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REVIEW ARTICLE

THE ROLE OF SLEEP IN THE BRAIN DEVELOPMENT OF ADOLESCENTS

***Augustine Kubdaar**

MA, Clinical Psychology Student, United States International University of Eastern Africa, P. O. Box 14634 - 00800, Kenya-Nairobi, E/Afr. Kenya

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ABSTRACT

Every normal person desires to live a happy, joyful and above all enjoys long and fruitful life on earth. Good quality (REM) sleep is therefore one of the factors that contribute immensely to a proper brain development and efficient total functioning of people especially adolescents. On the contrary, poor quality (Non-REM) sleep leads to incapacitation of the structural as well as hormonal development and functioning of the brain thus resulting in several poor health conditions and maladaptive behaviors.

INTRODUCTION

Sleep is essential for normal survival and integrity of most living organisms. For human beings sleep pattern is composed of two main stages: Rapid Eye Movement (REM) sleep, also known as paradoxical sleep (PS) and Non-REM sleep (Dang-Vu *et al.,* 2006). These two extreme main stages progress through four distinct phases spread over cycles lasting about 90 minutes (Feldman, 2013). This paper examines the role of sleep in the development and functioning of the human brain, in particular that of adolescents. The paper focuses on five main issues: the role of sleep in brain plasticity; brain processing and sleep in adolescents experiencing clinical depression; importance of sleep to the somatic and brain development of adolescents and lastly, some effects of poor quality sleep on the brain function of adolescents. As part of its significance, the findings of the paper are of great benefit to parents, teachers/educators, researchers and above all adolescents who have a desire for knowledge about the role of sleep in their development.

The role of sleep in brain plasticity

Researchers (Dang-Vu *et al.,* 2006) note thata good amount of sleep in early life plays a role in brain maturation. In particular, REM and non-REM sleep influence the development of the visual system and brain development of young people. Sleep amounts are reported to increase following a learning task for adolescents. Therefore, sleep deprivation impairs task acquisition and consolidation of skills learned. Neurophysiological studies reveal possible mechanisms for the consolidation of memory traces due to the fact that both thalamocortical and hippocampo-neocortical networks continue to work during sleep. Neuroimaging techniques demonstrate dependent changes in cerebral activity during sleep. There is always modulation of cerebral protein synthesis and expression of genes involved in neuronal plasticity during sleep. Dang-Vu *et al.* (2006) further report other exclusive roles of sleep which include brain thermoregulation; neuronal detoxification; tissue restoration; immune defense and energy conservation especially for adolescents who are usually hyperactive during most hours of the day. Good quality sleep accords the brain the ability to persistently modify its structure and function according to genetic information and external changes necessary for its proper integration and maximal functionality. Dramatic changes, such as synaptic plasticity, as well as levels of modulatory neurotransmitters also occur in the brain during sleep. A fraction of genes potentially important for synaptic plasticity are up-regulated by sleep. These genes belong to different functional categories suggesting that sleep and wakefulness may promote different cellular processes. In this way the adolescent brain is better energized to meet high energy needs and at the same time provide high synaptic excitatory neurotransmission; high transcriptional activity and synaptic potentiation in the acquisition of new knowledge (Dang-Vu *et al.,* 2006). Sleep also restores and replenishes the

Corresponding author: Augustine Kubdaar
United States International University of Eastern Africa, P. O. Box 14634 - 00800, Kenya-Nairobi, E/Afr. Kenya.

adolescent brain and body in that some activities of the brain are reduced during sleep, thereby giving room for neurons in the brain to repair themselves. All these in addition to the fact that growth hormones associated with physical growth and brain development are released during sleep, make good quality sleep very essential for all people, but especially adolescents (Feldman 2013).

Brain processing and sleep in depression

The study by Edge (2010) synthesizes some investigative research purported to explain the physiological mechanisms contributing to the relationship between sleep dysfunction and clinical depression in people. In the view of the author major depression is consistently linked to sleep abnormalities and insomnia. Neurobiological studies for example indicate among others the crucial role of sleep in the affective modulation of brain functioning among young people. Adolescents who suffer from major depression experience a reduction in slow wave sleep and interruptions in sleep continuity. While Feldman (2013) asserts that there are four stages of sleep, Edge (2010) notes that human sleep can be classified into five phases with the first four comprising of non-rapid eye movement (NREM) sleep and the fifth stage being REM sleep. The latter is the very depth of sleep. An adolescent normal sleep cycle is supposed to be 8 to 9 hours daily. Edge (2010) further explains that stages three and four are the deepest stages of NREM and are associated with energy conservation and refreshing of the immune system whereas, the fifth stage is associated with dreaming and memory consolidation. Alterations in brain chemistry at varied levels do occur as people oscillate through the various stages of sleep.

