as a result of treatment with citalopram. The results suggest that both the 'slowed thinking' and altered neuroanatomy may be reversed by successful treatment of major depression.

NEWBORN ERPS PREDICT LATER LANGUAGE SKILLS IN CHILDREN WITH AND WITHOUT FAMILIAL RISK FOR DYSLEXIA

Tomi K. Guttorm*, Paavo H.T. Leppänen, H. Lyytinen
Departmert of Psychology, University of Jyvaskyla, Finland

Early identification of dyslexia would facilitate well directed remediation even before language problems are typically diagnosed. Currently, few methods are available for identifying infants who will later have difficulties in their language development, and who thus would benefit from interventions. Our results show that newborn event-related potentials (ERPs) are associated with later language skills, suggesting that ERPs have potential to be developed as a diagnostic tool. The ERPs to synthetic consonant–vowel syllables (/ba/, /da/, /ga/) were measured from 26 newborns with familial risk for dyslexia and 23 control infants participating in the Jyväskylä Longitudinal Study of Dyslexia. The syllables were presented with equal probability and with 3910–7285 ms interstimulus intervals. Analyses of ERPs using the latencies identified with principal component analysis revealed clearest hemispheric differences between groups in processing of speech stimuli at the latency 540–630 ms: In the responses to /ga/, the polarity shift from the major positive peak toward the later negative deflection occurred later in the at-risk group (clearest at the right hemisphere). Correlation and regression analyses showed that this pattern at the left hemisphere was related to the poorer language skills in these same children at the ages between 2 y 6 m and 5 years. The similar pattern at the right hemisphere was associated with poorer language and visuo-spatial skills at the later stages of development. These results suggest that the differential role of the hemispheres in auditory speech processing predicts later language skills, and could thus be used in early identification of children at risk for language problems.

PSYCHOPHYSIOLOGICAL INDICES OF DYSLEXIA

Giuseppe A. Chiarenza, Giulia Frasson, Igor De Marchi
Department of Child and Adolescent Neuropsychiatry, Rho Hospital, Rho, Milan, Italy

The psychophysiological approach to reading processes is typically based on three types of studies: quantitative EEG, sensory evoked potentials and cognitive potentials. Considered all together, these studies show that during reading, numerous cerebral areas of both hemispheres are activated. The pattern of activation depends on the type of stimuli, simple or complex, on modality presentation, visual or auditory, on experimental conditions, on the involvement of the subject, active or passive, and on the clinical diagnosis. The cerebral areas involved in the reading processes are the parieto-temporo-occipital areas and the motor areas. The cerebral electrical activity both spontaneous and evoked, the sensory and cognitive potentials are different in subjects with dyslexia in comparison to normal readers in the above mentioned areas. The EEG at rest shows an increase of theta activity on parietal regions and the cerebral evoked potentials show an increase in latency and a reduction in amplitude. These differences are found in the unimodal and multimodal cerebral areas. These observations derive mainly from experimental conditions in which the normal subjects or with dyslexia view *passively* letters, words or symbols. This study presents the brain electrical responses when a normal subject and with dyslexia is *actively* engaged in reading aloud letters, either externally paced or self-paced. Forty two normal children and 18 with developmental dyslexia ranging from 8 to 10 years old participated in the study. The EEG was recorded from Fz, Cz, Pz, Oz, right and left pre-central, P3, P4, T3, T4, referenced to linked mastoids. EMGs from the right forearm and lips, ECG, PNH and voice response were also recorded. The reading performance of children with dyslexia were significantly lower ($P<0.0001$) than the normal children during both externally and self-paced reading. Those dyslexic children with low reading quotient had lower reading performance during externally paced reading than during self-paced reading. Student *t*-test and variance analysis showed that significant differences were present between normal and dyslexic subjects and between reading aloud letters externally paced and self-paced. The potentials most significantly affected were P2 (270–330 ms), N3 (310–375 ms), N4 (380–650 ms) and the Bereitschafts-potential in Fz, Cz, Pz, RPC, LPC.

AUTOMATIC MEASUREMENT OF ERPS IN NORMAL AND DYSLEXIC CHILDREN BY MEANS OF A NON-LINEAR ALIGNMENT BASED ON DYNAMIC TIME WARPING

Silvia Casarotto[a], Anna M. Bianchi[a], Sergio Cerutti[a], Giuseppe A. Chiarenza[b]
[a]Department of Biomedical Engineering, Polytechnic University, Milano, Italy;
[b]Department of Child and Adolescent Neuropsychiatry, Az. Osp. G. Salvini, Rho Hospital, Rho, Milan, Italy

The development of methods for automatic detection of peaks and troughs is a great challenge in order to cope with the intra- and inter-individual variability of ERPs and with that due to subjective evaluation of the experimenter.

The present study was performed on a population of normal and dyslexic children aged 8 and 9 years. The EEG was unipolarly recorded from Fz, Cz, Pz, Oz, C3, C4, P3, P4, T3, T4, referenced to linked mastoids; the EOG was bipolarly recorded. The method was applied to four different paradigms, designed to investigate the reading processes in normal and dyslexic children. Two paradigms, defined as *passive*, consisted in viewing letters or symbols without linguistic content. The *active* paradigms consisted of reading aloud letters after externally or self-paced action. A non-linear alignment technique based on dynamic time warping was used: it aligns the samples of the signals on the basis of their morphological similarity through a local compression and extension of their temporal axes. This similarity was measured from the amplitude and the first derivative of the signals. An ERP template was obtained for each group and for each task. The automatic meas-

urement of the latencies and amplitudes of the relevant waves was obtained through the alignment of the single subject's ERP with the corresponding template. Templates obtained during *active* tasks were characterized by significantly greater amplitudes with respect to that recorded during *passive* tasks in most of the cerebral areas recorded. In particular, during self-paced task there was a reduction of latency of ERPs' components before 200 ms. Dyslexic children had a significant increase of latencies of ERPs' components after 200 ms, mainly in parietal and central areas.

