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# Attentional Factors in Multiple Sclerosis

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Abstract

The purpose of this study was to investigate attentional deficits associated with multiple sclerosis (MS). Subjects were 10 MS patients and 10 control subjects. Two hemispherically defined attentional tasks were used: word superiority and spatial orientation. Results showed significant differences between the MS and the control subjects in the Non-word and the Pseudo-word conditions in the word superiority task. In the spatial orientation task, the MS patients subjects' responses were slower than those of the control group with demonstrated costs in the left visual field.

Key words: Multiple Sclerosis, attention, neuropsychology.

Multiple sclerosis is a chronic, progressive neurological disease, with varying courses and unknown etiology. Genetic, viral, and autoimmune factors have been postulated as the most probable causes. MS consists in the selective demyelination of cells in the central nervous system (CNS) and the consequent formation of plaques, particularly in the periaqueductal and periventricular regions (Whitaker, 1984).

A larger númber of symptoms seem to be consistently associated with this disease: depression, anxiety, euphoria associated with some degree of dementia, denial of the disease process and its symptoms, irritability, fatigue, apathy, sensorimotor dysfunctions, memory problems, etc. (Patterson & Foliart, 1985; Whitaker, 1984).

In addition, changes in cognitive processes, principally sensoriperceptual (mainly visual and auditory) have been described. Also, problems in attention, memory, abstract reasoning, problem solving, and intelligence have been noted in this kind of patient, although some of these findings seem to be anecdotal (Rao, 1986). Jennekens-Schinkel, Lanser, Van der Velde, and Sanders (1990) maintain that these deficiencies could be explained by peripheral deficits (ocular-motor, for example) more than by central deficits, pointing to linguistic or visuo-spacial factors. In addition, they did not find cognitive deterioration in patients who had not shown signs of general cognitive decline. In contrast, the data obtained by Callanan, Logsdail, Ron, and Warrington (1989) in patients with isolated lesions, like those seen in MS patients, would indicate the existence of a cognitive deficit originating in the CNS, which could be partially dependent on deteriorated attentional processes. In any case, these authors propose that this deficit could be seen as a marker of cerebral pathology and much more reliable than the psychiatric changes. Among these processes, specific memory changes, especially in serial position effect with words have been recently reported (Prez, Muela, Godoy, 1992; Prez, Muela, Mari-Beffa, Lorite, Vera, Catena, & Godoy, 1992).

The relatively few studies on changes in attention in MS patients have found deficits in performance in auditory attention tasks (Callanan, et al. 1989) which they have attempted to explain through the concept of working memory (Baddeley, 1986; Litvan, Grafman, Vendrell, Martinez, Junque, Vendrell, & Baraquer-Bord, 1988). Alterations in the temporal, parietal, and frontal lobes, principally in the left hemisphere, found by Pozzilli, Passafiune, Bernarde, Pantano, Incoccia, Bastianello, Bozzao, Lenzi, & Fieschi (1991) might be mediating these attentional deficits.

Nevertheless, there are many contradictions and inconsistencies in the data on cognitive changes associated with inconsistencies in the data on cognitive changes associated with MS. These variances are primarily due to the heterogeneity of the given samples, and the procedures and systems of measurement used in assessing these processes. Besides, an adequate correlation between the indicated deficits and the type of neurological lesion seen is not normally encountered.

In the present study, there were two principal objectives: (1) to determine if the use of chronometric techniques would be helpful in the evaluation of certain cognitive deteriorations (attentional and perceptual) and (2) to indicate with a certain degree of precision the level of processing in which they occur.

## Method

### Subjects

The experimental group (EG) was composed of 10 patients from both sexes, diagnosed with MS of different types and developments. Patients were able to complete a screening battery comprised of intellectual and emotional measures. There were no serious emotional alterations present (Godoy, Muela, & Perez, 1993; Muela, Perez, Garcia, Anguiano, Mendoze, & Godoy, 1992; Muela, Perez, & Gosoy, 1992).

The control group consisted of 10 non-clinical subjects with similar demographic and sociocultural characteristics of the experimental subjects (EG). These demographic and sociocultural characteristics with the respective means, standard deviations, and ranges are found in table 1.

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Insert Table 1 about here

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Apparatus and procedure

A portable Toshiba computer, model 3100E was used to present the stimuli and to measure the dependent variables in the two experimental tasks.

