

Sleep and the Developing Brain

Commentary on Touchette et al, Associations between sleep duration patterns and behavioral/cognitive functioning at school entry. *SLEEP* 30(9);1213-19.

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BROADLY SPEAKING, IT MIGHT BE ARGUED THAT THE MOST FUNDAMENTAL REQUIREMENTS FOR HEALTHY GROWTH AND DEVELOPMENT IN YOUNG CHILDREN include a) loving support and protection by parents/caretakers, b) adequate nutrition, and c) adequate sleep.

Regarding the first two categories, there is a long history of accumulating scientific evidence and deepening mechanistic understanding, which has informed clinical and social policies benefiting children. For example, the pioneering work of scientists like Harry Harlow, John Bowlby, and Michael Meany have provided the scientific basis for understanding the role of physical affection and responsive caretaking in the early development of specific neurobehavioral systems, in ways that continue to impact social policy and child health.¹ It is valuable to remember some of the official health recommendations in place when Harlow began his studies—when fear of infectious diseases led to harsh admonishments that parents should minimize all touch and affection and assiduously avoid kissing their children, and hospitals only permitted parents to visit their ill children once a week—policies that sound primitive and harmful in light of modern understanding. Similarly, scientific advances in nutrition, such as understanding the role of proteins, carbohydrates, lipids, vitamins, and essential minerals, has led to major health policies, such as adding vitamin D to milk, iodine to salt, WIC programs to support pregnant and lactating mothers, and school lunch programs.

Regarding the third category—the importance of sleep—our field is at a relatively early point in the curve of establishing needed scientific understanding. On one hand, many would argue that the current evidence for the fundamental role of sleep in the physical, emotional, and behavioral health of children is already sufficient to advocate for clinical and social policy changes and large-scale educational programs focusing on the value of sleep. On the other hand, skeptics can point to the distressingly small number of studies upon which to base these changes—and the fact that the current data are based almost exclusively on the acute effects of sleep loss. Given the health significance of these issues, there is a need for empirical data to guide the field—particularly studies that address the *long-term effects* of sleep patterns during early development.

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The paper by Touchette et al² provides an important contribution relevant to this critical area. There are several notable strengths to this study: it utilized a longitudinal design with a large sample of children; examined not only the total amount of night sleep but also the patterns of change in sleep times over development; utilized behavioral measures and cognitive tasks at school entry; and controlled for numerous potentially confounding psychosocial variables that could influence the outcome variables. The finding that short sleep duration in the first 3 years of life was associated with hyperactivity/impulsivity and lower cognitive performance on neurodevelopmental tests at age 6 is provocative and potentially very important.

These findings appear to be consistent with previous evidence for short-term effects of sleep loss. Yet some aspects of their findings are quite novel. Notably, they reported that specific cognitive deficits and high hyperactivity scores at age 6 were most strongly associated with a pattern of short sleep duration at age 2.5 years, despite the increase to normative sleep patterns from age 3.5 through 6 years. This suggests that obtaining insufficient sleep during the first few years of life may have long-standing consequences.

Of course, as is often the case with pioneering studies, there is a need to replicate and extend this work in several ways. Inclusion of objective measures of sleep duration and examining daytime naps as well as nighttime sleep will be essential. Similarly, a broader assessment of neurobehavioral and cognitive tasks (ideally addressing regulation of emotion as well as cognitive control) also would be extremely valuable additions.

Finally, the most provocative implications of the study—suggestive of a critical period of brain development that is sensitive to sleep—requires rigorous study. This possibility raises a set of intriguing questions about sleep, learning, and brain plasticity that could be addressed by translational research. Indeed, there is an emerging body of basic research exploring these ideas. While most of the studies examining sleep in the consolidation of learning focus on adults,³ a recent study has found preliminary evidence for the role of sleep in learning in infants.⁴ Another exciting body of work is the evidence that sleep homeostasis is involved in basic aspects of neural plasticity.⁵ Animal studies have long implicated a role for sleep in neural development, but the field now appears to be poised for a deeper and more mechanistic understanding of how sleep may be crucial for specific aspects of neural development and adaptation in response to early experience.

These issues represent a major frontier in developmental neuroscience. Moreover, they hold great promise for informing pragmatic social policies about the importance of sleep in brain development in ways that have an enormous capacity to benefit children. It is interesting to imagine which current policies and attitudes about child sleep may someday appear primitive and

harmful, and what types of insights and changes will contribute to healthy development. It is truly an exciting time of opportunity for our field.

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