Effectiveness of Attention Rehabilitation on Decreasing Selective Attention Deficits in Patients with Multiple Sclerosis

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ABSTRACT

Objective: Multiple sclerosis (MS) is a progressive disease of CNS and cognitive impairment is a common concomitant of it that affects various aspects of cognitive functioning like attention and memory as well as attentional complex tasks such as selective attention. The present study investigated the effectiveness of attention rehabilitation on decreasing selective attention deficits in patients with MS.

Methods: The current study was conducted with a single-subject design, A/B model, and follow-up. Six patients with secondary progressive MS (SPMS) were selected as study sample. Attention rehabilitation program comprised flash cards and pen-paper. Selective attention deficits were studied by Stroop test. Results were analyzed with visual analysis, percentage of zero data (PZD), and Cohen's d effect size.

Results: Of 6 subjects, 4 showed high effectiveness in attention rehabilitation and improved after treatment phase compared to the baseline phase, and maintained this condition during the follow-up period. The other two subjects had questionable results regarding attention rehabilitation.

Conclusion: These findings suggest that attention rehabilitation can decrease selective attention deficit in patients with MS.

1. Introduction

Multiple Sclerosis (MS) is a progressive disease of CNS and characterized by the production of widespread lesions or plaques in the brain and spinal cord. These lesions and plaques affect the myelin sheath, causing inhibition of axonal transmission. Inflammatory demyelination has traditionally been seen as the main disease process in MS; however, axonal damage or loss is increasingly being documented to occur early in the disease and result in permanent disability (Chelune, Stott, & Pinkston, 2008).

MS manifests with a broad range of symptoms, including motor, cognitive, and neuropsychiatric problems. In addition, cognitive deficits can occur independent of physical disability, which complicates their identification and recognition (Brassington & Marsh, 1998). Since 1980s, research has indicated that cognitive impairment is a common concomitant of MS, with prevalence rates ranging from 43% to 70% (Benedict, Cookfair, & Gavett, 2006) at both the early and late stages of the disease (Piras, Magnano, and Canu, 2003). MS detrimentally affects various aspects of cognitive functioning, including attention, information processing efficiency (Litvan, Grafman, Vendrell, & Martinez,

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1988), executive functioning, processing speed, and short-term memory (Rao et al., 1991).

Research on individuals with MS has repeatedly demonstrated impairment on complex attention tasks (Coo et al., 2005). The pattern of performance has been interpreted as evidence of a reduced capacity to hold and manipulate information in mind (Lensch et al., 2006). Up to a quarter of MS patients have deficits in attention, especially in complex functions like selective attention (Pelosi et al., 1997).

Selective attention refers to the ability of keeping a behavioral or cognitive set among the distracting or competing stimuli. It thus incorporates the notion of freedom from distractibility (Sohlberg & Matter, 2001). De Sonnevill et al. (2002) investigated divided and sustained attention in primary-progressive, secondary-progressive, and relapsing- remitting MS patients. They indicated that persons with MS were significantly slower than healthy control. In attention demanding tasks, secondary-progressive MS patients were slower than primary-progressive and relapsing-remitting MS patients.

Cognitive impairments are associated with reduced functional status in MS. It often has a deleterious impact on someone's personal, occupational, and social functioning, as well as overall quality of life (QoL). For example, Rao et al. (1991) found that people with MS who have cognitive impairments were less likely to be employed, engaged in fewer social and vocational activities, had greater difficulties in carrying out routine household tasks, and were more vulnerable to psychiatric illness. Given the significant effect of cognitive impairment on QoL of persons with MS, Obrain et al. (2008) suggested that such deficits should be a major goal of MS research and practice.

It seems that by cognitive rehabilitation, one can make slower the course of cognitive deficits and longer duration between mild and severe cognitive deficits. If cognitive rehabilitation were effectiveness in MS, it could remove a major financial burden from family and government and improve quality of life in patients with MS. But there have been few studies on the treatment of cognitive deficits and cognitive rehabilitation so far. Several authors have highlighted the need for additional effective cognitive rehabilitation (Longdon, 1998; Prosiegel & Michael, 1993). As a result, researchers and clinicians experience difficulty drawing firm conclusions regarding effectiveness, and current evidence is ambiguous and controversial. Although some studies (DeLuca et al., 2004; Fischer, 2001) exist showing the benefits of attention rehabilitation for persons with MS, others (Rao, 1986; Rao & Leo, 1989) have failed to show a benefit.

