

Neuroeducation and Artistic Expression. An Overview from the Biopsychology Viewpoint

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Abstract

In this research, the relationship between positive emotions and the pathways that govern how artistic concepts are processed in the brain and influence the essential characteristics of learning - focus, memory, and motivation - is investigated. In addition, the brain mechanisms of emotional and cognitive links are investigated in order to give a framework for the present discoveries of neuroscience in order to elucidate the relationship between emotions and cognition. The relationship between emotions and art and artistic activities in general is then established, and its contribution to the educational process is emphasized. In conclusion, the fundamental principles of neuroaesthetics and neuroimaging for this topic are studied, and therapeutic effects of artistic activities are discussed.

Keywords: Neuroeducation, Arts, Neuroesthetics, Biopsychology, Cognition, Motivation, Neuroimaging

1. Introduction

Through the perspective of biopsychology and neuroscience in general, this paper aims to highlight the significance of positive emotions during the educational process and the use of artistic activities to contact the individual's emotions and their therapeutic action where it is needed. According to the research literature (Lu Li, 2020), emotions influence many facets of the learning process because they are fundamental to student achievement and learning. In recent years, artistic activities have been evaluated and integrated into the educational process more systematically. Through observation and expression, this systematization aims to facilitate a connection between individuals and their emotions. When an individual creates for themselves, it is therapeutic. Creating art with integrity and sensitivity renders it more communicative and universal (Harding, 2016). Art forms that can be used to reduce or even heal feelings of anxiety, stress, depression, and sadness were chosen because it is a fundamental belief that feelings that cannot be expressed verbally are more easily expressed through art. Then, based on the research review, we will highlight how emotions influence cognition in the context of neuroscientific findings and how these affect cognitive processes central to learning: attention, memory, and motivation, which have been extensively studied in biopsychology. Additionally, some relatively straightforward strategies for applying these concepts in educational settings will be suggested.

2. Literature Review

Educational neuroscience

Educational neuroscience is an interdisciplinary field of study that aims to translate research findings about the cognitive mechanisms of learning into practical educational policy. The field of study also investigates how training affects the brain and the mechanisms that are altered by training (Thomas et al., 2018). Educational neuroscience, also known as neuroeducation, is a rapidly growing interdisciplinary field that investigates and integrates findings, theoretical frameworks, and methodologies from pedagogic and cognitive sciences, brain sciences, and psychology, with the goal of enhancing learning and teaching (Ansari et al., 2011, Tandon & Singh, 2016). Neuroscience and the neuroplasticity process are increasingly utilized by researchers to examine the relationship between the brain and learning. In addition, neuroplasticity is an essential bridging process, and its molecular, neuronal, and brain mechanisms should be investigated in the future. In addition, the methods of neuroscience and cognitive science have progressed to the point where we can now objectively track the developmental trajectory of a child's brain and document how this trajectory is influenced by parenting, education, and other environmental factors.

When Gadess (1968) approached learning problems from a neuropsychological perspective, there was a need to integrate brain research advances into education as early as the 1960s, as Caballero & Llorent (2022) explain. Then, a large number of other scientists and writers aimed to enhance all the processes involved in teaching and learning, emphasizing the significance of research in neuroscience, psychology, and education, and focusing on the adaptation of findings regarding neural mechanisms in education and art.

Educational neuroscience research contributes to the identification and development of methods educators and students can use to enhance the learning experience and gain a deeper understanding of how we learn (Jamaludin et al., 2019). Specifically, it improves the training of teachers by providing them with brain-related information so they can design more appropriate learning environments for their students and employ more effective teaching strategies (Caballero & Llorent, 2022). Regarding students, neuroeducation promotes the development of mechanisms that allow them to successfully adapt their behavior to the social and cultural environment. In the end, the purpose of education is the individual's comprehensive development and, in particular, the mastery of the three basic skills, namely literacy, mathematics, and social, emotional, and moral skills, which, according to UNESCO (2015), are essential for the development of the rest. Logically, a neuroeducation-based intervention should involve the development of these skills. It is not by chance that funding agencies and education policymakers have turned to neuroscience to solve widespread educational issues. Investments in interdisciplinary research programs and funding for the establishment of interdisciplinary research centers demonstrate the worldwide necessity to advance the field of neuroeducation in decision-making and leadership (Antonopoulou et al., 2019;2020; 2021a;2021b;2021c). In fact, many of the currently funded "Learning Science Centers" have cognitive neuroscientists at the core of their multidisciplinary research teams (Ansari et al., 2011).

