

LANGUAGE ACQUISITION AND PERCEPTION THROUGH THE ROLE OF NANO CHEMICAL NEUROTRANSMITTERS IN THE BRAIN

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Abstract:

It is ineluctable that language is a clear truism of the challenging of the human mind and it connects impressively to the brain. It has been investigated that neurotransmitters such as dopamine control human speech mechanism. In this work, it has been clarified the relation between language and brain through the chemical neurotransmitter by measuring the physicochemical properties of relative energy, Van der Waals forces and dipole moment via computational modeling. Then thermodynamic properties have been calculated by infrared radiation to recognize the active sites of dopamine structure and comparing it by some other neurotransmitters. In this paper, it has been exhibited that how dopamine can be effective for learning a new language and makes it easier and enjoyable.

Keywords: Language Learning, Brain, Dopamine, Chemical Neurotransmitter, Theoretical Method

Introduction

Among different species [1-4], only human has the most developed capabilities for speech and making language.

Inevitably, neurological experiments have shown a central controlling function by dopamine in suitable motor commands and perceiving and higher-order cognitive status accompanied with language institute [5-11].

Researchers have investigated the neuroscience of learning based on condition changes of brain [12-14], and they have focused on the learning of grammar knowledge through an explicit neurophysiological basis [15, 16].

It has been recognized several factors such as environmental and neural indices (musical

experience) [17,18], practice method [19-21], memorizing-base [22], and genetics parameters (gene ASPM for the perception of lexical tone, genes ROBO1, FOXP2,CNTNAP2, for work on communicative impairments and developmental delay) on prosperity of language learning [17,23-25].

Moreover, several characteristics of the dopaminergic system have been established, including relevant genes, brain systems, domain-general (cognitive) functions, and language functions. These characteristics can form the basis for developing informed hypotheses concerning the genetic basis of grammar learning and memory system [26, 27].

The dopaminergic system is connected to the frontostriatal process with other brain structures [28], associated with the procedural memory

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system [29], while encoded dopamine (DA)-gene receptors and transporters in non-linguistic components are related to different kinds of learning instructions and brain replies [30].

Dopamine has many functions, including effects in behavior and cognition, movement, attention, motivation and reward, mood, sleep, and learning. Its impact on motivation and learning is of particular note for changing minds. It has also been linked with sociability and creativity.

Especially, factors of development and environment are effective criteria for language learning in general.

In this paper, it has been clarified that how dopamine beside other chemical transmitters of epinephrine, norepinephrine, and histamine in the brain can be effective on learning process of a second language. Based on this purpose, it has been done theoretical force fields on the indicated small molecules to achieve physicochemical parameters as a practical model to prove the perspective of language learning and enhancing this ability.

Results and Discussion

In this research, it has been compared the chemical neurotransmitters through different aspects of physicochemical properties and how it relates to procedural acquisition and other areas of perception and cognition.

Dopamine is one of many significant neurotransmitters because of movement, cognition

and motivation roles through the physicochemical properties.

It has some specific roles in the way our brain monitors our movements, in controlling the flow of information from other areas of the brain, in accompanying with the happiness and satisfaction of the brain due to enjoyment and reinforcement to encourage us to do activities base on neurobiological theories. Moreover, dopamine covers the information flowing to the brain through learning and organization the knowledge of human beings.

It has been explored that dopamine has different manner and feelings through its chemical effect compared to other neurotransmitters of epinephrine, nor epinephrine and histamine.

Learning new things is a fulfilling and adventurous for the young and many adults, so dopamine enhances in the brain to keep our information. However, some learners cannot retain the new expertise and lose them due to lack of dopamine. On the other hand, we can increase dopamine levels by persuading students and generates enthusiasm on them to learn and remember the collection of data in their brain and it says to teachers how prosperous they are in different knowledge or skills such as language.

In this paper, it has been shown that dopamine has the most stabilized structure with the lowest minimized relative energy compared to some other neurotransmitters of epinephrine, norepinephrine and histamine which have been calculated by computational modeling (Table 1).