During NREM sleep, the brain stem, the thalamic, the basal ganglia as well as the prefrontal and temporal lobe regions all appear to undergo a significant decrease in their normal activity. However, Edge (2010) states that during sleep, clinically depressed patients do show increased activity not only in the midbrain but also in other important areas such as the reticular formation and the anterior paralimbic cortex. This is due to the over activation of limbic structures, which result in experience of stimuli in a more emotionally intense and often in a negative context thus predisposing the person to clinical symptoms of a major depressed patient. In a similar way, sleep deprivation may predispose the brain for the encoding of negative emotional memories thus stimulating a hyperlimbic response to negative emotional events. Lack of sleep also makes adolescents decline in logical reasoning ability and so adolescents who continuously experience insufficient sleep become edgy; slow in reaction time and lower in academic performance (Feldman, 2013). They also experience imbalance in memory encoding. It is evident that clinically depressed people worry so much about emotionally charged thoughts, which consequently rob their brain from recuperating during sleep hence a continuous cycle of depression is formed (Edge 2010).

A correlation between sleep and obesity

A study (Garaulet *et al.,* 2011) suggested that adequate sleep is a critical factor for adolescent's health and health-related behaviors. Laboratory studies have found that sleep need which influence brain maturation, and psychological changes in puberty is universal to all adolescents' across-cultures and over the world. Chronic partial sleep deprivation is highly correlated with the rising epidemics of overweight and obesity. Obesity is a chronobiological illness resulting from external synchronizers (for example shortened sleep) which do alter the central internal clock of human beings. Abnormal sleep–wake patterns have a higher probability of disrupting or altering the intracellular circadian system (especially the circadian clock) thereby resulting in increase in weight of a person. Television watching and sedentary lifestyle afford adolescents more time and/or more opportunities to eat food or snacks and drink more consequently leading to shorter sleep pattern and health hazard such as overweight for those who have the biological propensity to obesity. Cross-sectional studies have also consistently observed an association between short sleep duration and increased adiposity in children and adolescents. Chronic partial sleep deprivation also leads to feelings of fatigue and reduction in physical activity.

Importance of sleep to the somatic and brain development of adolescents'

The study by Brand and Kirvo (2011) presents interesting dual contemporary views about the complex neurobiology of sleep and its functions. They also examine the existing complex relationships about sleep-related issues and psychiatric disorders. Sleep is a universal biological feature in all species. It represents a global state of immobility with greatly reduced responsiveness to environmental stimuli. It is by no means a dormant state. Good sleep patterns therefore are strongly associated with better physical, cognitive, and psychological astuteness of adolescents who by nature are hyperactive at this developmental stage. By contrast, poor or disordered sleep patterns also correlate with impairment of cognitive and psychological functioning and worsened physical health of adolescents. Again, given the undeniable fact that adolescence is hallmarked by dramatic maturational changes, the role of sleep and its corroborated neurobiological regulation, hormonal status, psychosocial as well as physical processes cannot be overemphasized.

Brand and Kirov (2011) continue to posit among others that sleep is beneficial for neuronal recuperation, synaptic homeostasis; the human metabolism system; immune system functioning, thermoregulatory, cardiovascular, respiratory and the normal brain and body homeostasis. With adolescence being an especially maturational time and at the same time a vulnerable period during which many cognitive, as well as psychological processes greatly mature and are at risk for morbidity, the role of sleep for the adolescent cannot be overstated in this regard. Poor sleep cycles during adolescence are common conditions that lead to highly specific somatic and psychiatric disorders. The same situation may also result in maladaptive functioning among adolescents. Obesity, poor academic achievement, and slower psychological processing in this age group of persons are characteristically evident due to continuous poor sleep pattern. These conditions can also be observed in the adolescent making suboptimal decisions and actions; emotional liability; stress in social relationships with

peers; increased incidence of unintentional injuries; violence, substance abuse, and excessive use of electronic media. Chronic sleep loss in this group also results in deteriorated synaptic plasticity. All the above conditions are regarded as preconditions for developmental psychiatric disorders. Therefore, treatment of the aforementioned common adolescent health conditions should also consider the alterations of sleep patterns.