The growth of Neuroeducation

Ansari et al. (2011) explain that modern neuroimaging techniques (e.g., fMRI, EEG, NIRS) make it possible to determine not only which regions of the brain are involved in school-taught skills (e.g., reading, arithmetic), but also how neural synapses change during learning and development. Changes in the brain's structure can be observed in addition to alterations in its function, according to recent research. Ansari et al. (2011) demonstrate that 100 hours of intensive remedial instruction altered the

white matter structure of the left hemisphere in 8- to 10-year-old poor readers (increased myelination). In addition, it is reported that the brain continues to mature into adulthood and exhibits a much higher degree of structural plasticity in learning compared to previous studies. The ability to visualize the effects of learning on the nervous system increases the likelihood that increased knowledge in the field of neuroeducation will lead to the development of optimal academic skill-acquisition-promoting learning environments.

Tandon & Singh (2016) identify two major streams of knowledge linking neuroscience to education: (i) the brain structures responsible for various educational processes such as reading, attention, memory, calculation, language acquisition, etc., and (ii) how these learning processes influence brain structure and function. Recent research has demonstrated the significance of these processes in literacy and education. For instance, learning to read affects the neuroplasticity of the brain because, according to the neuron recycling hypothesis, children must first learn to associate sounds with letters (phonological and graphemic correspondence), which involves the formation of neural circuits between brain structures, initially in vision (the occipital cortex) and hearing (the auditory cortex) (the auditory cortex). Developmental dyslexia is an example of a structural or functional disorder of the brain's reading network (incidence 15-17% worldwide). However, if dyslexic students are identified early, they can receive individualized, systematic instruction to master reading skills (Tandon & Singh, 2016).

Functional Applications of Neuroeducation

At this juncture, it is crucial to emphasize that neuroeducation does not provide precise rules that instruct teachers in every situation. In contrast, it is the educator's understanding of the physiology and function of the brain that prepares them to deal with diversity in the classroom and paves the way for inclusive education. As brain and mind are inseparable, any problem can alter all brain processes such as perception, attention, memory, emotion, awareness.

Therefore, it is necessary to determine what teachers should know about neuroscience and how they should apply this knowledge. Caballero & Llorent (2022) emphasize that in addition to maintaining their own goals, teachers must also manage the extent to which they can influence student performance. Tokuhamma-Espinosa and Nouri (2020) evaluated a previous survey conducted by the International Delphi Panel on what educators should know about the mind, brain, and education, according to the authors. It asserts six universally applicable fundamental principles that every educator should be aware of:

- Unique combinations of genetic makeup and life experiences compose every human brain.
- Each individual's brain is uniquely wired for learning.
- Prior knowledge is influenced by prior experience.
- The brain undergoes ongoing changes as a result of experience.
- Neuroplasticity is a lifelong process, but it varies with age.
- Memory and focus systems are required for learning.

In the article by Caballero and Llorent (2022), a brief review of recent applications of neuroeducation is also provided; however, the teacher training program and the evaluation of student outcomes must be described simultaneously. Among these are the positive effects that a single 15-hour workshop in fundamental neuroscience had on teachers, as validated by multiple studies, and the positive effects that a one-semester neuroeducation course had on the teacher training curriculum, altering participants' perceptions of learning. In addition, Arwood & Merideth (2017) highlight the potential benefits of incorporating neuroscience-based instruction by shifting the focus to a framework that views learning from the child's perspective, whereas Green-Mitchell (2016) used a model neuroeducation to examine

the relationship between the functional language use of 10 students from different schools and their previous social and moral development. Lastly, Anderson et al. (2018) conducted a mixed-approach study that demonstrated a shift in teachers' beliefs and attitudes while simultaneously improving fifth-grade students' mathematics performance.

Considering the flaws and weaknesses of the experimental studies in the preceding examples, Caballero and Llorent (2022) deemed it necessary to present the methods and results of a global model of neuroeducation that was applied in authentic learning contexts and demonstrates the change in the students' fundamental abilities. Specifically, the purpose of the research, which is discussed in detail below, is to highlight the effect that the implementation of a teacher training program based on neuro training had on the development of the reading, mathematical, social, emotional, and moral abilities of Compulsory Secondary Education students, as well as to compare these abilities between the experimental and control groups (Masson, 2012).

3. Methodology

Bibliographic research was utilized in the development of this paper. Utilized were academic publications discovered by searching official databases of previously published research papers (Scopus, PubMed, Web of Science).

