Neuro-Arts Education: Neuroscience and Education

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Abstract

The term Neuro-Arts Education was coined by R.L. Garner, following the success of his Neuropsychological Art Therapy Model (1996). It concerns the integration of education and neuroscience, and is conceptually in line with the tenets of the International Mind, Brain, and Education Society. Whereas, great advances have occurred in neuroscience, connecting those advances to education has been elusive. New brain science relevant to education is emerging continually. The incorporation of chaos theory and neuro-constructivism forms an additional conceptual basis for the Neuro-Creative Arts Theory (NCAT), developed by Garner, to address education of students with disabilities. The concepts of brain development, drawn from neuro-constructivism, and brain function, from chaos theory, provide a framework for NCAT based educational methodologies involving the creative arts. Recent information from the fields of creativity, cognitive, and brain research give support to Neuro-Creative Arts Theory and Neuro-Arts Education. Knowledge of this content is important to special education, specifically traumatic brain injury (TBI). Focus should be placed on the importance of art education as a means to, not only encourage creativity, but also to address issues of behavioral and cognitive functioning. Accordingly, brain functions are described as they relate to various disabilities, as well as to the production and comprehension of artwork. Examination of the theoretical and applied aspects of creativity, art education, and art therapy illustrate the connections between creative activities, human development, brain function and disabilities. Finally, there is discussion of methods through which creative arts activities aid teachers, and students with special needs,

in gaining insight of skills, abilities, and potentials for learning through art.

Keywords: Neuro-Arts Education, Neuropsychological Art Therapy, Neuro-Creative Arts Theory, Traumatic Brain Injury, Special Education, Art Education, Creativity, Chaos Theory, Neuro-Constructivism

Neuro-Arts Education: Neuroscience and Education

This paper will spotlight recent information from the fields of creativity, cognitive, and brain research relevant to Neuro-Creative Arts Theory (NCAT) and Neuro-Arts Education (NAE). NCAT contributes the theoretical underpinnings to NAE, which deals with application. Research on creativity and brain function can enhance educational methods for students with disabilities. Art education can serve as a means to, not only encourage creativity, but also to address issues of emotional, behavioral and cognitive functioning. The incorporation of chaos theory and neuro-constructivism forms a conceptual basis for the Neuro-Creative Arts Theory (NCAT) and the application of Neuro-Arts Education (NAE). The concept of brain development, drawn from neuro-constructivism, and brain function, drawn from chaos theory, provide a framework for NCAT based educational methodologies involving the creative arts.

Of particular importance, to neuro-constructivism, is evidence which indicates that the types of problems encountered by the learner directly affect brain development. This is contrary to conceiving of the brain as containing pre-wired circuitry, or modules, which make learning possible (Fodor, 1975). Although, the study of adult brains reveals that some degree of modularity exist. Neuro-constructivists posit that brain development and organization result from problem solving activities, in conjunction with environment (Garner, 2004).

Cognitive Processing and Development

Investigations of brain and cognitive development have generally been undertaken independent of one another until relatively recently. Cognition basically is interpreted as referring to the process of “thinking” or “knowing”. Human abilities encompassed by the term typically include: perception, memory, attention, problem solving and learning (Spreen, Risser, & Edgell, 1995). Development, from the point of view of cognitive psychology, consists of a “gradual acquisition of a widening range of abilities, rather than the quantitative increments traditionally associated with the term ‘intelligence’” (Spreen, Risser, & Edgell, 1995, p. 57).

Child Development

A varied array of external stimuli impinge upon the human newborn. Through a process of discrimination between these external representations or environmental codes the stimuli are stored and processed as “mental codes.” Much of this early learning or cognitive activity is probably acquired and reinforced in the manner of a classical conditioning paradigm (Rovee-Collier & Lipsitt, 1982). Studies have shown the formation and retention of associations via conditioning in the earliest days of life (Cairns & Butterfield, 1975; Little, 1970). Related to this stimulus/response process, several studies of infants have found that a diminished duration of peak fixation to a face stimulus has predicted lower levels of intelligence in pre-school children and at eight years of age (Colombo et al. 1987).

