Neuropsychological and Neurophysiological Indices of Auditory Processing Impairment in Children with Multiple Complex Development Disorder
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Several investigations have revealed a characteristic pattern of behavioral and emotional dysfunction in children that has been referred to as borderline personality disorder or borderline disorder (BD) (Bemporad et al., 1982; Guzder et al., 1996; Kernberg, 1982; Pine, 1986) and more recently characterized as "multiple complex developmental disorder" (MCDD) (Cohen et al., 1987; Towbin et al., 1993; Van der Gaag et al., 1995). Although the labels of BD or MCDD are controversial (Towbin et al., 1993), these children are likely to represent a significant percentage of the childhood psychiatric inpatient population. In an adult outcome study, such individuals continued to manifest significant psychopathology in later life (Lofgren et al., 1991). Cohen et al. (1987) delineated three primary core symptoms found in children with MCDD. These include (1) the impaired regulation of affect states and anxiety, (2) consistent impairments in social behavior, and (3) impaired cognitive processing (thought disorder). BD/MCDD children appear to manifest extreme fluctuations in cognitive, attention, and emotional functioning (Bemporad et al., 1982; Towbin et al., 1993). Comorbidity between BD/MCDD and other disorders of childhood, such as attention-deficit hyperactivity disorder (ADHD), is evident in many cases (Bemporad et al., 1982; Boksenbaum, 1993; Guzder et al., 1996; Towbin et al., 1993).

Impairments of attention regulation in children with ADHD are well documented. (Agrawal and Kaushal, 1987; Hamlett et al., 1987; Pearson et al., 1991; Swanson et al., 1991). Attention impairments have also been associated with pathophysiology in individuals with ADHD. Abnormalities of event-related potentials (ERPs) associated with attention, the P300 in particular, have been described in persons with ADHD (Bloom, Lincoln, Courchesne, and Johnson, unpublished; Loiselle et al., 1980; Robaey et al., 1992; Satterfield et al., 1990).

ERPs are derived by averaging EEG to time-locked stimulus events. In such an averaging process, EEG that is not correlated with the onset of an experimentally controlled stimulus is averaged out, while EEG correlated with the experimentally controlled stimulus is retained in the average. This process results in recognizable ERPs that are defined by their topography, voltage (in microvolts), and latency (in milliseconds from either the onset of the time-locked stimulus or time-locked behavior response). An ERP component, P300 (also referred to as P3 and includes both P3a and P3b), has been studied extensively in nonpatient populations (Hillyard and Picton, 1987, review; Johnson, 1986, 1993, review; Lincoln et al., 1993; Pritchard, 1981, review).

The P300 is typically elicited by the use of an "oddball" paradigm in which the subject is directed to respond behaviorally to an infrequent target stimulus that occurs within a series of more frequently occurring nontarget stimuli.

The amplitude of P300 has been suggested to represent a variety of factors involved in
attention processing, including the updating of the current cognitive schema regarding the stimulus (Donchin, 1981; Donchin and Coles, 1988). The amplitude of P300 is thought to reflect the culmination of several factors that include stimulus modality, stimulus probability, and stimulus meaning (Johnson, 1986, 1993).

In both the auditory and visual modalities the amplitude of P3a and P3b are sensitive to changes in the probability of target stimuli; the amplitude of each component increases as the target stimulus probability decreases (Johnson, 1986, 1993). The P300 also decreases in latency (the time from the onset of the stimulus to when its peak amplitude is reached) from childhood through early adolescence (Courchesne and Yeung-Courchesne, 1978).

Thus, it takes children more time than adolescents or adults to cognitively register that a stimulus event has occurred. Generally, the time required for a behavioral response (reaction time) to the target stimulus is longer than the cognitive response as indexed by the P300. In children the P300 may reflect overlapping components: the P3a, which has a more frontal-central distribution and is of earlier latency, and the P3b, which has a more posterior distribution and is of later latency.