4. Results

The enhancement of attention

Positive emotions can improve an individual's focus, which has substantial educational ramifications. According to research sources (Gkintoni & Dimakos, 2022b), positive emotions can enhance the individual's range of attention in comparison to neutral emotions (Gkintoni et al., 2021). For instance, the delight children have during an experiencing activity, their excitement, the satisfaction provided by a reward, and notably the reciprocal teacher-student affection can have a tremendous impact on the educational process. Moreover, when emotional stimuli are used as target stimuli or cues, they can boost attention and promote cognitive processing, as opposed to neutral emotions. Additionally, event-related research has revealed an attentional preference toward emotional stimuli. Positive stimuli elicit a more substantial positive wave (P2) between 120 and 180 ms after stimulus initiation compared to neutral stimuli, which represents the early attentional bias in emotional processing. Mordkoff(2011) also discovered that pleasant emotions emphasize selective attention. This explains why uninspiring instructional content is unpopular and might hinder learning. The amygdala receives emotional stimuli quickly and then transmits them to the cortex, which promotes attention and perception in emotional learning. It has also been demonstrated that the amygdala moderates cognitive goals via very intricate connections between the ventral (VMP-FC) and dorsolateral prefrontal cortex (DLPFC).

In a classroom setting when teachers struggle to keep their students' attention or focus it to the course subject, emotional stimuli that can attract and direct attention may be applicable. It is crucial to note the purported benefits of negative emotions on focus. According to a corpus of studies, happy emotions assist people to focus on a broader context of information. In contrast, negative emotion causes individuals to concentrate on particular objects. The relative impact of negative and good emotions has been examined. A prominent illustration is the expanding and building idea, which contends that happy

emotions enhance attention. In particular, Fredrickson and Branigan (2011) discovered that happy emotions broadened the attention span, whereas negative emotions had a diminishing effect relative to the neutral condition.

Memory improvement

Positive emotions significantly improve memory processing. The relationship between emotion and memory entails recalling information with an emotional component and how emotion affects the creation of that memory. Emotional events predominate, and emotional arousal influences the encoding and consolidation stages of memory, hence enhancing emotional memory. Studies have demonstrated that emotional events have a greater role in memory formation and that emotional context improves memory in general. According to cognitive neuroscience studies, the amygdala, which governs hippocampal and prefrontal lobe activity and is engaged in a number of other processes that have already been mentioned, is the major brain region involved in this phenomenon. In addition to the amygdala, several types of emotional memory include distinct neural pathways. For instance, declarative emotional memory requires integrated prefrontal and temporal lobe activity. During the beginning phases of consolidation and early stages of emotional memory recall, the amygdala, prefrontal, and medial temporal lobes construct an integrated memory system. This neural network employs the hypothalamic-pituitary-adrenal circuit. The amygdala, prefrontal lobe, and hippocampus play crucial roles in conditioned emotional acquisition, extinction, and recovery for emotional autobiographical memory.

Negative and neutral emotions can hinder memory processes. Consider a student who suffers from chronic anxiety and stress (Gkintoni et al., 2021b). In this case, their adrenal glands secrete cortisol, a stress hormone that stays in the body for a long time, reduces immune function, and impairs memory and cognition. In other words, it negatively affects their bodies and their ability to learn. Studies indicate that negative emotions are more likely to result in false memories, whereas positive emotions are essential for rapid and accurate recall influencing also quality of life index (Gkintoni et al., 2019a;2019b; Tzanos et al., 2019). Different types of emotional states (negative, neutral) may also have an impact on different types of working memory, influencing the complexity and capacity of these operations. Studies on test anxiety have also revealed that anxiety reduces students' working memory capacity, thereby affecting their ability to perform complex or difficult tasks. Lavric et al. (2003) induced anxiety in normal humans via electric shock threats. Arousal of negative emotions had a detrimental effect on spatial working memory, and anxiety induced performance impairment. Furthermore, Lu Li (2020), demonstrated that negative emotions have a significant impact on the impairment of spatial working memory, which is heavily dependent on scientific and mathematical subjects. Therefore, it is evident that a negative emotional state impedes learning, impairs the cognitive function of memory, and, in the worst-case scenario, puts it at risk influencing also executive functions and decision-making process (Halkiopoulos et al., 2022).

Enhancing Learning Motivation

Positive emotions can generate effective learning motivation and strategies, resulting in greater academic success. Students' intrinsic and extrinsic motivation to learn can be enhanced by positive emotions, such as happiness and optimism. Reinhard Pekrun, a German psychologist, has conducted extensive research on the emotions students experience during the learning process. Pekrun (2002) proposes the cognitive motivation model of emotion, which posits that emotion affects academic

performance through the mediating mechanism of cognition and motivation, such as learning motivation, learning strategies, cognitive resources, and the self, ultimately influencing students' academic success (Giannoulis et al., 2022; Gkintoni et al. 2021a; Pekrun, 2022). Knoch and Fehr (2007) demonstrated that goal-directed cognitive control is always accompanied by solid dorsolateral prefrontal cortex activity. As they share the same brain region - the dorsolateral prefrontal cortex (DPC) - it is not difficult to understand that students' learning motivation integrates cognitive and affective factors. A variety of positive emotions, including optimism, pride, hope, self-belief, and self-confidence, can propel students to greater achievement. This indicates that students are more likely to adopt flexible, practical, and innovative learning strategies when they are in a positive and joyful emotional state (Pekrun, 2022).

