

CORRESPONDENCE

Brain Development During Adolescence: Neuroscientific Insights Into This Developmental Period

by Prof. Dr. rer. nat. Kerstin Konrad, Dr. PhD Christine Firk, Dr. PhD Peter J. Uhlhaas in volume 25/2013

Taking More Time

The issue of “adolescence, brain development and mental disorders“ is central to child and adolescent psychiatry, because the early diagnosis of mental disorders (prodromal symptoms) and the differentiation between “normal“ age-specific behavioral peculiarities in puberty is not always easy and generates risks in two directions: on the one hand, over-interpretation of “normal“ behavioral peculiarities and their pathologization, which, especially in this stage of life characterized by the need to find one’s own identity and a high degree of suggestibility, entails the risk that adolescents may accept a diagnosis as their own identity, resulting in iatrogenic undesirable developments. On the other hand, there is the trivialization of prodromal symptoms, e.g. he or she “will grow out of it“, which may have unfavorable consequences. Therefore, a careful specialist diagnosis, taking into account all aspects, is required to enable initiation of proper treatment. “Early interventions“ as well as exceedingly long watchful waiting may be fatal. A psychiatric illness, if not treated, may have serious consequences for further brain development, especially in the sensitive adolescence phase. Incorrect interpretation of symptoms, for example, misdiagnosing age-specific mood swings, or typical adolescent narcissistic or histrionic patterns as psychiatric illnesses, and focusing the adolescent on them (pathologization), may as well have fatal consequences for the further brain development, because, for example, many psychiatric drugs interfere with relevant brain processes and may cause disorders under certain circumstances. In addition, the self-image of being a mentally ill person may have consequences for the development of one’s own personality and subsequently for brain development.

My appeal: Take time for thorough diagnostics, including family dynamics/the life circumstances. In case a definite diagnosis can be established, be courageous and initiate consequent treatment. In case of uncertain diagnosis, regular specialist follow-ups/drug withdrawal trials should be undertaken. In addition, a cost-benefit analysis of medication should be performed together with the patient at various times along the treatment course

DOI: 10.3238/arztebl.2013.0732a

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Conflict of interest statement

The author declares that no conflict of interest exists.

Neuromolecular Analogies

I would like to sincerely thank the authors of the review about brain development in adolescence (1). With their paper, they contribute to a differentiated approach to a sensitive issue which at times is dealt with in a very simplifying manner.

I very much agree with the key statements, but would like to highlight another aspect: Underlying the described maturation processes and an asynchronicity of their distribution over the cortex, there are in parallel neuromolecular analogies, which again correspond, rather phenomenologically, to two poles or “basic needs“ (i.e. functions of development and maturation) – seen from a biological perspective, one could thus refer to “protection and connectedness“ on the one hand, and “autonomy and freedom“ on the other (2). While maturation occurs earlier on the lower limbic levels, the upper limbic or paralimbic areas reach “maturity“ later and then lose plasticity, a phenomenon which may also be due to the effect of dopaminergic groups of neurons in the mesolimbic-mesocortical network (2, 3).

The endogenous reward systems not only control affective-emotional conditioning and the “memorizing“ of corresponding contexts, but obviously also social integration and control, although not at the same time. Essentially this ability seems to be maintained beyond adolescence, which occurs to be highly relevant from a medical perspective, because decisions in terms of lifestyle and health behavior, or the active change of it, over the entire lifespan depend on those reward mechanisms, and on an only slowly maturing (i.e. unceasing) integration and control ability. Subjective quality of life and life satisfaction seem to be influenced by it as well (4). Health promotion interventions should make larger use of that knowledge, not only in adolescent medicine (2, 4).

DOI: 10.3238/arztebl.2013.0732b

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Conflict of interest statement

The author has received honoraria for research projects initiated by him from Stiftung Humor Hilft Heilen, the Oberberg-Stiftung, and the Samueli Institute.

Temporal Limitation and Irreversibility of Brain Development

In the mental development (compare the article by Konrad et al., 1) the increase of puberty hormones stimulates the development of the hypothalamic-pituitary-adrenal axis.

Here, androgens show a rather inhibiting effect on CRH production, while estrogens have a stimulating effect. Emotions and stress tolerance are influenced by this. Stress hormones, in turn, stimulate the development of the subcortical structures, which stimulate the development of the cortical structures.

Thus, in summary it can be stated that this development also follows the usual principles of temporal limitation and irreversibility, as well as step-by-step progression.

As bone growth ultimately induces heart growth under physiological conditions, while the reverse does not apply, an increase in puberty hormones ultimately induces the development of cortical structures during the mental development, while the reverse does not apply.

The developmental discrepancy between subcortical and cortical structures, i.e., the emotionality without sufficient cortical control, is responsible for the behavior patterns typically observed in puberty. However, under physiological conditions it will not be observed – in analogy to physical development – that cortical structures are more developed than subcortical structures or that they even stimulate their growth.

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Conflict of interest statement

The author declares that no conflict of interest exists

In Reply:

We like to thank our colleagues for their interesting ideas on our article and would like to take the opportunity to comment on some key points of the discussions.

Mr. Calia is right to highlight the importance of thorough diagnostic workup, including the life circumstances of the teenage patient, for the early diagnosis of psychiatric illnesses in adolescent patients. Within the field of psychoses, diagnostic techniques have meanwhile developed to a point where they allow to estimate the psychosis risk in adolescents and young adults reasonably well; however, it has also been shown that subjects meeting ultra-high risk criteria for psychoses frequently have other conditions as well (1).

Therefore, it seems justified to view adolescence as a pluripotent risk stage, from which various psychiatric illnesses can emerge. Further long-term studies are required to arrive at a better understanding of the courses and the development of various abnormal mental conditions among adolescents.

Prof. Dr. med. T. Esch’s correspondence item highlights the association between the phenomenological level and the neurobiological dynamics in adolescence, resulting from the difference in maturation of cortical and subcortical structures, apparent in the opposing basic needs of “protection and connectedness“ versus “autonomy and freedom“. Here, it certainly can be stated that the plasticity of the reward system which, for example, has a crucial impact on risk behavior is maintained beyond adult age. However, data from human and animal studies appear to indicate that especially this system undergoes particular deep changes in adolescence.

The connection between the hormonal maturation processes in puberty and the neurobiological changes in adolescence is a further and central subject of future research.

The authors agree with Dr. phil. Dr. med. H. Niederhofer that maturation of cortical structures does not by itself cause an increase in puberty hormones. Likewise, it is not assumed that subcortical changes directly stimulate growth in cortical structures.

However, only limited conclusions can be drawn that neurobiological changes are only the result of hormonal factors. Rather a complex interaction of both organizing and activating effects of sexual hormones on brain development can be assumed, i.e. that on one hand permanent reorganization of neurohormonal networks may occur under the influence of hormonal changes, but also that the activity of the matured networks changes as a result of acute hormonal stimulation (2).

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Conflict of interest statement

Prof. Konrad has received lecture honoraria from Medice, Lilly and Novartis. She has received research support (external funds) from Vifor Pharma Ltd.

The remaining authors declare that no conflict of interest exists.