The current study was trying to examine the effectiveness of attention rehabilitation in reducing selective attention deficits in MS patients.

2. Methods

The current study was a single case study with A/B design and follow-up. The cognitive changes of 6 patients with SPMS, under cognitive rehabilitation were studied. The statistical population consisted of all patients with SPMS that had attention deficits and were referred to medical centers in Tabriz. Subjects were selected based on non-random and judgment-based sampling. Inclusion criteria were as follows: (1) Having secondary progressive MS; (2) Having the memory complaint and difficulty in concentration in past years; (3) Receiving no steroid therapy; (4) Not attending concomitant medical processes that could be contributed to MS symptoms. Exclusion criteria were as follows: (1) Meeting DSM-IV criteria of severe dementia; (2) Having mental retardation; (3) Having severe psychiatric disorder; (4) Getting a score above

Table 1. Demographic information.

Subjects	Age	Sex	Duration of education (years)
1	41	Male	19
2	40	Male	12
3	27	Female	7
4	42	Male	8
5	44	Male	12
6	40	Male	10

Table 2. Patient's medical information.

Subjects	1	2	3	4	5	6
MS Type	SPMS	SPMS	SPMS	SPMS	SPMS	SPMS
Chief complaint	Forgetting, distraction	Forgetting, distraction	Neglect forgetting	Losing of objects (for examplemo-bile & money)	Forgetting, distraction	Forgetting, distraction
EDSS duration of disease (year)	6.00 17	5.00 13	6.00 12	6.00 19	6.50 13	6.00 10

PRACTICE in CLINICAL PSYCHOLOGY

29 in Beck depression inventory (BDI-II), and (5) having severe physical illness that may interfere with research.

The medical records of MS patients that had been accepted to Bozorgmehr Medical Clinic in Tabriz from 2002 to 2003 were studied. Fifty patients who received diagnosis of SPMS with a complaint of attention impairment during past year were selected.

The clinical examination, assessment, and accurate diagnosis of SPMS were performed by neurologist. Finally, 8 SPMS were identified who among them 6 patients, with similar type of medication were selected as study sample. After explaining the logic of treatment, the written consent forms were taken from the patients.

Measures

Tools for notifying the status of patients

Demographic questionnaire: This questionnaire contained personal details and educational status (Table 1).

Patient's Medical Information Questionnaire: This questionnaire included the type of disease and patient's disability level based on Kurtzke expanded disability status scale (EDSS) (Table 2).

Tools for evaluating cognitive (attention) changes

Computerized Stroop test: In current study, Stroop test was used for the evaluation of the selective attention. Typically, the stimuli were words with two dimensions (the form of the word and its color). The answers could be congruent (congruency between the meaning of the word and the its color), or incongruent, (difference between the meaning of the word and its color; e.g. the word 'blue' printed in red). In the current study, 48 congruent and 48 incongruent colored words were shown randomly and sequentially. The subject's task was to determine the apparent color regardless of the meaning of word. Dependent variables included congruent error, congruent omission, incongruent error, and incongruent omission.

Ghadiri et al. (2007) reported constant coefficient of 0.6 for reaction time and 0.55 for the errors number in the first stage. However, he found 0.83 for reaction time and 0.78 for errors number in the second stage. At the third stage, constant coefficient was 0.97 for reaction time and 0.79 for errors number.

Study tool for intrusive trigger

Beck depression inventory-II: This questionnaire is used for the measurement of the intensity of depression. Fata et al. (2005) reported the alpha coefficient as 91%, correlation coefficient between two halves was 89%; and test-retest coefficient at an interval of one week was 94%. It was implemented in the patients selection stage before the intervention, and those participants who were scored higher than 29 (severe depression) were omitted. The selected patients with a score of less than 29 (Table 3) were evaluated at least 4 times (in the baseline 2, 5, evaluation of intervention stage 1, 3, 6 and follow-up 1) (Table 4).

