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ABR Outside of Otolaryngology. On the Influence of Pathological Activity of the Brainstem on the ABR in Mental Illness

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ABSTRACT

This article deals with effects of mental illness on the ABR (Auditory Brain stem Response). The stimuli of the studies reviewed consist of complex sounds – different amplitudes, frequency spectra and backward and forward masking samples. Registration is made by newly constructed ABR equipment and various methods of curve analysis are applied. Stimuli of complex sounds were chosen as they are differently handled by the brain stem of individuals with mental illnesses. Analysis had to be developed to establish a foundation for the construction of markers for psychiatric use. Various studies are described where aberrances of the ABR-curve correlate with degrees of states such as schizophrenia, manic depressive disorder, depression, ASD (Autism Spectrum Disorder) and ADHD (Attention Deficit Hyperactivity Disorder). Reports of biochemical and pathophysiological influence from surrounding tegmentum of the mesencephalon on the auditory pathway are referred to. Finally, the importance for diagnosis and therapy control in psychiatry is emphasized.

BACKGROUND

The idea of using ABR (Auditory Brainstem Response) outside of ear, nose and throat and neurological investigations resulted from studies on perception of complex sounds. Early studies established that diagnostic groups of psychiatric patients perceived complex sound (samples of symphonic music of western character) in significantly distinctive ways [1]. Manic and depressive patients showed signs of tempo disturbances which were interacting with other specific preferences in those disorders. Neurotics were over-sensitive for aggressive elements in the music, and anxiety patients found most music unattractive, unable as they are to relax from their preoccupation with the severe symptoms. However, effects of schizophrenic psychotic states were not possible to detect, because paper and pen registration applied (verbal differential scales) was not suitable for these cases. Still, psychotic patients doubtlessly suffer from the most extreme perceptive disturbances known in man.

In literature on "auditory function" [2-4] it is supposed that many processes underlying perception are sorted already at lower levels than at the pallium, that is in the brainstem. Among these may be mentioned directional cues, feature separation (e.g. comodulation release from masking) and streaming as examples. Some studies were initiated to further elucidate the low-level processing postulate and its relation to psychosis. They concerned the use of psychoacoustic stimuli, namely, streaming, continuity illusion, and contralateral illusion. It turned out that schizophrenic patients processed and perceived these stimuli in significantly different ways from healthy subjects [5]. In a study of simultaneous auditory masking and forward and backward masking, more evidence for psychotic pathological relations to the brainstem was found [6]. In simultaneous masking there were no significant differences from healthy subjects, but in the two other forms there is a greater delay in the schizophrenic group to build up the normally expected percepts in the steps of the masking samples. In forward and backward masking conditions, schizophrenics showed plateaus in the series of increasing and decreasing steps from none to total masking. This could tentatively mean that a change based on a sorting mechanism in the schizophrenic midbrain did not function as smoothly as in healthy subjects.

STAGES TO CLINICAL APPLICATIONS

Major psychiatric disorders are lately hypothesized to have demonstrable relations to deficits in the brainstem. It is not long ago that a similar statement was strongly rejected by medical authorities under the belief that the brain-stem is a biologically archaic structure without developing dynamics. As such it would not function but in unchanging, rigid and safe ways. Recent research results show that functional and structural abnormalities in the mesencephalon of psychiatric patients are demonstrable [7-9]. It was desirable to corroborate the above-mentioned hypothesis, at first hand for schizophrenic psychosis. Masking (forward and backward) and other complex sound stimuli (e.g. with varied spectra and sound levels) were chosen as stimuli in an ABR registration procedure. ABR gives indications of biological aberrances in the functions of the brainstem. The testing is impossible to influence by will and is not sensitive to bodily changes, sleep and unconsciousness included. Therefore, the measurements made may be said to be objective as opposed to subjective decisions in clinical practice.

STUDIES FROM THE OWN RESEARCH GROUP

One study investigated ABR-changes in Autism Spectrum Disorder (ASD). It unveiled differences in comparisons between schizophrenics, ADHD (Attention Deficit Hyperactivity Disorder) -patients and healthy subjects. The amplitude of wave III was highly significantly reduced for ASD subjects in relation to all the other study groups on a specific stimulus condition. This would indicate a lower activity in the cochlear-olivary region of the auditory pathway [10]. Data from 2012 show aberrances in a multi-diagnostic sample. Laterality – different wave patterns from the right ear and the left ear, especially in the region of wave II – significantly separates schizophrenics from study groups of healthy controls, ADHD, Autism and Drug Psychotic Patients [11]. The earlier finding of deviating reaction in schizophrenics to forward masking [6] is at the same time reflected. The findings are interpreted as an expression of a reduced activity in the supra-olivary region, (wave IV). Schizophrenics, ADHD-patients and healthy controls were also significantly separated in a study from 2016 [12]. A study of possible aberrations in reactive depressive states showed many significant aberrations connected with various complex sound stimuli [13]. They are useful in clinical practice due to good correlations with a clinically used rating scale for depression (MADRs, Montgomery Asberg Depression Rating scale). In a collaboration with another university in Sweden, bipolar type I and schizophrenic patients could be separated by cABR (ABR with complex sounds as stimuli) measurements [14].

EXTERNAL STUDIES

Claesdotter et al [15] used ABR in connection with young ADHD patients. Several analytical parameters were applied in the analysis of curves, and the authors concluded that their research showed "that ABR has the potential to be the objective diagnostic instrument child and adolescent psychiatry has been looking for".