Such classical conditioning and related behavioral methods are often utilized in special education settings. NCAT posits that the limitations of behavioral approaches hinder, not only student potential, but also the conceptual abilities of

teachers to initiate alternative methods for addressing individual student needs. Behavioral patterns developed through educational or clinical uses of behaviorist techniques can be difficult to break due to years of repetition and practice within the school, home or therapeutic environment. Hence, the concepts of chaos and randomness, valued in NCAT, are disdained by this classical school of thought with its focus on stimulus associations and predictability.

Models of Cognitive Development

Overall, models of cognitive development have generally consisted of a series of stages through which one passes. One of the most familiar and widely used of these models or theories is that of Piaget (1952, 1960). The earliest phase of development, the sensorimotor stage (birth to 18 months), is characterized by dependency on sensorimotor schemes where action is the basis of thinking. Over time these schemes are internalized and form the foundation of cognition. During the preoperational stage (early childhood) cognitive schemes, although still unorganized (i.e. chaotic, nonlinear), are formed and aid in problem solving. The concrete operational stage (elementary school years) involves the growing comprehension of categorization, relationships, and numbers (i.e. ordered, linear). And finally, in the formal operations stage (adolescent to adult) thought processes are no longer limited to concrete events (Spreen, Risser, & Edgell, 1995).

Researchers, overtime, have moved away from the concept of discrete independent linear concepts of cognitive development, as have other recent

theorists. Now, such stages of development are conceived of as being multi-layered and capable of operating simultaneously, as well as throughout the lifespan.

Recently, Gardner (1991, 1999) has delineated a cognitive system composed of “multiple intelligences.” This more inclusive and dimensional concept proposes at least eight forms of cognitive capabilities and admits the possible existence of others. These are outlined in the list below.

Intelligence	**Core Operations**
Linguistic	syntax, phonology, semantics, pragmatics
Musical	pitch, rhythm, timbre
Logical-mathematical	number, categorization, relations
Spatial	accurate mental visualization, mental transformation of images
Bodily-kinesthetic	control of one's own body, control in handling objects
Interpersonal	awareness of others' feelings, emotions, goals, motivations

Intrapersonal	awareness of one's own feelings, emotions, goals, motivations
Naturalist	recognition and classification of objects in the environment

Hence, theories of cognitive development have moved to increased complexity in their conception of human development and capacities. The move appears to be away from the general to the specific, from the group to the individual. This is in line with NCAT, chaos theory and neuro-constructivist theory. Contrary to our current educational environment, operating upon a prevailing and engrained focus on “order” and behaviorist techniques as its functional methodology, NCAT is sensitive to the value of initial conditions, randomness and self-organization as developmental and educational assets. Thus, NCAT’s premises place the specific above the general, as well as the individual above the group.

The Neuro-Constructivist Model

Over time, the previously described theories and constructs have become increasingly embedded within the 21st century system of education. It is only through their refinement that the conceptual development of a neuro-constructivist model has become possible.

The constructivist concepts of Piaget (1952, 1960) and the modular concepts of Fodor (1975) have now become a synthesis, rather than antithesis. What we now

know reinforces the value of a wide range of learning experiences and reveals that the Creative Arts are a unique source of brain development. The following quote summarizes the value of incorporating neuro-constructivism into a model for education:

> ...according to "neural constructivism," the representational features of cortex are built from the dynamic interaction between neural growth mechanisms and environmentally derived neural activity. Contrary to popular selectionist models that emphasize regressive mechanisms, the neurological evidence suggests that this growth is a progressive increase in the representational properties of cortex. It is argued that the interaction between the environment and neural growth results in a flexible type of learning: "constructive learning" minimizes the need for prespecification in accordance with recent neurological evidence that the developing cerebral cortex is largely free of domain-specific structure. Instead, the representational properties of cortex are built by the nature of the problem domain confronting it... this uniquely powerful and general learning strategy undermines the central assumption of classical learning theory, that the learning properties of a system can be deduced from a fixed computational architecture" (Quartz & Sejnowski, 1997, p. 537).