Table 3. BDI-II results in patients select stage.

Subjects	1	2	3	4	5	6
Score BDI-II	20	16	25	25	21	19

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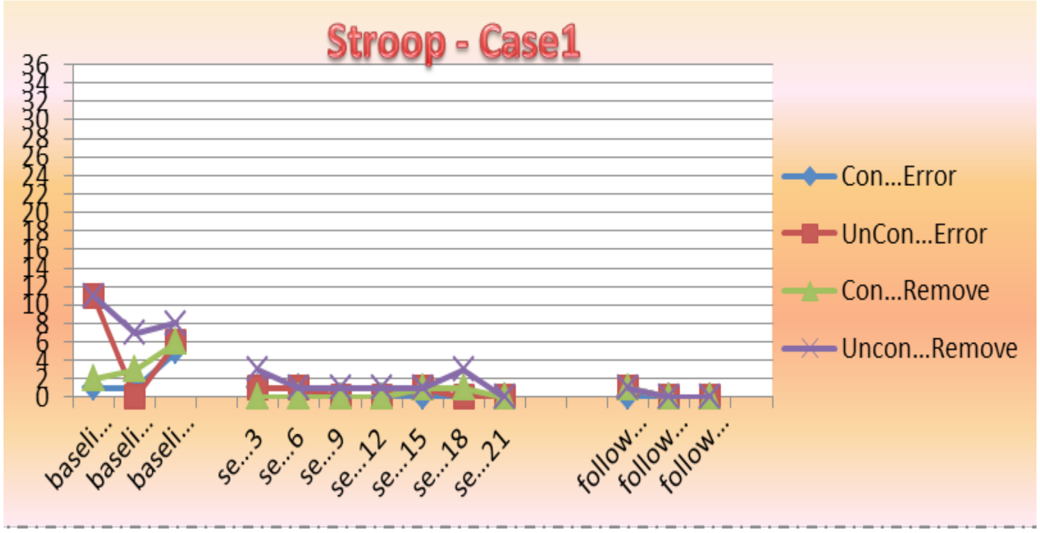
Stroop - Case1
36
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se...9
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follow...
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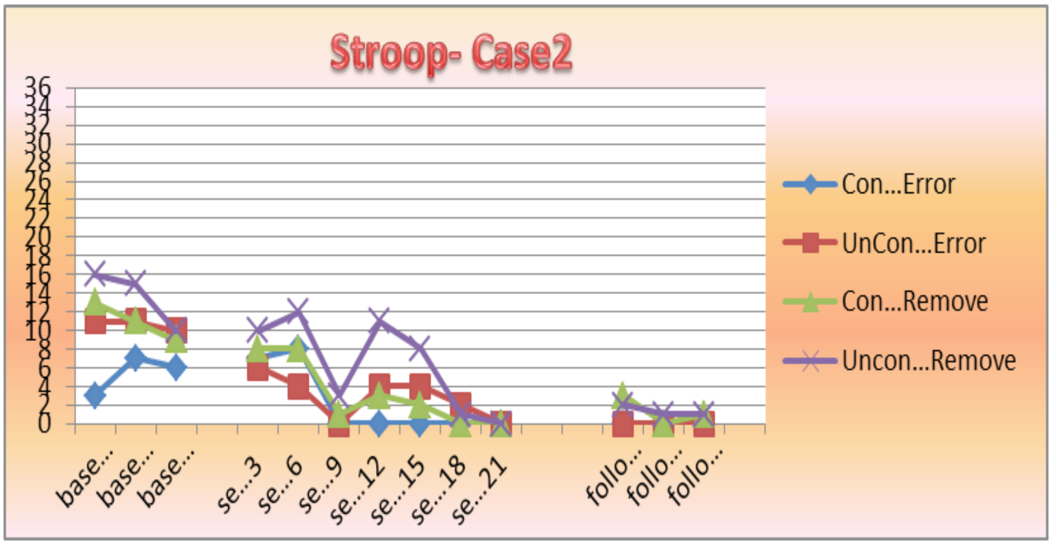
Con...Error
UnCon...Error
Con...Remove
Uncon...Remove