This method applied to ERPs, extends the previous applications of non-linear alignment techniques to short latency potentials. Despite of the great interindividual variability that characterizes ERPs in children, the method succeeds in reducing the temporal differences between the signals and in making easier their comparison. This non-linear method overcomes other heuristic techniques that require great experience of the experimenter, are time consuming and fail in the automatic recognition of the relevant waves of cognitive potentials.

PRINCIPAL COMPONENT ANALYSIS FOR REDUCTION OF OCULAR ARTEFACTS IN ERPS FROM NORMAL AND DYSLEXIC CHILDREN

Silvia Casarotto[a], Anna Bianchi[a], Sergio Cerutti[a], Giuseppe A. Chiarenza[b]
[a]Department of Biomedical Engineering, Polytechnic University, Milano Italy;
[b]Department of Child and Adolescent Neuropsychiatry, Az. Osp. G. Salvini, Rho Hospital, Rho, Milan, Italy

The recording of ERPs in normal and pathological children is always a difficult and time-consuming task, because they cannot refrain from blinking or moving, due to developmental or pathological reasons. We present an application of principal component analysis (PCA) for removing ocular artefacts from single EEG recordings of ERPs in normal and dyslexic children.

The EEG was unipolarly recorded from Fz, Cz, Pz, Oz, C3, C4, P3, P4, T3, T4, referenced to linked mastoids; the EOG was bipolarly recorded. The method was applied to four different paradigms, designed to investigate the reading processes in normal and dyslexic children. Two paradigms, defined as passive, consisted in viewing letters of the alphabet or symbols without linguistic content. The *active* paradigms consisted in reading aloud letters after externally paced or self-paced action. The method described below was applied to every single trial: PCA was applied on a matrix containing EOG and all EEG recordings. Correlation coefficients between EOG, the first (c1) and the second (c2) principal component were computed. The method had effect on the recorded trials only in the following two conditions: the first principal component was subtracted from the original trial if $c1 \geqslant 0.9$; the second principal component was subtracted if $c1 < 0.9$ and $c2 \geqslant 0.95$. The number of trials with artefacts decreased with age: 8-year-old children had 1.2 times the number of artefacted trials recorded in 9-year-old children. The *active* paradigms produced 4% more artefacted trials than *passive* paradigms. The percentage of artefacted trials during *passive* paradigms was 57.1% in normal children and 56.2% in dyslexics; during *active* paradigms the percentage was 65.9% in normal and 72.5% in dyslexic children. With the application of PCA, the number of artefact-free trials increased of 155 and 179% in normal children during *passive* and *active* conditions, respectively. In dyslexic children the increase per cent was of 150 and 189% during *passive* and *active* conditions, respectively. The achievements of the method are: a reduction of the experiment time and a great improvement in the quality of ERPs, without modifications of latencies and amplitudes.

APPLICATIONS OF THE 'MANGINA-TEST' IN THE CLINICAL INVESTIGATION OF CHILDREN AND ADOLESCENTS WITH NEUROPSYCHIATRIC PATHOLOGIES AS COMPARED TO NORMAL CONTROLS

G.A. Chiarenza, V. Benvenuti
Department of Child and Adolescent Neuropsychiatry, Rho Hospital, Rho, Milan, Italy

The 'Mangina-Test' is used for the diagnosis of varying degrees of 'analytical-specific visual perception' and was standardized in North America as a neuropsychometric diagnostic tool for specific learning abilities and disabilities (Mangina, 1981, 1994, 1998; Erlbaum Publishers, New Jersey, USA).

The purpose of our present research was to apply the 'Mangina-Test' to investigate the 'analytical-specific perceptual skills' of pathological and normal children and adolescents in Italy. The control group consisted of 58 children, 10 girls and 48 boys which age ranged from 7.10 years to 14 years, mean age 10.6. The performance of our normal sample fell within the normal four subcategories of the 'Mangina-Test': 74.1% above average perceptual abilities, superior and very superior 'analytical-specific perceptual abilities' and 25.9% average abilities similar. The pathological subjects to whom the 'Mangina-Test' was applied consisted of 130 subjects, 89 boys and 41 girls, within an age range between 5.6 and 16.0 years, (mean age 8.7) and divided in 8 diagnostic groups: generalized learning disabilities ($N=17$), specific learning disabilities ($N=27$), language disorders ($N=12$), attention deficit disorders ($N=6$), mixed developmental disorders ($N=8$), not otherwise specified learning disabilities ($N=4$), mental retardation ($N=17$), motor disturbances ($N=3$). 'Analytical-specific perceptual disabilities' were present in 72.3% of all considered pathologies, ranging from severe to moderate perceptual disabilities. Out of this percentage, 100% of children with mental retardation revealed perceptual disabilities, followed by children with generalized learning disabilities (89.5%) and mixed developmental disorders (80.0%) and with equal percentage (75.0%) children with attention deficit disorders and motor developmental disorders. The comparison of the diagnostic categories of the 'Mangina-Test' between the pathological subjects and normal controls showed highly significant differences ($P<0.001$) between the two groups: generalized learning disabilities ($z=-6.37$), specific learning disabilities ($z=-6.52$), language disorders ($z=-3.79$), attention deficit disorders ($z=-4.12$), mixed developmental disorders ($z=-5.11$), not otherwise specified learning disabilities ($z=-4.15$), mental retardation ($z=-6.56$), motor disturbances ($z=-3.41$).

The results of this investigation clearly testify as to the clinical usefulness of the 'Mangina-Test' and also confirm its 'culture-free'