While positive emotions can contribute to motivation, negative emotions can undermine learning motivation. Under the influence of positive emotions, students will focus on information pertaining to their sense of self-efficacy — a belief in one's ability to act. Moreover, negative academic emotions can reduce one's ability to function in a learning environment and even predict long-term college dropout rates, a factor that can be mitigated by fostering a positive learning environment. In addition, the DPC is one of the primary brain regions involved in negative emotion regulation. Therefore, the ability to regulate one's emotions, particularly negative ones, is crucial for sustaining compelling learning motivation. It demonstrates that when students experience positive emotions, they are able to concentrate on the current learning process, whereas negative emotions diminish their motivation to learn.

Educational strategies for enhancing positive emotions

According to a study (Lu Li, 2020), there are a number of well-established strategies to improve the effectiveness of learning environments, including eating a healthy breakfast, engaging in optimal exercise, and getting sufficient sleep. The following strategies will aim to improve learning environments by addressing concepts such as the role of positive emotions in academic performance, the role of the social brain in learning, and the significance of rewards in influencing behavior. This collection of ideas is neither exhaustive nor universally applicable, but it can positively influence learning environments.

Arts

Education and culture engage in a continuous dialogue that is reflected not only at the theoretical level, but also in multilevel practices, research, and associated policies. The relationship between art and education has become increasingly systematized in recent years. This systematization aims to enhance students' observation, research, experimentation, and correlation with their emotions in order for them to achieve success and express themselves. Art can contribute to the formation of an individual's mentality, processes, and overall personal development.

The connection between neuroeducation and the arts

Neuroscientific studies (Immordino-Yang & Christodoulou, n.d.) indicate that the limbic system of the brain is primarily responsible for controlling emotions. The original description of the limbic system or Papez circuit included the hippocampus, hypothalamic striatum, anterior thalamic nucleus, and afferent gyrus. Other regions of the system, such as the hippocampus, parahippocampal gyrus, hypothalamus,

amygdala, and septal area, have been included. The relationship between education and the arts is indispensable. However, from the perspective of the teachers, the way of learning and, even more so, the contribution of the arts to social, cognitive, and emotional learning should be discussed with the parents of the student. Arts-based pedagogy can enhance learning by creating experiences with demonstrated positive effects that appear to cultivate emotional investment in the learning process and a heightened sense of social awareness (Hardiman et al., 2009).

According to neuroscientific research (Di Dio, & Gallese, 2021), aesthetic judgments and the physical content of works of art simultaneously activate cortical motor systems and parietal and premotor regions. The arts have a positive influence on the growth of symbolism and the creation of emotional experiences through images. In addition, symbolic thinking is the capacity to consider one's immediate physical environment as well as past and future events. Additionally, the arts facilitate communication growth and self-adjustment. Self-adjustment is a process of self-observation through artistic activities that builds self-esteem.

According to a research article (Halkiopoulou & Boutsinas, 2012), the connection between the arts and learning outcomes becomes clear. A key objective for educators is to move beyond merely connecting the arts to reading and mathematics and to emphasize the notion that the arts can influence and potentially improve broader aspects of education. The relationship between art and its effect on students' emotions is intuitively recognized by teachers. The arts, particularly the performing arts, foster collaborative learning, which influences psychosocial development as well. In this study, teachers claimed that neuroscientists and cognitive scientists are required to investigate the overhead views (Hardiman et al., 2009).

Neuroimaging and neuroaesthetics

The cognitive neuroscience of aesthetic experience is neuroaesthetics. It can be considered a sub-field of cognitive neuroscience (as it includes the study of human cognition and behavior), leading to the combination of cognitive science and neuroscience techniques in order to explain the cognitive and neural contexts of aesthetic experiences. Cognitive models of aesthetic experiences recognize fundamental perceptual processes, such as memory, attention, emotion, and social cognition. Every one of these processes is linked to underlying brain regions and neural networks. Neuroaesthetics investigates the ways in which we create, perceive, and think about art. This discipline investigates the function of the brain in such processes.