Stroop- Case2
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base...
se...3
se...6
se...9
se...12
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se...18
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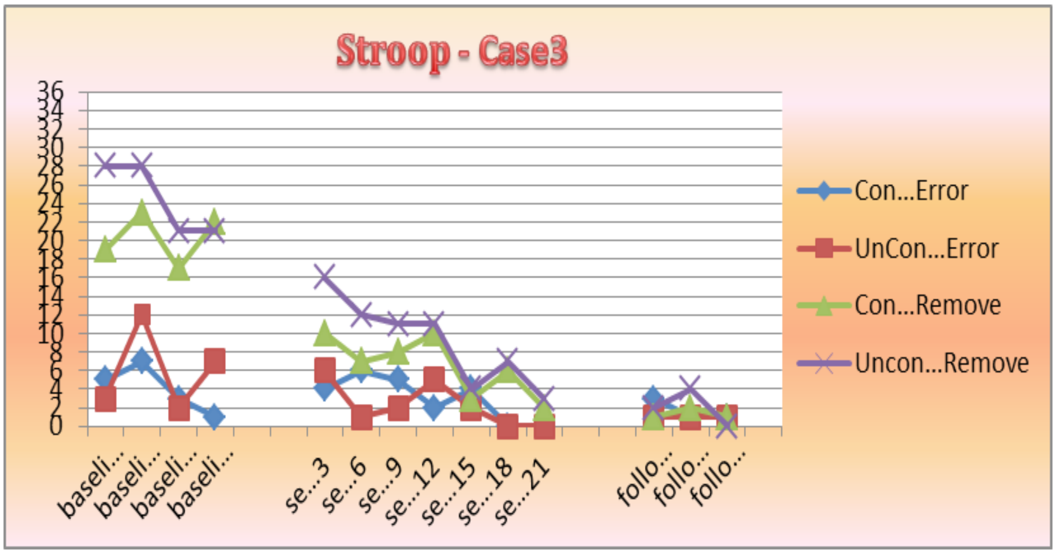
follo...
follo...
follo...
Con...Error
UnCon...Error
Con...Remove
Uncon...Remove


Stroop - Case3
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Con...Error
UnCon...Error
Con...Remove
Uncon...Remove

