BEHAVIOURAL AND ELECTROPHYSIOLOGICAL STUDY OF DEVELOPMENTAL DYSCALCULIA

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Approximately 5-6% of the population exhibit severe difficulties in solving simple arithmetic tasks due to a disorder called developmental dyscalculia (DD). In spite of the recent extensive use of modern brain imaging techniques in studying the field of mathematical cognition, the neural basis of DD and its different subtypes have not yet been explored deeply enough. The aim of our study was to describe processing differences of adolescents with DD and their age-matched controls, by means of reaction times (RTs) and event-related brain potentials (ERPs).

Normal adult subjects need more time to decide if a number is larger or smaller than another one if the numerical distance between them is smaller relative to the case when the numerical distance is larger. This phenomenon is the so-called numerical distance effect (NDE). According to former results, the NDE can be observed in RTs and in ERPs.

We hypothesized that adolescents with DD had difficulties in categorizing and comparing numbers, i.e. they would need more time to decide whether a number is smaller or larger than 5 than their age-matched controls. Furthermore, our analysis has focused on assumed developmental differences between adolescents and a group consisting of young adults.

Six adolescents with developmental dyscalculia (Group D) and six gender, age and education matched control subjects (Group MC), as well as six young adults (Group AC) have participated in our study. All the participants were female.

Stimuli (numbers 1-9 except 5) were presented visually. The subjects` task was to determine whether the perceived number was smaller or larger than 5. In one condition (D1, digits 4 and 6) the numerical distance from 5 was one, whereas in the other condition (D4, digits 1 and 9) the numerical distance from 5 was four. EEG was sampled at 32 channels at 1000 Hz. An on-line bandpass filter of 0.15-70 Hz and an off-line filter of 0.3-30 Hz was used. Epochs were baseline-corrected relative to the average voltage of the 100 to 0 ms interval. All the epochs where voltage exceeded ±80 μV were excluded from the analysis. All groups' data was entered into a group x distance ANOVA.

The pattern of NDE found in both RT and ERP data lead us to the conclusion that the basic analogue representation of numerals should be intact in adolescents with D. The differences found in P3b ERP component between group D and group MC suggest left parietal dysfunction and abnormalities in number processing among adolescents with D (see Fig. 1.).

The significantly greater amplitude of N2b in group D than in group MC (Fig 1.) might be due to the lack of adequate problem solving strategy among adolescents with D expressed by expectations during the task.

Age differences were found in the RT and in the errors made during the task, regardless of DD. The decreasing RT and the lower rate of errors might be a result of maturation in perception, decision or executive processes.

Fig. 1.
Differences between groups in their N2b and P3b amplitudes