Effect of poor quality sleep on the brain function of adolescents

In a most recent study (Telze *et al.,* 2013) the authors examine the links between normative levels of sleep, brain function and risk taking in adolescence. The authors hypothesize that poor sleep quality relates to cognitive control and reward related brain function during risk taking. Working with a sample of forty-six adolescent who completed a cognitive control and risk taking task in a functional magnetic imaging (fMRI) scan the results show that adolescents who reported poorer sleep also score higher in risk-taking. Poor sleep quality particularly accounts for emotional deficits, decreased cognitive modulation, and less effortful control of attention. Adolescents who experience continuous poor quality sleep particularly during weekend activities and some festive occasions for example, turn to involve themselves in risky behaviors such as smoking, alcohol and drug abuse, unsafe sex, drunk driving and/or over speeding thus endangering not only their lives but also that of others. High risk taking during adolescence is heightened by reward seeking and immature impulse control. As a result of insufficient sleep adolescents may lack the cognitive capacity to appropriately evaluate consequences in decision making. Functional connectivity analyses in adolescents reveal that poor sleep not only impairs brain function in affective and cognitive control regions but also disrupts cross-talk between two neural systems — the affective system, responsible for reward sensitivity, and the cognitive regulation control system, which in adolescence is still undergoing a process of maturation. Neural imbalance may push adolescents towards riskier decisions and hinder their ability to regulate their behaviors. As a result of poor sleep, adolescents' brains show less activation in the dorsolateral prefrontal and affective regions thus rendering them more oriented towards risk taking behaviors. Behaviorally, poor sleep quality is also associated with more apathy and less self-esteem. Hence, adolescents' who have poor quality sleep may be more apathetic and less confident to inhibit taking risky behaviors. This could be due to dampened or reduced dorsolateral prefrontal cortex activation coupled with reduced functional insula.

What is more worrying is that the interaction between poor sleep, heightened arousal, as well as a dampened cognitive control might continue to create and complicate a negative chain of events resulting in most adolescents continuously having sleepless nights (Telze *et al.,* 2013) Given the fact that poor quality sleep pattern is so pervasive during adolescence, it is very important that further studies be done to capture variability along this normative continuum.

Conclusion

The role of quality sleep in brain maturation and functioning especially in the life of adolescents cannot be overemphasized. The study indicates a strong correlation between sleep and the adolescents' brain plasticity, learning and memory processes. Sleep plays an executive or a permissive role for brain plasticity and memory consolidation. It is striking to note that normative levels of poor sleep quality among adolescents correlate with risk-related behavior and brain function. Sleep disorders on the other hand, result in normative imbalance affective as well as cognitive control system. This may result in great behavioral and health risk such as depression. However, the precise contribution that each of the four or five sleep stages makes to the processing of memory and brain maturation and functioning is yet to be established. Poor sleep can also cause brain disruption and render adolescents' ever more vulnerable to suboptimal decision making.

REFERENCES

Brand, S. and Kirov, R. 2011. Sleep and it's importance in adolescence and in common adolescent somatic and psychiatric condition. *International journal of general medicine*, 425-442.

Dang-Vu, T. T., Deseilles, M. and Peigneux, P. 2006. A role of sleep in brain plasticity. *Taylor & francis group: pediatric rehabilitation*, 98-118.

Edge, L. 2010. The role of emotional brain processing during sleep in depression. *Journal of psychiatric and mental health nursing*, 857-861.

Feldman, R. S. 2013. *Understanding psychology.* US: McMGraw-Hill.

Garaulet, M., Ortega, F., Ruiz, J., Rey-Lopez, J., Beglim, L., Manios, Y. *et al.* 2011. Short sleep duration is associated with increased obesity markers in european adolescents: effect of physical activity and dietary habits. *International journal of obesity 35*, 1308-1317.

Telze, E. H., Fuligni, A. J., Lieberman, M. D. and Galvan, A. 2013. The effect of ppor quality sleep on brain brain functioning and risck taking in adolescence. *Neuroimage* 71, 275-283.

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