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Letter to the Editor

Physiological Evidence for Lifelong Brain Development: A Comment on Bartzokis

Irwin Feinberg*[,1]

[1]*UCD Sleep Lab, University of California, Davis, CA, USA*

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Sir

Bartzokis' (2002) proposal that schizophrenia is caused by errors in a lifelong process of brain development makes a valuable addition to neurodevelopmental models of schizophrenia. Bartzokis is primarily concerned with anatomical evidence (myelination) for prolonged developmental brain changes. Physiological evidence also supports his thesis that developmental brain processes persist late into life. These are dramatically demonstrated by the ontogenetic changes in NREM delta EEG and are apparent in both computer-measured 0.3–3 Hz activity and visually scored stage 4. Both measures show that the rate of delta production peaks in early childhood, declines rapidly across adolescence and then diminishes more slowly during adulthood, reaching a plateau at 50–60 years of age. Period-amplitude analysis demonstrates that the production of 0.3–3 Hz integrated amplitude declines by about 60% between ages 5 and 22 years, a change of −3.5%/year (Feinberg *et al*, 1990). All children show this delta decline. It must therefore be considered a normal developmental process. The delta decline continues across adulthood but at a slower rate. Nevertheless, the change is still substantial. Thus, delta at age 72 years is about 50% of the 22-year old mean, an average change of −1%/year (Feinberg *et al*, 1983).

Until recently, most other sleep researchers and I interpreted the delta decline in childhood–adolescence as due to developmental processes and assumed that the decline during adulthood was produced by aging (degenerative) brain events. However, there is no evidence indicating that different brain processes produce the delta decline in these two age periods (Feinberg, 2000). In fact, in old age, when degenerative brain changes increase markedly, delta remains at plateau levels. The decline of delta sleep across adulthood, which appears to be a continuation of the childhood decline, therefore provides physiological evidence that supports Bartzokis' hypothesis that some kind of developmental change takes place in the human brain over most of the life span. The ontogenetic changes in delta are especially interesting because this EEG component appears to reflect a homeostatic process by which sleep reverses the effects of waking brain activity (Feinberg, 1974; Borbely, 1982), presumably acting on plastic neuronal systems (Moruzzi, 1966).

Recent investigators of neurodevelopmental models of schizophrenia have tended to overlook the relevance of sleep EEG evidence. However, it is useful to recall that it was a search for the explanation of the delta decline during adolescence that gave rise to the first modern neurodevelopmental model of schizophrenia based on synaptic pruning (Feinberg, 1982/83). The sleep EEG remains a useful tool for new research on late brain development. Computer-quantified NREM delta is a highly reliable measure (Tan *et al*, 2000) that can be studied repeatedly and noninvasively.

*Correspondence: Dr I Feinberg, UCD Sleep Lab, TB148, University of California, Davis CA 95616, USA, E-mail: ifeinberg@ucdavis.edu
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