In the first task (superiority of the word, SP), a point of fixation (*) was presented to the subjects in the center of the monitor screen for 500 milliseconds. After an interval of 150 ms with no stimuli on the screen, a chain of characters appeared, consisting either of a word, a pseudo-word (orthographically correct but with no Spanish meaning), or a non-word (neither orthographically nor semantically correct in Spanish). The stimuli had between 4 and 8 letters (between 1.9 and 3.8 cms. in length; between 1.8 and 3.62 visual angle degrees, v.a.d., at a distance of 60 cms.), and always appeared centered in the location where the point of fixation had appeared. In one third of the trials, the stimuli lasted for 20 milliseconds, in one third for 50 milliseconds, and in the last third of the trials for 100 milliseconds. The words were obtained from a rule book on semantic categories and the pseudo-words were formed by changing one letter in each word for another letter or by changing the position of a syllable group.

The subjects' task consisted in indicating, by pressing a computer key, if the stimulus was a word (key "m" for right-handed subjects, "v" for left-handed ones). The instructions emphasized the importance of responding as reliably and rapidly as possible. Subjects worked at a 60 cms. distance from the monitor and received 24 practice trials followed by 108 experimental trials. Each class of these trials appeared at random and for one third of the time. Practice trials were not included in the statistical analysis.

In the second task, spatial orientation (SO), a point of fixation (+) was presented to the subjects for a duration of 250 milliseconds. After a blank-screen interval of 150 ms, an arrow pointing either to the left or the right of the screen or a line of the same length (1.5 cms.; 1.43 v.a.d.) appeared for 400 ms.

Then, in addition, the target stimulus (*, 0.5 cms., 0.48 v.a.d.) appeared to the right in half of the trials and to the left in the other half, at a distance of 4.8 cms., 4.57 v.a.d to the signal (arrow or line). The mixture of these two variables produced six experimental conditions, in three of which the target was presented in the left visual field (LVF): arrow to the left (LL, valid trial), arrow to the right (RL, non-valid trial), and no arrow (NL, neutral trial). In the remaining three conditions, the arrow was presented in the right visual field (RVF): arrow to the right (RR, valid), arrow to the left (LR, non-valid), and no arrow (NR, neutral).

Each subject had 48 practice trials, not included in the analysis, followed by 240 experimental trials. In each case, 64% of the trials were valid, 20% non-valid, and 16% neutral. The target stimulus together with the signal remained visible for only 175 milliseconds. The task consisted of indicating in the most rapid and precise manner possible if the target had been presented to the left (key "v") or to the right (key "m").

# RESULTS

Two one-way analyses of variance, between groups design, were used (experimental group, control group) with the factors age and cultural level. In neither case was there a significant difference, allowing for randomization of patients into groups.

Table 2 presents the averages for reaction times and the proportion of hits (correct responses) by both the MS and the control subjects in the conditions Words, Pseudo-words, and Non-words for each of the given exposition times.

Insert Table 2 about here

It can be seen that both groups took less time to decide if the stimulus was a word than to decide if it was a non-word. However, this difference could be due to the different hand needed to make each response (the affirmative response "yes, it's a word" could have been made by pressing corresponding key with the dominant hand, while the response "no, it's not a word" could have been made with the opposite hand). Additionally, in both groups, responses to the non-words were affected more rapidly than to the pseudo-words. It was also observed that a reduction in reaction time was associated with an increase in hits in the different experimental conditions.

The analysis of reaction times was carried out with the non-parametric Wilcoxon Test. The MS subjects spent more time in deciding that the stimulus was a pseudo-word than a word ($p<.05$, in the three stimulus conditions). No differences were found, however, between responses to non-words and to words with the stimulus conditions of 50 and 100 ms but differences were seen with the 20 ms duration ($p>.05$). Additionally, no differences were observed between non-words and pseudo-words in any of the exposition times ($p>.10$, in all cases).

In the control group, the pattern of results was similar. Subjects spent more time in the presence of the pseudo-words than in the presence of the words in the three stimulus conditions ($p<.05$) and less time when presented non-words than pseudo-words ($p<.05$), although no significant differences were noted between non-words and words.

Regarding the proportion of hits, the Wilcoxon results obtained from both groups were not significant. In both groups, there were equal proportions of hits with the words as with the non-words.