Table 1. Physicochemical values of neurotransmitters dopamine, epinephrine, norepinephrine and histamine neurotransmitters using theoretical calculations.

structure	Dipole(Debye)	Relative Energy (kcal/mol)	van der Waals forces (VDW)
dopamine	1.0719	-8.5953	4.9525
epinephrine	1.4928	-6.8923	6.0963
norepinephrine	1.9711	-6.5628	4.7042
histamine	-1.5714	12.0059	1.2008

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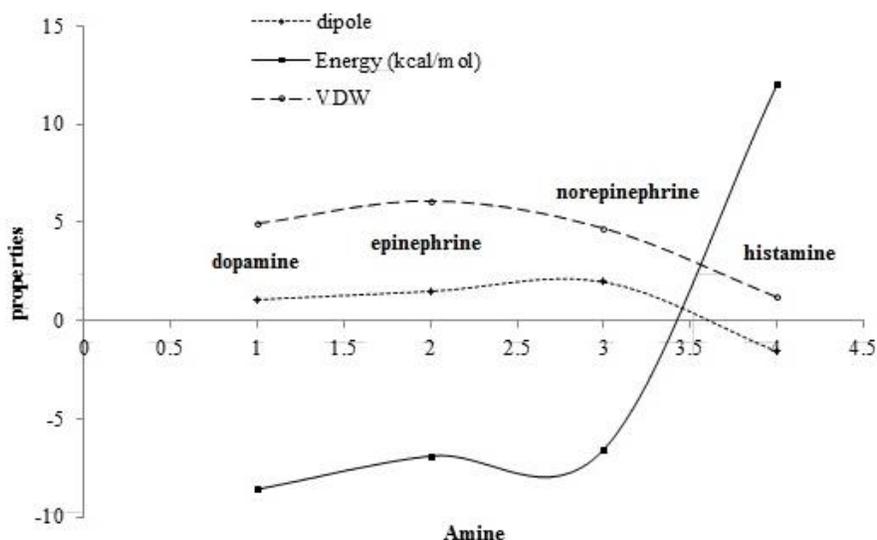


Figure1. Comparison of neurotransmitters of dopamine, epinephrine, norepinephrine and histamine, based on Changes of physicochemical properties by theoretical studies

The chart of stabilized relative energy, van der Waals forces (VDW) and dipole moment versus compounds exhibits the fluctuation of physicochemical properties in different chemical neurotransmitters in the human brain (Figure 1). It has been shown that dopamine is the most stable structure among other compounds because of its structure. In fact, dopamine has the most charge transfer to perform its function in the brain (Figure 1). So, dopamine that is a neurotransmitter released by the brain in humans and other animals, has some notable functions including

memory, pleasurable reward, behavior and cognition, attention, inhibition of prolactin production, sleep, mood and learning.

Moreover, thermodynamic properties of dopamine has been gained due to infrared radiation (IR) method to distinguish how this compounds performs its function in the brain via three active parts of O-H, N-H and benzene chain (Table 2). It has been indicated that the intensity and frequency of the peak in the second part (benzene part) is increasing, so the charge transfer is induced in the whole of structure (Figure 2).

Table2. Thermodynamic properties of optimized dopamine structure via the theoretical methods through IR calculation

Properties	Value
Total Energy (kcal/mol)	-54031.0650544
Binding Energy (kcal/mol)	-2314.6509424
Isolated Atomic Energy (kcal/mol)	-51716.4141120
Electronic Energy (kcal/mol)	-266960.7667459
Core-Core Interaction (kcal/mol)	212929.7016914
Heat of Formation (kcal/mol)	-82.7319424
Gradient (kcal/mol/Ang)	21.8033837