Garner (2004, p. 1299) states:

> In the end, neuro-constructivism provides evidence which indicates that the types of problems encountered by the learner directly affect brain

development. This is contrary to conceiving of the brain as containing pre-wired circuitry, or modules, which make learning possible. Neuro-constructivists posit that brain development and organization result from problem solving activities, in conjunction with environment. Overall, this model enhances, not only the value of Humanities and Arts Education in general education, but also the current international and global education initiatives within higher education.

Under a neuro-constructivists model for education, the Humanities and Arts Education become important, not only as content areas, but as contributors to brain development itself. Additionally, a curriculum based heavily or solely on mathematic, scientific, and verbal skills is seen as an inhibitor to brain development, thereby limiting human potential. Utilizing problems/classroom activities and content delivery that encourages compartmentalization and modularity within the developing brain, particularly at a young age, is detrimental to the human mind. Ultimately, a curriculum rich in the Arts and Humanities offers opportunities, which further enhance and contribute to the actual physical development of the brain through encounters with unique problems.

These conceptions are crucial to NCAT and NAE. Most importantly, an altered vision of the possibilities of education in and through the Creative Arts, particularly in the area of special education, is urgently needed. The recognition that we are

immersed in the Arts, through “old school” and technological media, on a daily basis makes Art Education’s contributuions to brain development evermore paramount.

Structured, Unstructured and Chaotic Applications

Neuro-Creative Arts Theory (NCAT) is an outgrowth of the preceding concepts, theories and research. In addition, NCAT has incorporated aspects of non-linear dynamics/development as key considerations for educational curriculum and design.

In discussing chaos theory and nonlinear dynamics, Garson (1996, p. 305) states:

> Classicists are not likely to be impressed with the idea that chaotic unpredictability resolves the mystery of human intelligence. The proposal seems an obvious non-starter. Assuming that chaos amounts to randomness, they will ask: how can randomness by itself explain cognitive processes such as language understanding and problem-solving? Thought depends on coherent, reproducible, organized routines, some of which are probably innate. Random forces can only be obstacles to thought.
>
> But this reasoning rests on a common misunderstanding about chaos. Although chaotic unpredictability would seem to entail randomness, its proponents associate it with order and richness of information. Nicolis (1989, p. 346) asserts: `chaotic attractors are potential information-generating devices. We are thus led to the tantalizing picture of how information, one of the most conspicuous attributes of the human brain, can be linked to, and even emerge from, its dynamical activity'.

> The alignment of chaos with order is best illustrated in the surprising phenomenon of self-organization. In non-linear dynamic systems, a seemingly disordered activity at the micro level can still produce coherent and stable large-scale structures. For example, the apparently random motions of molecules in a turbulent stream of water spontaneously organize themselves into large-scale waves, eddies and whirl-pools that persist over relatively long periods of time. Chaotic models of Jupiter's famous red spot suggest that such structures can persist autonomously for centuries, and that there is no need for any special mechanism to create or maintain them (other than the natural behavior of the system as a whole) (Gleick, 1987, pp. 54-56, illustration facing p. 115). Contrary to our intuition that forms of order should cancel out in a highly-energetic and unguided system such as the atmosphere of a gigantic planet, the theory of dynamical systems shows that emergent structures such as the red spot are natural and expected consequences of the behavior of gases on the surface of a heavy rotating sphere. Understanding that such order and information is compatible with chaotic unpredictability is crucial for appreciating the possibility that order in chaos has a genuine function in cognition.

Overall, there is an obsession with order and structure in the current system of education. Emergent properties and self-organization are overtaken by an over-emphasis on control/order in an endeavour to create a pseudo-vail of comprehension and success. NCAT advocates that NAE avoid such follies being

more informed and open to non-traditional, even chaotic and experimental, approaches to learning.