The comparison between groups was obtained using non-parametric Mann-Whitney U. Statistically significant results were found in the Pseudo-word and Non-word conditions ($p<.05$), but were not with the Words condition.

Table 3 presents the averages in measured reaction times obtained for both groups with stimuli in both visual fields in the valid, non-valid, and neutral conditions during the orientation task. It can be seen that in the right visual field, the pattern of cost-benefit is the same in both groups. In contrast, in the left visual field, the MS subjects showed costs but not benefits (See Figure 1). The control subjects, however, demonstrated both costs and benefits in both visual fields.

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Insert Table 3 and Figure 1 about here

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The between group analysis on reaction times was completed using the Wilcoxon Test. In the MS group, the signal (benefit) effect in the right visual field was seen ($p.<.05$) and of non-validity (cost) in the same field ($p.<05$). However, in the left visual camp, the cost effect was found ($p<.01$), but not the benefit effect ($p.>.10$). In the control subjects, benefit and cost effects were found in both the right and the left visual fields ($p<.05$) in all cases.

Additionally, the reaction time data were compared between both groups in each of the conditions using the Mann-Whitney U. In all cases, the MS subjects' responses were slower than those of the controls ($p<.05$). However, an analysis of the errors showed no significant differences.

DISCUSSION

The relatively similar pattern of results across groups in both reaction times and in hits seems to indicate that the MS subjects, at least of the type included in this study, do not suffer from significant perceptual alterations. In fact, like the control subjects, they showed word superiority, tended to identify more rapidly the words than the other chains of letters (pseudo-words or non-words) and with the similar precision. This seems to indicate that the perceptual system is not affected by MS.

The differences found between the MS and the control subjects in the Non-word and the Pseudo-word conditions could be interpreted as a consequence of damage in the visual attention system (Posner, Peterson, Fox & Raichle, 1988). As such, an attention deficit would cause the performance to deteriorate in the Non-word and Pseudo-word conditions which would require a search by the attentional system to determine if the stimulus might be a word (orthographic filter). Thus, the non-words would not pass through this filter, and if this stimulus has or does not have meaning (lexical filter) it would not be overpowered by the pseudo-words. Given that the orthographic filter requires an analysis based on the physical characteristics of the stimulus, this analysis would require a lower level of processing than that effected by the lexical filter. As such, it requires more time to process the pseudo-words than the non-words. Accordingly, the MS subjects are slower in processing the information when the attentional system is used, while this does not occur only when the perceptual system is working.

These results cannot be attributed to a linguistic failure due to the low number of errors committed by MS subjects. Furthermore, clinical subjects tend to perform the same in the condition of 100 ms (when the exposition time is greater) as the control subjects in the Pseudo-word condition. These data would coincide with the absence of linguistic deficits found by Callanan et al. (1989) and Jennekens-Schinkel et al. (1990). Although these present our tests were not designed to explore the existence of a slower information processing in this type of MS subjects, an increase in stimulus time usually is correlated with a better performance. In contrast, this does not occur in control subjects. These data, although not conclusive, would be supportive with the data reported by Litvan, et al. (1988), who observed a slower information processing in tasks of memory recovery after long intervals.

Additionally, the fact that the MS subjects demonstrated costs in the left visual field, but did not show benefits, seems to indicated that MS patients might suffer from an alteration in the course of attention related to this visual field. It does not seem possible that these attentional problems are due to an attentional disengagement. In the present study, attentinal problem should produce differences between the reaction times in non-valid trials of both visual fields and such differences did not appear. Thus, it is difficult to interpret these data as resulting exclusively from an attentional engagement problem, given that in this case they should have obtained the same reaction times equally as long in valid trials as in non-valid trials in this visual field. However, there were significant differences between both types of trials.

Lastly, Pozzilli et al. (1991) found in MS patients verbal tasks deficits associated with the left temporo-parietal lobe, secondary to disconnections in the subcortical structures. This might explain these results based on the major functional involvement of this hemisphere in this type of task, instead of a quantitative increment of lesions which could be selectively produced in this hemisphere. In this study, the deficit shown when stimuli are presented in the left visual field (and processed in the right hemisphere) could be due to the fact that the task involved visuo-spacial orientation which, is normally processed in the right hemisphere. Yet, because these results were obtained with a small number of subjects and with a heterogeneous population, conclusions must be limited. Further studies with larger populations and different MS subjects will have to be conducted.

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