variables increased the explained variance to 40%. The present study showed that the type of abilities that RSPM measure contributes to predicting ADHD. Thus, it would be useful to add RSPM to the tests that are used in the diagnostic assessment of ADHD.

Reference

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EVENT-RELATED BRAIN POTENTIALS DURING SEMANTIC AND SYNTACTIC PROCESSING IN 2.5-YEAR-OLD CHILDREN

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Behavioral studies on language development demonstrate that at about 18 months of age, children experience a ''vocabulary burst,'' that is, they learn new words very rapidly and start combining words. From 24 to 30 months, children show a ''grammar burst'' in which they begin to use functional words. Multiword utterances appear at 28–30 months, and between 36 and 42 months, children develop a nearly adult-like grammar, including morphosyntax. To date, very little is known about how a young child's brain processes semantic and grammatical information in sentences. Our previous event-related brain potential (ERP) studies have provided electrophysiological evidence of syntactic processing in 36- and 48-month-old children. In that study, preschool children displayed P600-like and N400-like components, similar to those recorded in adults, but with later peak latencies and durations. The results suggested that semantic and syntactic processing are reflected by two different neural systems in children, as proposed for adult language processing. In addition, the previous results suggested that the longer duration and latency observed in children might be related to the development of neural circuitry and myelination. In the present study, we asked whether even younger children display the same type of ERP patterns observed in the 36- and 48-month-old children. The specific goal of the study was to investigate the distinctiveness and the relative time course of the ERPs elicited by syntactically and semantically anomalous sentences in 30-month-old children. We used words from the MacArthur Communicative Development Inventories to build our syntactically anomalous (i.e., My uncle will watching the movie*), semantically anomalous (i.e., My uncle will blow the movie*) and control sentences (i.e., My uncle will watch the movie). Each child ($N=20$) was fitted with a 20-channel electrode cap. ERPs were recorded while children listened to sentences and looked at a puppet show. Each spoken sentence was presented via loudspeakers which were placed on top of the puppet theater. The results show that semantic violations elicit a frontal negativity peaking around 800 ms, whereas the morphosyntactic violations elicit two slow positive shifts: the first peaking around 800 ms with a fronto-central distribution over the scalp and the second starting at 1500 ms and peaking around 2000 ms with a posterior topographical distribution on the scalp. These results demonstrate that 2.5-year-old children replicate the ERP patterns observed in 3 and 4 years of age using the same stimuli. As in the 36- and 48-month-old children, the 30-month-olds exhibit ERP components that are similar to those elicited in adults, though they occur later in time and show some differences in morphology. Taken together with our previous results, the data indicate that the neural signatures of sentence processing can be observed at a very early point in development.

EVENT-RELATED BRAIN POTENTIALS IN READING-DISABLED CHILDREN DURING DETECTION OF INVERSE SERIAL DIGITS

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Three inverse serial digit detection tasks were evaluated with event-related brain potentials (ERPs) in 15 male, normal IQ, right-handed, 8-year-old, reading-disabled children (RD) and a control group (CG), to determine how the increase of perceptual or memory demands could modify detection processing. Neuropsychological assessment showed that RD children had statistically significant slower reaction times on a continuous performance task; low color–word interference effect in the Stroop test, lower forward and backward digit span, as well as lower word retention and higher response times in a verbal learning task. Difference-ERPs (dERPs; target minus nontarget condition) showed three significant components in both groups: one earlier positive parietal peak at 183 ms interpreted as an index of working memory load; the same landscape and polarity 320-ms peak which probably represents a P3 analogous and a subsequent negative-polarity component (500 ms) possibly involved with motor preparation. A fourth difference component was a fronto-central positive peak with maximum at 760 ms, interpreted as probably related to the task difficulty. Components in RD group were weakened, and the former positive peak was frontally located, with an earlier fronto-central positive shift in task with higher memory demand. Behavioral and electrophysiological results lead to the conclusion that RD children seem to make use of different cognitive strategies, with respect to the control group, probably as an adaptive route to solve a central executive failure.