Creativity

Divergent Vs. Convergent Thinking

Along similar conceptual lines, divergent and convergent thinking, typically, have been associated with creative thought processes. Convergent thinking is that of typical academic tasks, which ask you to converge upon one correct answer. Conversely, divergent thinking involves the generation of multiple solutions to a given problem or situation. Divergent thinking is easily conceived of as a chaotic nonlinear process, whereas convergent thinking yields a linear process of ordered/structured progression through rule-based processes. It is this nonlinear chaotic type of processing valued by NCAT, and abhorred by the current practices of the educational system, particularly in the area of special education.

Hence, chaos theory further clarifies and defines properties relevant to the cognitive processing concept of divergent thought.

IQ Vs. Creativity

The concepts of IQ and creativity involve a similar dialectic. The intelligence quotient (IQ) is thoroughly based in the ordered, structured and rule-based processes inherent within a given culture and its educational system. Although such cultural content or information may have been initiated in a nonlinear chaotic type of process, the outcome is perceived as logical, rational and linear. It is this perception

that inhibits seemingly illogical and nonlinear approaches to education as those incorporated by Neuro-Creative Arts Theory (NCAT) and Neuro-Arts Education (NAE).

Gardner (1993, p. 20-21) presented some conclusions reached by psychologists regarding IQ and creativity in particular. One such conclusion was that"…creativity is not the same as intelligence." Further, "[E]even more so than intelligence tests, then, tests of creativity have failed to satisfy the expectations they were designed to meet."

"The remaining conclusion is, in my view, devastating for the enterprise of measuring creativity using paper-and-pencil tests. Despite a few suggestive findings, it has not been possible to demonstrate that creativity tests are valid. That is, high scores on a creativity test do not signal that one is necessarily creative in one's actual vocation or avocation, nor is there convincing evidence that individuals deemed creative by their discipline or culture necessarily exhibit the kinds of divergent-thinking skills that are the hallmark of creativity tests."

NCAT, therefore, concludes that the flaws of current measures and procedures in use within the education system should yield to more promising methodologies. Additionally, investigation of structured, unstructured and chaotic applications in education need to be undertaken in order to decipher when and who will benefit from these different approaches. NCAT advocates an experimental approach not limited by prevailing research findings and encourages a teacher/researcher model customized to individual students/settings.

Structured and Unstructured Applications

Literature discussing the issue of structured approaches to art therapy primarily examines this technique in group therapy settings. Diane Waller (1993) in her book Group Interactive Art Therapy: Its Use in Training and Treatment discusses structured art therapy approaches versus the use of non-structured approaches, directed versus non-directed groups. It is important to note that these groups generally consisted of individuals being treated for psychiatric disorders and/or substance abuse. Waller (1993), working in Britain, contrasted a structured approach delineated by Marion Liebmann (1979) with the unstructured approach of Gerry McNeilly (1983).

Waller (1993) describes Liebmann's concept "as being composed of an introduction followed by an activity (the art making process) and then by discussion. Thus the groups are highly structured" (p. 10). In contrast, McNeilly (1983) advocates a non-directive approach because this makes it "possible to go beneath the surface of authority struggles" (p. 213) allowing the freedom for group development. Liebmann and McNeilly, therefore, illustrate two extremes of the debate (Thompson, 1993).

A synthesis of the above positions can be found in the work of others. Thornton, in Britain, finds the downfalls of the non-directive approach to be its slowness and the high drop out rate incurred (Waller, 1993). Wadeson (1980), an American art therapist, stated that "the most significant question regarding structured art activities (including guided imagery) is not what to use, but whether and when

one should use them at all" (p. 158). Regarding structure, Silver (1978) stated that memory for details is better when tasks are ordered into structured forms which can aid the preservation of memory events.

A somewhat structured art therapy approach was used by Hendrixson (1986) for, Mike, a 24 year old male with short-term memory impairment. His memory deficit involved the acquisition of new information. He could remember things that had occurred before his accident, but could not recall day to day events occurring since the brain injury, anterograde amnesia. As a result, the art therapy experiences were primarily task-oriented.

Following a failed attempt with scribble drawing Hendrixson decided to use self-portraits in addressing Mike's issues. She determined "that what he needed was a form of expression that would not elicit undue anxiety about performance but would address his special problem of short term memory loss by promoting an ability to form associations" (p. 15).