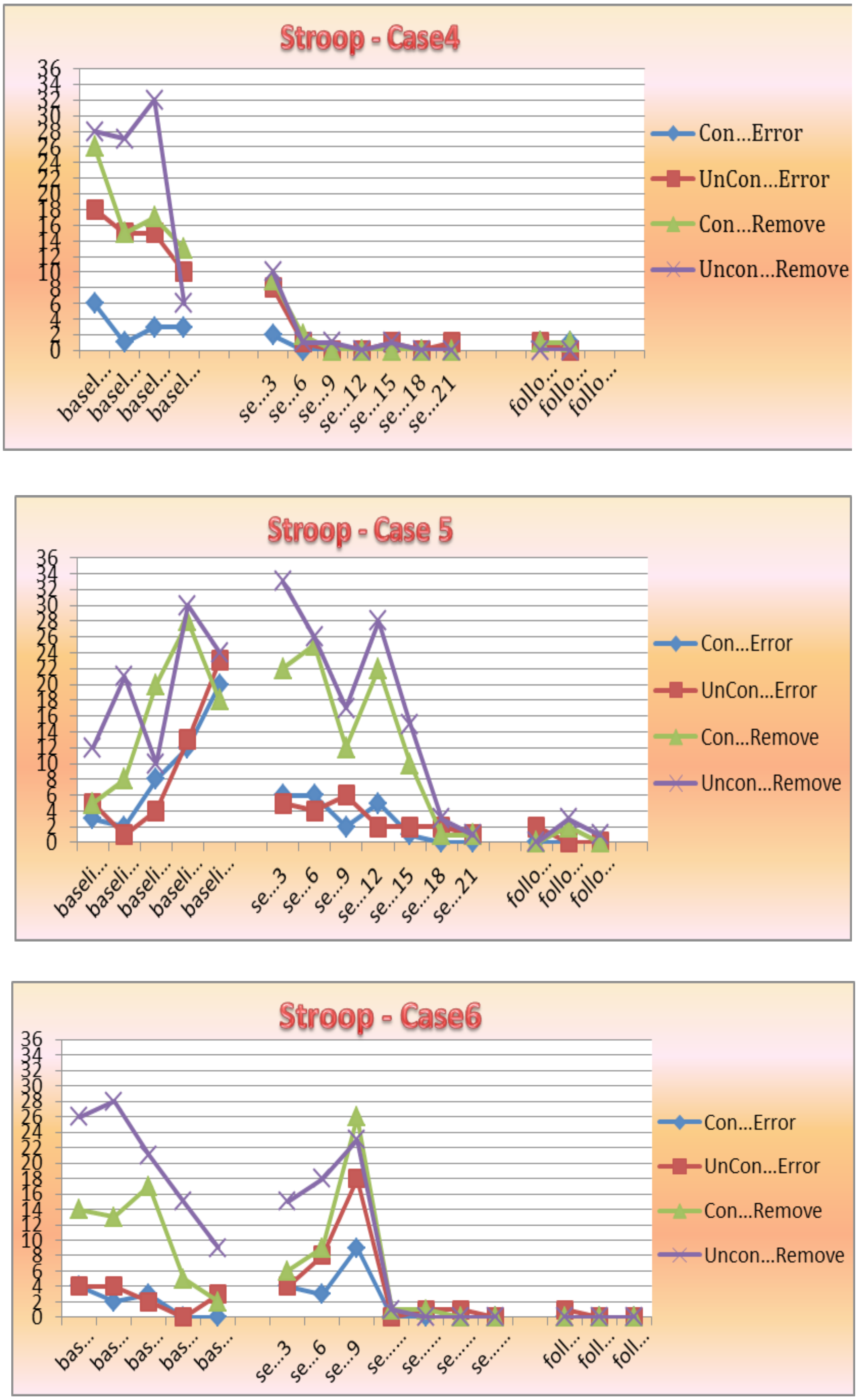

Figure 1. Visual analysis of Stroop test (selective attention).

Table 4. BDI-II results in intervention stage.

Subjects	1	2	3	4	5	6
Baseline 2	16	24	30	29	21	24
Baseline 5	---	—	---	----	6	20
Measurement 1	25	18	25	30	---	---
Measurement 3	---	---	---	---	7	28
Measurement 6	15	30	11	30	10	30

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Procedure

We divided the subjects into 3 groups (1-2, 3-4, 5-6 subjects). Six subjects entered into intervention stage. Three weeks were devoted to the baseline stage in the first group, and at the fourth week, the third group entered into the treatment. Subjects participated in intervention for 7 weeks (21 sessions) and every patient was evaluated at 7 time points (at 3, 6, 9, 12, 15, 18, 21 sessions) by Stroop test. The interval assessments were 7 days and before the assessment there was no intervention. The follow-up stage had 3 assessment points. In addition, the assessments in follow-up stage began 10 days after the intervention.

Cognitive rehabilitation tasks were prepared by the researcher and confirmed by two experts. The task was based on Sohlberg and Matter (2001), Dolatshahi (2004), Clair (2008) cognitive rehabilitation programs. Each session was dependent on physical state of patient from 45 minutes to an hour. Attention rehabilitation program included selective attention, sustained attention, vigilance, working memory, and concentration.

Statistical analysis

In order to analyze the data of the study, qualitative analysis (visual analysis and charts were used and changes of the intervention based on the level, slope, and variability were interpreted) and quantitative analysis (the changes based on the level, slope, and variability were studied quantitatively) were used including:

I- Percentage of zero data (PZD): shows the changes in the level.

