorrect ROM	0
Compensation	
No compensatory movements	1
Use of compensatory movements	0
Duration=speed of movement	
Total time taken for exercise correct	1
Time taken for exercise incorrect	0
Reps	
Correct number of repetitions	1
Incorrect number of repetitions	0
Frequency	
Correct number of times per day	1
Incorrect number of times per day	0