Neuroimaging has focused on analyzing the cognitive and emotional activities of humans. Researchers have identified regions of the brain that are activated during the execution of specific processes using various imaging techniques. Expressions of art involve distinct neural circuits, including sensory networks. Each artistic discipline engages distinct sensory systems. According to the findings of studies (Gkintoni et al., 2017; Gkintoni et al., 2022a) a comprehensive analysis of the various brain regions involved in each art form is provided. For instance, Daniel Levitin, a psychologist and neuroscientist, has discovered that a region of the cerebellum is involved in some of the emotional aspects of music, as listening, composition, and movement all involve cerebellar regions (Hardiman et al., 2009).

Contribution of creative endeavors to education

Enhancing artistic activities in the educational process has a significant impact on student learning. This obviously presupposes the equal treatment of aesthetic cycle courses and so-called "core subjects." Neuroscience has benefited through this method from the previously mentioned alternative learning process (Hardiman et al., 2009). According to neurophysiological studies, the information content of a work of art facilitates the processing of the work itself and heightens positive emotions (Antonopoulou et al., 2022). This processing is accompanied by increased neuronal activity in the orbitofrontal cortex and medial ventromedial prefrontal cortex, regions intimately associated with reward experience and emotion processing.

The artistic production process is a form of expressive psychotherapy. It contributes to the enhancement of social, mental, and emotional functions, as well as the development of feelings that promote happiness. Through creation, the individual is able to explore himself and his emotions, thereby promoting healing. This spiritual treatment helps to alleviate anxiety and negative mental symptoms. Given that art is used as a means of healing in modern times, there is a need to comprehend the neural basis of the effects of emotion on the application of art to clinical examination and its creation. The brain's adaptability and relative sensitivity are responsible for the complexity and variety of visual expression. The brain's modular and hierarchical structure confers flexibility. Neurology, neuroanatomy, and, more recently, functional neuroimaging emphasize this structure.

The expression of emotional concepts, which are influenced by culture and language experiences acquired through engagement with art, such as reading fiction, demonstrates a further relevance (Farhan & Chee, 2022). Emotions play a crucial role in the learning process. Essentially, it is a method of preparing for the immediate or distant future, such as preparing for anxiety in an upcoming emotionally charged test situation. This neuroscience perspective permits us to ask additional emotion-related questions during the learning process, given that emotions help prepare us for future situations (Farhan & Chee, 2022).

A therapeutic form of art use in education

There are numerous types of art therapy, including painting, drama therapy, and music therapy, which may be used individually or in combination. Cortisol secretion is associated with negative emotions. Cortisol is a steroid hormone that increases stress and impairs the processing of information. On the basis of these scientific findings, the need to develop educational models that can be adapted to the individual needs of students becomes apparent. Spiritual healing can be used to alleviate anxiety and negative mental symptoms. Music therapy is a form of therapeutic art. Observations indicate that it contributes to the reduction of both anxiety and obsessive-compulsive symptoms. A music therapy review study revealed a significant improvement in social outcomes. This included anxiety, rage, motivation, depression, deprivation syndrome, coping mechanisms, stress, and depression. Music can have a positive effect not only on those who listen to it, but also on those who create it. It can be even more beneficial when speech, mental status, language, or motor skills are deficient. It is a given that art therapy presents fewer obstacles in the cultural and linguistic field to those being treated, and has tremendous therapeutic success, as it is based on encouraging limited verbal success. As a result, art as a form of therapy can work more effectively with vulnerable populations and benefit severely traumatized refugee children, as it provides the opportunity to overcome language barriers. Additionally, many individuals prefer to express their emotions nonverbally (Gkintoni et al., 2022).

5. Conclusion

This literature review demonstrates the catalytic role of positive emotions in enhancing cognitive processes that are central to many aspects of learning, including attention, motivation, and memory. The advantages of encouraging positive emotions during the learning process are discussed. To provide an objective context for this debate, it has been supported by findings from contemporary neuroscience research. Nonetheless, it has been demonstrated that positive emotions can enhance learning, and this paper describes how this can be implemented. Additionally, each child learns differently and at a different rate. Therefore, it is likely that factors involving individual differences between people and environmental factors that are beyond the control of teachers play a decisive role in determining how individuals are educated. When one considers that each child's first contact with writing, reading, and mathematics is enhanced by the visual stimulus provided by images, sounds, and kinesiology, the connection between education and art becomes apparent. Art is an integral component not only of human creativity but also of the natural sciences in general, particularly in the field of education. Observing the brain structures that are active during the creation or appreciation of art has led us to the conclusion that art should be incorporated into all forms of education, therapy, and rehabilitation.

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