II- Mean percentage reduction (MPR): shows the change in slope.

III- Cohen's d effect size: shows the rate of variability.

3. Results

We hypothesized that attention rehabilitation could reduce selective attention deficits in patients with MS. According to chart 1, all subjects showed a reduction in the number of errors and removed in congruent and incongruent indexes in the intervention stage, although this result was not observed in the baseline stage and it maintained until the follow-up stage. All participants at the baseline

Table 4. Incongruent error and congruent error Stroop test (effect size & PZD).

Subjects	Effect size D cohen congruent error	PZD congruent error	MPR congruent error	Effect size d cohen incongruent error	PZD incongruent error	MPR incongruent error
92%	0****	1.6	87%	71%**	0.9	1
73.5%	100%*	505	59.6%	71%**	1.3	2
63%	42%***	1.2	25%	28%***	0.4	3
89.6%	100%*	6.2	91%	85%*	2.2	4
66.8%	0****	1.1	68.8%	42%***	2.2	5
50.7%	0****	-0.3	-22.2%	0****	-0.1	6

* High effectiveness ** Moderate effectiveness *** Questionable effectiveness **** Low effectiveness.

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Table 5. Incongruent remove and congruent remove Stroop test (effect size & PZD).

Subjects	Effect size d cohen congruent remove	PZD congruent remove	MPR congruent remove	Effect size d cohen incongruent remove	PZD incongruent remove	MPR incongruent remove
1	2.8	100%*	91%	4.7	100%*	83.7%
2	3.7	100%*	72%	1.9	57%**	54.8%
3	6.8	100%*	68%	4.9	100%*	68.9%
4	4.8	100%*	91.5%	2.8	58%**	92.2%
5	0.3	28%***	16.6%	-0.1	28%***	-10%
6	0.6	57%**	40.6%	1.7	57%**	59.3%

* High effectiveness ** Moderate effectiveness *** Questionable effectiveness **** Low effectiveness.

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showed some levels of instability but at the mid-intervention, errors reduced and congruent and incongruent indexes in Stroop test were removed. The chart also declined while reaching to end and to follow-up phase.

According to Table 4, the Cohen effect size for the baseline-treatment phase is 2.2 as the index of congruent error in subjects 4 and 5. Also, subject 2 benefited more from the most effectiveness. The lowest effectiveness belonged to subject 6.

The maximum MPR (the index of congruent error) is for subject 4 and subject 1 (91% and 87%, respectively). The minimum MPR (Baseline-treatment) was for the subject 6 that showed not only eliminating congruent error but also an increase in congruent error index in the treatment phase. The maximum PZD (the index of congruent error) was seen for subject 4 and 2 (85% and 71%, respectively).

The maximum d Cohen effect size (the index of incongruent error of baseline-treatment phase) was seen for subject 4, (6.2), subject 2, subjects 1, 3, and 5. The minimum d Cohen effect size (-0.3) belonged to subject 6 whose performance declined compared to the baseline phase.

The maximum MPR (the index of incongruent error) belonged to subject 1 (92%), i.e. 92% reduction in the incongruent error. The minimum MPR (the index of incongruent error) belonged to subject 6 (-50.7%). It means that not only there was no reduction in the treatment period of the incongruent error, but also there was an increase of the congruent error in this period.

The maximum PZD (the index of incongruent error) belonged to subjects 4 and 2 (100%) that have showed the maximum levels of increase, and the minimum belonged to subjects 1, 5, and 6.

According to Table 5, the maximum effect size of the congruent remove index (baseline-treatment) belonged to subject 3 (6.8) and then subjects 4, 2, and 1. The minimum effect size was seen for subject 5. The maximum PZD belonged to subjects 1, 2, 3, and 4, i.e. about 100% reduction during the treatment phase compared to the baseline phase. The maximum MPR (the congruent remove index) was seen in subjects 4 and 1 (91.5%, 91%, respectively), then subject 2 (72%). The minimum reduction of remove belonged to subject 5 (16.6%).