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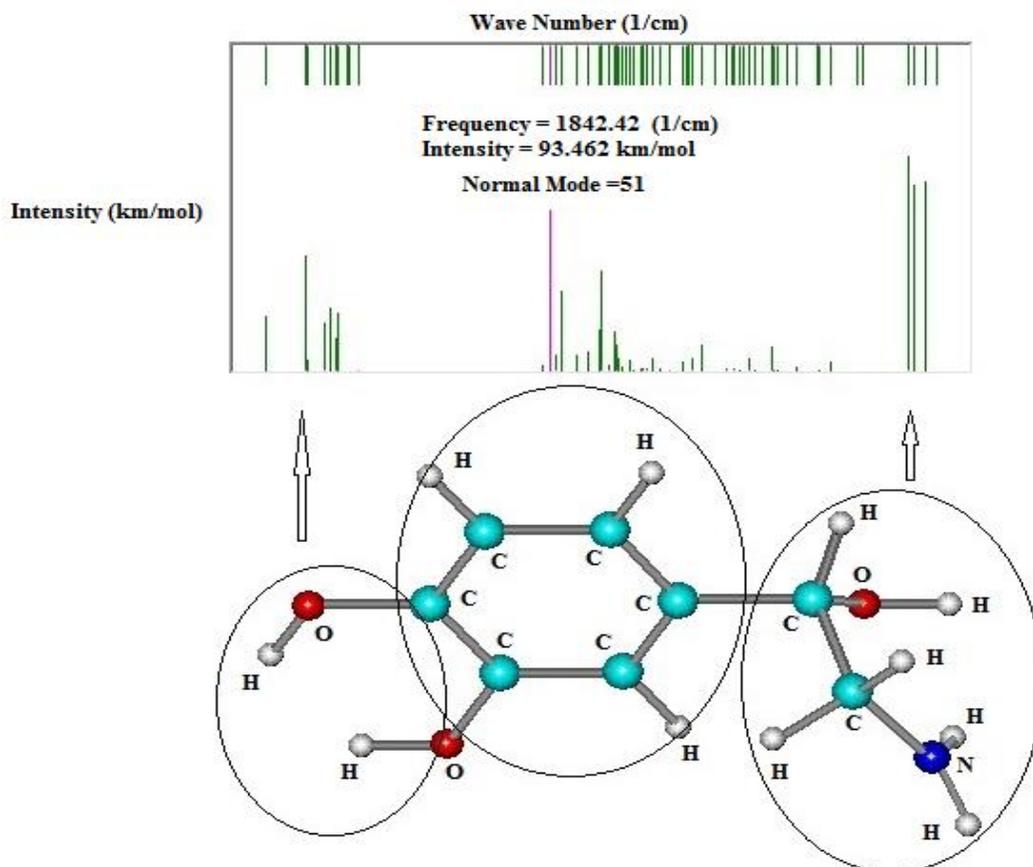


Figure 2. Infrared radiation (IR) calculation of optimized dopamine in different areas of vibrations.

All in all, when we want to learn a new language, dopamine can really facilitate learning and which makes studying languages easier because of its flexibility and activity. So, if we manage our dopamine, we can develop at different languages. When we do certain things, dopamine as a chemical neurotransmitter releases in our brains and says to us we just did an enjoyable thing and motivates us to do it again. It is crystal, when people study new languages, it makes them elated and totally the covert and principal key for their prosperity is their excitation and hunger for learning different languages. Although some people think getting the message across is enough even if the grammar is wrong, most of them believe communication and reciprocal feedback are really rewarding, so this manner encourages them to brush up on their capabilities aspect of different

skills of speaking, reading, listening and writing in the second language.

Conclusion

It has been concluded that chemical transmitters in the brain can lead us to discover the key of language learning by choosing some compounds; epinephrine, norepinephrine, histamine and dopamine. Theoretical calculation exhibited that dopamine based on the coordination of atoms interaction and charge electron transfer has the most significant effect on learning a new language.

Thermodynamic values have been approved by infrared technique to emphasize the activity of dopamine structure and comparing it by some other neurotransmitters.

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References:

- [1] Janik VM, Slater PJB. Vocal learning in mammals. *Advances in the study of behavior*. 1997;26:59–99.
- [2] Jurgens U. Neural pathways underlying vocal control. *Neurosci Biobehav Rev*. 2002;26:235–258.
- [3] Jarvis ED. Learned birdsong and the neurobiology of human language. *Ann N Y Acad Sci*. 2004;1016:749–777.
- [4] Poole JH, Tyack PL, Stoeger-Horwath AS, Watwood S. Animal behaviour: Elephants are capable of vocal learning. *Nature*. 2005;434:455–456.
- [5] Newton-John H. Acute upper airway obstruction due to supraglottic dystonia induced by a neuroleptic. *Bmj*. 1988;297:964–965.
- [6] Warren J, Thompson P. Drug-induced supraglottic dystonia and spasmodic dysphonia. *Mov Disord*. 1998;13:978–979.
- [7] Hornykiewicz O. Chemical neuroanatomy of the basal ganglia--normal and in Parkinson's disease. *Journal of chemical neuroanatomy*. 2001;22:3–12.
- [8] Friedman JH. Involuntary humming in autopsy-proven Parkinson's disease. *Mov Disord*. 1993;8:401.
- [9] Bonvin C, Horvath J, Christe B, Landis T, Burkhard PR. Compulsive singing: another aspect of punding in Parkinson's disease. *Ann Neurol*. 2007;62:525–528.
- [10] Kataoka H, Ueno S. Compulsive singing associated with a dopamine agonist in Parkinson disease. *Cogn Behav Neurol*. 2010;23:140–141
- [11] Walsh B, Smith A. Linguistic complexity, speech production, and comprehension in Parkinson's disease: behavioral and physiological indices. *J Speech Lang Hear Res*. 2011;54:787–802.
- [12] Hubel DH, Wiesel TN. The period of susceptibility to the physiological effects of unilateral eye closure in kittens. *Journal of Physiology*. 1970;206(2):419–436.
- [13] Merzenich MM, Nelson RJ, Stryker MP, Cynader MS, Schoppmann A, Zook JM. Somatosensory cortical map changes following digit amputation in adult monkeys. *Journal of Comparative Neurology*. 1984;224(4):591–605.
- [14] Recanzone GH, Merzenich MM, Dinse HR. Expansion of the cortical representation of a specific skin field in primary somatosensory cortex by intracortical microstimulation. *Cereb Cortex*. 1992;2(3):181–196.
- [15] Abrahamsson N, Hyltenstam K. Age of onset and nativelikeness in a second language: Listener perception versus linguistic scrutiny. *Language Learning*. 2009;59:249–306.
- [16] Weber-Fox CM, Neville HJ. Maturation constraints on functional specializations for language processing: ERP and behavioral evidence in bilingual speakers. *Journal of Cognitive Neuroscience*. 1996;8(3):231–256.
- [17] Wong PCM, Perrachione TK, Parrish TB. Neural characteristics of successful and less successful speech and word learning in adults. *Human Brain Mapping*. 2007;28(10):995–1006.
- [18] Slevc LR, Miyake A. Individual Differences in Second-Language Proficiency: Does Musical Ability Matter. *Psychological Sciences*. 2006;17(8):675–681.
- [19] Morgan-Short K, Sanz C, Steinhauer K, Ullman MT. Acquisition of Gender Agreement in Second Language Learners: An Event-Related Potential Study. *Language Learning*. 2010;60(1):154–193
- [20] Norris JM, Ortega L. Effectiveness of L2 instruction: A research synthesis and quantitative meta-analysis. *Language Learning*. 2000; 50(3): 417–528.
- [21] Peach RK, Wong PCM. Integrating the message level into treatment for agrammatism using story retelling. *Aphasiology*. 2004; 18: 429–441.

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- [22] Miyake A, Friedman N. Foreign language learning: Psycholinguistic studies on training and retention. In: Healy AF, Bourne LE, editors. Foreign Language Learning: Psycholinguistic Studies on Training and Retention. Mahwah: Lawrence Erlbaum Associates, Inc.; 1998. pp. 339–364.
- [23] Hannula-Jouppi K, Kaminen-Ahola N, Taipale M, Eklund R, Nopola-Hemmi J, Kaariainen H, Kere J. The axon guidance receptor gene *ROBO1* is a candidate gene for developmental dyslexia. *PLoS Genetics*. 2005;1(4):e50.
- [24] Lai CS, Gerrelli D, Monaco AP, Fisher SE, Copp AJ. *FOXP2* expression during brain development coincides with adult sites of pathology in a severe speech and language disorder. *Brain*. 2003;126(Pt 11):2455–2462.
- [25] Whitehouse AJ, Bishop DV, Ang QW, Pennell CE, Fisher SE. *CNTNAP2* variants affect early language development in the general population. *Genes, Brain, and Behavior*. 2011; 10(4): 451–456.
- [26] Ullman MT. Contributions of memory circuits to language: The declarative/procedural model. *Cognition*. 2004;92(1-2):231–270.
- [27] Opitz B, Friederici AD. Interactions of the hippocampal system and the prefrontal cortex in learning language-like rules. *NeuroImage*. 2003;19(4):1730–1737.
- [28] Seamans J, Yang CR. The principal features and mechanisms of dopamine modulations in the prefrontal cortex. *Progress in Neurobiology*. 2004;74:1–57.
- [29] Shohamy D, Adcock RA. Dopamine and adaptive memory. *Trends in Cognitive Sciences*. 2010;14(10):464–472.
- [30] Karabanov A, Cervenka S, de Manzano O, Forsberg H, Farde L, Ullén F. Dopamine D2 receptor density in the limbic striatum is related to implicit but not explicit movement sequence learning. *Proceedings of the National Academy of Sciences USA*. 2010;107(16):7574–7579.