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Specific Long- and Short-Term Memory Deficits Producing Dyscalculia in a Physicist: A Single Case Study Carried Out Using the São Paulo MAT Test

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Introduction

After giving a concise description of the SP-MAT, a test battery developed by our Laboratory in order to study acquired mathematical disabilities, we present the results obtained with its employment in the investigation of AA, a 42-year-old right-handed man, physicist, operated in 1992 in order to remove a left arteriovenous malformation.

Method

The SP-MAT was conceived as a methodological tool sufficiently detailed to yield a precise description of a patient's actual performance during the cognitive processing of mathematical entities both in the elementary and in the advanced level.

It consists of 5 parts designed to assess: **(I)** deficits related to the perceptual processing of numerical entities, **(II)** basic arithmetical calculation abilities, **(III)** abilities required to deal with elementary algebra problems, **(IV)** abilities involved in solving elementary geometry problems, **(V)** abilities required to deal with problems of higher mathematics.

Results

AA was examined 43 months after his surgery and only the first two parts of the SP-MAT were given to him.

On the neurological examination, AA presented a right homonymous hemianopia (compensated) with no motor deficits. SPECT showed a dramatic reduction in rCBF values of the left temporal, occipital and inferior parietal regions. Standard neuropsychological assessment showed: **(a)** a slight impairment of AA's performance during discourse comprehension tasks, **(b)** a discrete anomia, **(c)** an important retrograde amnesia mostly affecting the mathematical information the patient normally dealt with before surgery, **(d)** a below-average reduced memory span, more pronounced for oral than for written stimuli, worse for non-significant syllables than for words and numbers, the span for letters being almost normal, and **(e)** a mild impairment in AA's arithmetical calculation abilities.

Results showed no deficits related to the perceptual processing of numerical entities.

Results of Part II allowed a precise characterization of AA's calculation impairment, namely: **(a)** variability of its degree of expression as a function of the type of operation involved: The impairment was more evident during the performance of multiplications and divisions than during the performance of additions and subtractions; **(b)** presence of an important "row effect": The greater the number of rows involved in AA's processing of a given algorithm, the greater the number of errors detected. Such effect was most evident during the performance of multiplications and additions, but it could also be observed in divisions; **(c)** presence of a mild "column effect": The greater the number of columns involved in AA's processing of a given algorithm, the greater the number of errors detected. Such effect was most evident during the performance of subtractions and additions, but it could also be observed in divisions; **(d)** a detailed analysis of the relative frequencies of each type of error revealed a consistent pattern (except in case of subtractions): table value and algorithm errors being much more frequent than any other type of error.

Discussion

We claim that the impairment in AA's calculation abilities can be entirely understood if his specific STM and LTM deficits are taken into account.

Both the "row" and the "column effect" can be understood as being caused by the same set of STM deficits: **(a)** an increase in the rate of decay of STM traces and **(b)** a reduction in STM capacity.

Both the variability of the degree of expression of AA's calculation impairment (which is a function of the type of operation involved) and the pattern displayed by the relative frequencies of each type of error can be understood as being produced by the same LTM deficit: an important retrograde amnesia mostly affecting the declarative semantic explicit LTM related to the storage of information concerning the mathematical facts the patient normally dealt with before surgery.

Finally, it is important to point out that AA's lesion affects a set of brain areas which have already been described (e.g., Deloche & Seron, 1987) as possible sites for the group of mechanisms which constitute the cortical network underlying (a) declarative semantic explicit LTM (left temporal area) and (b) STM (left occipital and inferior parietal areas).

Reference

Deloche, G. & Seron, X. (Eds.). (1987). Mathematical disabilities: A cognitive neuropsychological perspective. London: Lawrence Erlbaum Associates.