STUDY OF READING PROCESSES COMBINING READING-RELATED POTENTIALS AND fMRI

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The aim of this work is to describe temporally and spatially the activation of the cerebral areas involved in reading processes by combining fMRI and reading-related potentials (RRPs). RRPs and fMR images were recorded in separate studies during a specifically designed experimental procedure. The protocol consisted of three visual tasks of increasing complexity. In the first two tasks, subjects passively watched at letters and symbols, respectively, without making any effort in reading aloud or silently. In the third task, subjects read aloud letters appearing on a screen every 2 s. Seven young healthy subjects (mean age 26.1 ± 0.1 years) participated in the experiment. The analysis of RRPs highlighted the following results. During non-alphabetic symbols presentation, the amplitude of the potentials was lower in comparison to presentation of letters. Reading aloud generated RRPs of greater amplitude than implicit reading. The analysis of fMRI scans revealed that the visual presentation of both letters and symbols produced similar activation of primary visual cortex. Besides these areas, reading aloud activated the primary motor cortex and the supplementary motor cortex located anterior to the pre-central gyrus on the medial surface of the frontal lobe. Furthermore, the left temporal polar area and the middle/inferior temporal gyri were activated: they are related to word retrieval and identification of objects from orientation and shape. The combined analysis of RRPs and fMRI characterizes both temporally and spatially the development of reading processes.

THE IDENTIFICATION OF CLINICAL SUBTYPES OF DYSLEXIA IN NATIVE-LANGUAGE ITALIAN CHILDREN

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The aim of this study is to demonstrate the existence of clinical subtypes of dyslexia in native-language Italian children, as they have been identified in native-language English subjects with the Boder test of reading–spelling patterns (BTRSP) (Boder, 1973). BTRSP has been modified and adapted to the Italian language and called TDLS (Test diretto di Lettura e Scrittura) (Chiarenza and Bindelli, 2002). The TDLS is computerized, self-paced and made of two lists of 20 words for each of the five school grades. The words were visually presented for 250 ms, flash presentation and repeated for 10 s and untimed presentation, if were erroneously read. The reading test determines the reading age and the reading quotient: QL (Quoziente di Lettura). The spelling test consists of the dictation of two lists made of 10 known and 10 unknown words, respectively. By combining the QL and the percentage of known (VC) and unknown words (VS) correctly spelled, it is possible to identify the subtypes of dyslexia. A total of 057 normal children (mean age 10.92 ± 1.63 years) and 85 children with learning disabilities (mean age 9.46 ± 2.20 years) were investigated with TDLS. Among the pathological subjects, 10 were diagnosed as nonspecific reading retardation (11.8%), 47 dysphonetic (55.3%), 8 dyseidetic (9.4%) and 17 had dysphonetic/dyseidetic dyslexia (20%); 3 pathological subjects have become normal after a period of rehabilitation.

The mean QL of normal subjects was 93.8 ± 6.8. VC and VS were 91.4 ± 8.8 and 92.5 ± 8.4, respectively. Subjects with nonspecific reading retardation had mean QL of 82.4 ± 6.5, percentages of VC 80 ± 9.4 and VS 78 ± 16.9.

Dysphonetic children who had a mean QL was 75.47 ± 7.0, the lowest percent of VS (mean 49.8 ± 15.1) and a percent VC (mean 66.6 ± 18.3) in comparison to the other subgroups; dyseidetic subjects had a QL lower than the dysphonetic group (QL: mean 70.1 ± 7.9), the lowest percent of VC (mean 51.4 ± 15.7) and a percent of VS of 75.7 ± 25.1. QL and VS were both very low in children with mixed dyslexia (mean 64.1 ± 6.5 and 45.9 ± 25.3, respectively), while the mean VC was 70 ± 25.2. We observed that dyslexic children made reading and spelling errors characteristic of each subtype. The dysphonetic errors were wild guesses, gestalt and semantic substitutions, while the dyseidetic errors were inversion of letters and syllables. This classification has important implication for developing specific rehabilitation programmes.