After reviewing the results of incongruent remove, the maximum PZD went to subjects 1 and 3, and the minimum belonged to subject 5 (during treatment, not only there was no reduction of level but also we found an increase in his congruent remove).

Subject 6 had the maximum d Cohen effect size in baseline follow-up. The profile of this subject shows that in both congruent error and incongruent error indexes, the participant had performance degradation. However, in the congruent and incongruent remove indexes based on effect size and MPR, there was a moderate efficacy. Subjects 1, 3, and 4 had moderate recovery based on d Cohen effect size in the baseline follow-up phase.

In addition, subjects 4 and 1 have had the highest MPR. Subject 5 had the minimum MPR (-10%). It means that there is not only reduction in his removal rate but there was an increase in the amount of the congruent remove index during the treatment phase. In the follow-up period, the rate of the error of remove decreased.

Totally, of 6 subjects, 4 subjects certainly showed high effectiveness in attention rehabilitation and improved after treatment phase compared to the baseline phase, and were maintained at the follow-up period. Two subjects (5 and 6) showed questionable effectiveness in attention rehabilitation.

4. Discussion

We studied the effectiveness of attention rehabilitation in decreasing selective attention in patients with MS. Four subjects certainly showed high effectiveness, improved after treatment phase and maintained at the follow-up period. Two subjects showed questionable effectiveness in attention rehabilitation.

It seems that SPMS patients who received cognitive (attention) rehabilitation showed improvement on measures of selective attention. Thus, based on the above results, attention rehabilitation could effectively decrease selective attention deficits in patients with MS.

We propose 3 reasons for this change. First, there were reductions at errors in congruence and incongruence indexes in the treatment stage (not the baseline stage). Second, all subjects were not entered into the intervention process at the same time and as a result, the group who did not enter into the intervention, could play the role of control group for those who were already in the intervention stage. Noteworthy of mention that the assessment measures of the selective attention changes were computerized, which could minimize the learning effect.

The rate of effectiveness in subjects 4 and 5 were questionable. It may be due to progression of the disease that slows the reaction time. Nevertheless, in visual analysis, the number of errors decreased; however, one cannot observe these results in the baseline stage.

Current study dealt with the effectiveness of attention rehabilitation in patients with MS. Plohmann et al. (1995) focused on participants diagnosed with clinically definite mixed subtypes of MS who were outpatients at an MS clinic. Twenty-two patients participated for twelve 40-minute sessions over 3 weeks during which they used a computer-assisted rehabilitation program that remediates 4 types of attention: selective, divided, sustained, and vigilance. The computer program was designed to include attentional demands that the researchers considered complex enough to approximate attentional situations with demands in everyday life.

The researchers found support for their hypothesis that tailoring attentional training to the specific type of attention impairment results in improvements. They found significant improvement in people who received specific (vs. nonspecific) training attention. Participants also self-reported improvements in cognitive functioning in everyday life and QoL. Treatment effects were found to be sustained for 9 weeks.

In another study, Plohmann et al. (1998) focused on participants with mixed subtypes of MS recruited through an MS clinic. Participants were included in the study if they had documented or subjective complaints of cognitive impairment. Participants engaged in six 45- to 60-minute training sessions, 4 times a week. Again, specific details about the attentional remediation components of the computer-aided programs were lacking. The researchers reported preliminary results stated that there were qualitative improvements from the treatment group; however, no quantitative support was provided for these results. Improvements described included decreased reaction time, decreased task errors, and increased performance on the paced auditory serial addition test, 7.24 spatial recall, and Stroop color word interference score. This result was found in other studies (Solari et al., 2004; Birnboim & Miller, 2004; Lincoln et al., 2002).

In summary, cognitive rehabilitation decreases selective attention in patients with MS. It seems that such specific intervention could improve some aspects of cognitive impairment. However, the researchers suggest targeting other aspects of cognition simultaneously.

The limitation that should be addressed for this research was the small sample size that limited the generalization of cognitive rehabilitation efficacy to other patients with MS. Thus, large sample size is recommended for future studies. Special thanks to Neuroscience Research Center of Imam Reza Hospital in Tabriz and all the participants for their cooperation.

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