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Dopamine and Language Acquisition: A Conscientious Look

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Abstract

Dopamine has long been known to be important for the reinforcement of learning. Although dopamine turns out to be in a variety of forms, most of which act as transmitters of neural signals that control the synaptic plasticity of the brain. The present study keeps a plausible look at the relationship between dopamine and language acquisition and implies finding ways in order to increase the very given hormone.

Key words: dopamine, estrogen, motivation

1. Introduction

The latest developments and growing interests in the human brain and learning urged scientist and educators to work on research in neuroscience. Mountains of study have been reported regarding the individuality of language learning. And one potential source of this variation is individuals' genetic differences. As Wong, Morgan-Short, Ettlinger, and Zheng (2014) assert adult language learning provides a unique opportunity for understanding individual differences and genetic bases of neuroplasticity. Of interest to the present study is the focus on the impact of the dopamine level in language acquisition. The given review aims to ignite a conscientious look at the studies conducted in the related field.

It goes without saying that some activities and topics activate students more than others in language learning. "Nor is it a surprise, that when activated, students retain more of what they are being taught" (Kelly, 2013, p.17). Kelly (2013) also asserts that positive motivation on the part of students is linked to the role of dopamine. Dopamine is an important neurotransmitter for a number of brain functions, including movement, drive, and reward, and its presence also facilitates long-term learning. Furthermore, dopamine-related genetic variation and language acquisition may be correlated. As Wong et al. (2014) report, provided that the probability of such correlation is strengthened, future empirical findings may point to neurogenetic markers that allow for language learning to be personalized.

Research shows that the level of dopamine is positively correlated with the procedural memory since the procedural memory system is associated with inferior frontal gyrus where dopamine--associated neurons are found (Wong et al, 2014). In the same vein, de Vries et al. (2010) assert that performance of healthy adults will be improved after levodopa (a precursor of dopamine) intake. In other words, it can be claimed that the more exercise, the higher procedural memory will be. Thus, exercise increases dopamine levels in the brain through a calcium-dependent process (Suto & Akiyama, 2003. Hence, as Surmeier (2007) maintains, the release of dopamine by neurons is necessary for sustaining neural activity and working memory.

There have been mountains of papers written on the influence of dopamine on the brain circuitry system, yet we still don't have a clear answer to how dopamine will have an influence on the brain. Particularly, Surmeier (2007) claims "sorting out what dopamine is doing is a particularly difficult issue for a variety of reasons" (p. 885). Elsewhere, Surmeier asserts that the manipulation of dopamine "depends upon how the cell is interrogated or excited" (p. 885).

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As mentioned earlier, dopamine was discovered to be a transmitter in the central nervous system (Carlsson, 1959). The major source of dopamine are the dopamine-releasing neurons of the ventral midbrain located in the cerebral cortex and in the subcortical areas (Bromberg-Martin., Matsumoto, & Hikosaka, 2011). The dopamine system is responsible for the control of locomotion, cognition, emotion, positive reinforcement, appetite, and endocrine regulation (Missale et al. 1998). Dopamine influences these physiological processes by activating at least five different dopamine receptors (D1, D2, D_3, D_4, & D_5) located throughout the brain (Dawes & Fowler, 2009). However, the role of D_2 is being meticulously investigated as it has a vital role in modulating dopamine synthesis, cell firing, and release (Hurd & Hall, 2005, cited in Dawes & Fowler, 2009). The D2 receptor is linked "to differences in cognitive function" (Dawes & Fowler, 2009, p. 1159).Studies (e.g., Backman et al., 2000) show that D2 receptor is correlated with attention. Henceforth, fluctuation in the amount of D2 receptor will readily debilitate the amount of attention.

Dopamine level is also responsible for the control of positive reinforcement (Dawes & Fowler, 2009). As put by Wise (2004), the influence of dopamine on motivational function was earlier identified by Ungerstedt's report that "feeding and drinking deficits that are similar to those caused by lesions of the lateral hypothalamus can be induced by selective damage to the dopamine fibers that traverse this region" (p. 1). Wise also concluded that the level of "dopamine is important in goal-directed behavior" (p. 10). In a sense, dopamine release is closely "linked to the efficacy of the unconditioned rewards" (Wise, 2004, p. 1). Of particular interest will be the role of dopamine and the extent to which it is involved in the acquisition of language.

Dopamine neurons appear in a variety of forms. Bromberg-Matin, Matsumoto, and Hikosaka state (2011) "some dopamine neurons encode motivational value, supporting brain networks for seeking, evaluation, and value learning. Others encode motivational salience, supporting brain networks for orienting, cognition, and general motivation" (p. 815). They further hypothesize "both types of dopamine neurons also transmit an *alerting signal*, triggered by unexpected sensory cues of high potential importance" (p. 815). In sum, dopamine controls synaptic plasticity (Montague et al., 1996; Schultz, 1998). The control of the synaptic plasticity is done through reinforcement learning.

Dopamine, the hormone of motivation, is involved in reinforcement learning. Daw and Shohamy (2008) assert that the level of dopamine increases when one is rewarded unexpectedly. In fact, when the reward is phasically expected, the release of dopamine by neurons does not occur. Daw and Shohamy, further, put forth that there is a trade-off between the expectation of reward and the level of dopamine. Put simply, a fully predicted reward does not activate the neurons.

Brizentine (2007) also declares that dopamine is the best friend of estrogen. Studies (e.g., Uster, 2008) show that when the level of estrogen diminishes, dopamine level also decreases. Henceforth, since homogenizing females based on the level of estrogen is not that much easy since estrogen fluctuates and is not fixed during a month, dopamine can be a good indicator of study in order to hypothesize and study the impact of estrogen on the related variables.

Importantly, the brain develops from the bottom up. The midbrain and the brainstem are among the first areas of the brain to develop. These areas, also called survival brain, control the basic functions of body. It goes without saying that some topics and activities activate students more than others. This is surely related to the role of dopamine— an important neurotransmitter—that facilitates long-term learning. As Kelly (2013) asserts "dopamine connects drive, reward, and learning gives us a picture of how the brain learns: your brain remembers things related to what you desire, and things that make you feel good" (p. 2013).

2. Final Remarks

Identifying a special gene that may be partly responsible for the tendency on the part of human beings that contributes to language acquisition is legitimate. Further study is needed in order to cast lights upon the identification of genes that are transcribed in the brain areas known to be involved in language acquisition.

Nevertheless, due to the lack of anatomical landmarks on the brain this is not an easy task to conduct experiments on human beings' brains in order to investigate the role of hormones including dopamine.

Thus, of critical importance is the assumption that when learners are motivated through unexpected stimuli, their dopamine will increase; henceforth, learning a particular action will enhance. What is worth mentioning is that whether the level of dopamine is the same in males and females. If so, it is worth trying to have a critical look at the stance of dopamine in order to find ways in order to increase the very given hormone in this regard.

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