ANALYSIS OF READING-RELATED POTENTIALS BY COMBINING WAVELET DECOMPOSITION AND DYNAMIC TIME WARPING

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The problem of obtaining a reference signal for RRP during reading tasks is here addressed. The classical procedure based on the calculation of grand averages on a group of subjects is strongly affected by the high inter-subject variability that becomes especially relevant when dealing with long-latency waves related to the cognitive functions. A dynamic time warping procedure is applied to pairs of signals after a time-scale decomposition through wavelet transform. The RRPs used for this analysis were recorded from 16 normal children of mean age 9.6 ± 0.08 years. The subjects underwent three different tasks: symbol presentation, letter presentation and letter recognition. Two signals coming from two different subjects are decomposed in seven wavelet details and one approximation windowed in time on the bases of the different wave time duration. The obtained coefficients coming from the two subjects are then aligned according to morphological characteristics, as shown in Fig. 1: segn x is related to subject 1, while segn y is related to subject 2; the dotted lines link coefficients pairs with a morphological correspondence in the two sequences, while the dark line in the middle is the calculated double mean. The template of the two subjects is obtained reconstructing the signal from the aligned details and approximation. The procedure was iterated according to a binary tree on the whole set of 16 normal subjects, and a signal template is obtained that represents the examined population. Five characteristic peaks were identified on the templates: N_1, around 150 ms, related to attention; P_2, around 300 ms, traditionally linked to cognitive processes; N_3 and N_4, between 400 and 500 Hz, likely related to association graphema–phonema during reading and P_{600} probably related to feedback processes. The multiscale decomposition of the signal permits to optimize the time-warping procedure to the different temporal dynamics of the analyzed components and then to reconstruct a more reliable template, as shown in Fig. 2. The proposed method provides a tool for the evaluation of RRPs during cognitive tasks and for a better comparison among subjects and between groups.

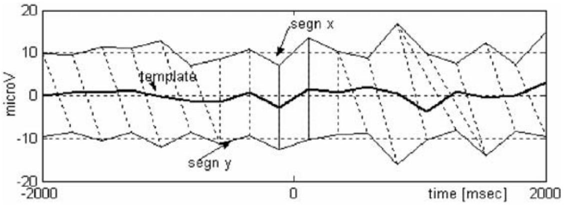

Fig.1: Alignment of the wavelet coefficients during symbol presentation task. The dotted lines link the coefficient pairs with a morphological correspondence in the two sequences, while the dark line in the middle is the calculated double mean.

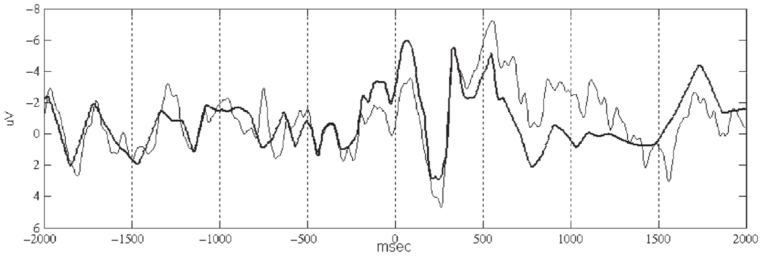

Fig. 2: RRPs grand average (thin line) superimposed to the template (bold line) during symbol presentation task

CHRONOLOGY OF READING PROCESSES

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This study describes the time course of reading-related potentials (RRPs) during different reading-related tests. RRPs were recorded from 24 normal children of mean age 9.27 ± 0.26 years. The stimuli consisted in letters and nonalphabetic symbols visually presented. The first two tasks, defined as passive, consisted of watching at letters and symbols, respectively, without any effort in reading aloud or silently. The other two tasks, defined as active, consisted respectively of reading aloud the letters appearing on the screen either externally or self-paced by a button press. On the basis of the muscular activity of the lips during reading aloud and of the right forearm flexor muscles during button press, the RRPs components were divided into four periods. The pre-motor period occurs while the subject is preparing to read and is characterized by the Bereitschafts potential (BP). The pre-lexical period (0–160 ms) consists of the following potentials: motor cortex potential (MCP), P0, N1, P1 and is related to the first stages of sensory and visual information processing. During lexical period (160–420 ms) likely related to stimuli categorization and control mechanisms, the potentials recorded were N2, P2, N3, P4 and N4. The post-lexical period (420–800 ms) is represented by the long-latency components P600 and a long-standing negative potential probably associated with long-term memory and feedback processes. Statistically significant differences of RRPs latency and amplitude were present in the four periods in different cerebral areas according to task condition. Both latency and amplitude of the pre-lexical components were reduced during visual presentation of symbols in comparison to letters presentation. RRPs in the temporo-parietal and occipital regions were of greater amplitude during reading aloud than passive reading. The self-paced reading condition produced a shortening of RRPs latency components associated to the pre-lexical period in comparison to externally paced reading condition. Furthermore, the components associated with post-lexical period were increased in latency.

SLOW MOTION PROCESSING IN DEVELOPMENTAL DYSLEXIA

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