Mauilenko et al [16] tested the aptitude of ABR as a diagnostic instrument in a study of schizophrenia, ADHD and ASD. They didn't get evidence for the efficacy for clinical use. However, results for schizophrenia and ADHD showed tendencies from markers known from other studies. Regrettably, there seem to have been technical imperfections of the measuring managing and equipment at this potentially valuable study.

Baghdassarian et al [17] made a ABR-study with the same purpose as in the two studies immediately above. Study groups were 26 schizophrenics, 24 adult ADHD cases and 58 healthy controls. For schizophrenia they found a specificity of 93, 1% and a sensitivity of 84,6%, for ADHD 91, 3% and 87, 5% respectively. Such values imply that the method, if used in the same manner and upholding equal reproducibility of measuring, may be developed into an unquestionable contribution in the search for objective assessment of diagnosis and treatment control in psychiatry.

BRAINSTEM AND MENTAL ILLNESS

Auditory Brainstem Response measures deficits in the functioning and structure of the brainstem. It is used in neurophysiology, neurosurgery, audiology and neurology. The rationale for its use in psychiatry might seem doubtful and calls for an explanation. Psychiatry deals with partly different definitions of illnesses as general medicine. A considerable component of causative factors and symptoms are ascribed to socio-economic or psychological influence. Psychiatric disorders may by many psychiatrists be taken as mainly instrumental, i.e. an effect of multifactorial interaction with less focus directed towards the biological dominion. Many states within psychiatry are in fact more of a biological origin both regarding gross hereditary illnesses and aggravated reactive disintegrations. During the latest half century, the conceptualization of schizophrenia has included psychodynamic elements that has led to increased risks of missing the diagnose, false expectations and inadequate therapies. From the standpoint of experimental research, it is now clear that the biological foundation, hereditarily and physiologically, is undisputable [18]. The lesions of the brain discovered in the schizophrenic disorder are situated mainly in the prefrontal cortex, the hippocampus, the posterior lobe or at seemingly random spots as well. The idea of studying the brainstem origins in the assumption that Schizophrenia must express itself in deficits in the mesencephalon where all sensory- motoric activity must pass and be partly processed. The study of the hearing system in connection with a developmental nervous change is a good starting point. The system contains a multitude of sensitive and specialized complex functions and represents general neurophysiological principles of the CNS. The results reviewed above indicate that schizophrenia is a generalized state comprising basic receptive and efferent structures.

THE VALUE OF OBJECTIVE MEASUREMENTS IN PSYCHIATRY

The ABR method has decisive advantage by its barrier against influence of subjective reactions, mood state, bodily state and consciousness. The results can never determine the clinical diagnosis, but they give a hint on a biological aberrance common for a specific diagnostic group. The final diagnosis is, as always, the responsibility of the doctor with his/her responsibility for the patient. The function of being an objective support of diagnostic decisions in psychiatry cannot be estimated highly enough. Correct diagnoses of psychiatric diseases from general practitioners don't reach the 50% level [19]. Specialists in psychiatry reach about 70% accuracy in connection with first hand diagnostics of schizophrenic persons [20]. There is no doubt that an objective contribution in the care and treatment of psychotic patients would mean less controversial discussion, faster decisions, more adequate and early medication and other means of treatment. The ABR measurements must show greater accuracy than those mentioned above to be trusted by the profession, and this lies within possibilities already at this stage of the adaptation of the method to psychiatry. The method must be further tested by external researchers and its consistency, reliability and validity be ascertained from them as well. Comparisons between diagnostic groups (including healthy controls) give the basis for efficacy expressed as sensitivity and specificity governing the probability for a patient's pertinence to a specific diagnostic group. It will then be able to use the method not only to "give hints" but to enable operational categorizations of diseases.

ORIGINS OF AUDITORY BRAINSTEM CHANGES IN MENTAL ILLNESS

Originally the suspicion of brainstem dysfunction in psychosis was assumed to depend on organic deficits. It may not be the only explanation of mentally induced changes in the auditory pathway. Recent research on physiology and biochemistry of the cells and synapses of the auditory pathway has revealed amazing knowledge. Psychotic states have near connections to the monoamine functions in the brain. Epinephrine, Dopamine and Serotonin have been found at various levels and cell groups in the auditory pathway where they monitor different functions [21-23]. The auditory pathway may react in direct ways to mentally induced disturbance of general functioning of the brainstem. Tzonopoulos et al have shown how influence from surrounding brainstem cells may alter the firing patterns of cells of the auditory pathway [24]. There is also evidence that plasticity of auditory networks is active even at low levels of the brainstem [25].

FINAL COMMENTS

This brief review underlines organic and pathophysiological causes of mental disorder. The psychodynamic era of the latest half century has meant a great progress of theory development as well as caring and therapy activities of psychiatric patients. This revolution was at its time necessary but led to a decreased interest in formal diagnostics, phenomenological stringency and sometimes to negativistic attitudes toward diagnostic culture and even pharmacological or somatic treatments. An example of this is the banning of the, in serious cases, live- saving ECT (Electro-Convulsive-Therapy) from clinics in several countries. A sound balance of the levels of psychiatric work must be regained by an up to date integration of biological thinking within the discipline. The search for objective diagnostic markers is an important part of such a desired movement.

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