Hendrixson (1986) employed body-tracing and the use of a mirror allowing Mike to draw or paint his likeness within the outline. These therapy sessions were held three to four times weekly with Mike making a new self-portrait in each session. The "treatment goals included facilitating Mike's ability to form associations and to recognize familiarities, as well as to develop a fuller self-concept" (p. 24). Overall, Mike had no conscious recall of the individual sessions or portraits, but it was evident that he had gained practical skills. Both Mike and the artwork had undergone developmental changes.

McGraw (1989), using a more structured approach, states that the goals of cognitive rehabilitation “might include improving memory, acquiring new information, and learning how to prioritize, plan, and organize tasks” (p. 37). She sees patients both individually and in groups. After an initial assessment the art therapist devises individualized art therapy goals, relevant to a rehabilitation plan, for each client. In the art therapy setting a “drawing assessment is conducted to evaluate the patient’s functional, cognitive, and artistic abilities, establish a baseline, and help set goals for future sessions” (p.38). Basic drawing materials such as pencils, pastels, or markers are used at this stage.

Also drawings about the individual’s personal life and a “Past/Present/Future Picture” (McGraw, 1989, p. 39) may be performed later on, depending upon the patient’s tolerance for these activities at the time. Printmaking is sometimes used as a means of improving sequencing and motor skills, as well as increasing self-esteem. Collage can also be important when working with severely impaired individuals. This art task aids developing organizational and decision-making abilities and the ability to follow directions. A common format such as paper with the same pre-drawn pictorial element has also been used for groups practicing problem solving skills as well as examining and achieving personal goals (i.e. bridge drawing). Self-portraits, using any type of media, can help discover and recognize difficult emotions and thoughts. As well, “Pass-the-Portrait” (p. 42) techniques encourage group interaction, cooperation and communication. “Of real value to this diverse and complex group of patient’s is art therapy’s ability to meet multiple needs on multiple levels” (p. 44).

These examples using varying degrees of structure illustrate some possible applications within the structured/unstructured continuum and debate. Published works in the field of art therapy, appear skewed, due to their reliance on only select examples of a client's artwork, whereas Garner and Gregory (1997) viewed the entire progression of works, produced in art therapy sessions, as crucial to comprehending the complex and dynamic nature of a client's functioning, particularly in the case of TBI. Thus, a prime concern, of NCAT and NAE, is how to achieve the appropriate structure/order in a manner that is most relevant and personal to the individual.

Chaotic Applications

Whereas, the above conceptions of structured interventions would be accepted as logical to most in the field of education or rehabilitation, it could as well be detrimental. A broader view and wider range of alternatives could be more beneficial to students with disabilities. Hence, relevant aspects of chaos theory and nonlinear dynamics become important.

Garson (1996) stated the following:

> In the science of chaotic systems, the phenomenon has been labeled the "butterfly effect" after the title of a paper given by Edward Lorenz, at the annual meeting of the American Advancement for Science, in 1979. He observed that the tiniest alterations in starting conditions could manifest in radically different weather forecast (Gleick, 1988, p. 11 -- 31). In so doing, he

> demonstrated that insignificant, random or chaotic behaviors can be repeatedly copied to become a highly significant new order of doing things. Jantsch (1980, p. 42 -- 53) observed the "butterfly effect" in the evolution of living systems and social systems. Jantsch saw this process occurring through purposeful, cooperative and autonomous behavior (Sullivan, 1999, p. 3).

Carlos A. Torre, in Chaos Theory in Psychology (Abraham & Gilgen, 1995), states:

> Additionally, using varied teaching strategies optimizes the possibilities of creating a learning environment conducive to students of widely diverse backgrounds and learning styles. A particular teaching strategy may stimulate one student while irritating another. Nonetheless, both stimulation and irritation can serve as agents for driving students' mental activities far from stable but maladaptive attractors, through unstable bifurcations, toward new stable, adaptive attractors of creative mental functioning that seeks to integrate apparent opposites" (Torre, 1995, p. 292 -- 293).

Speaking of students and chaotic dynamics Torre (1995, p. 292 -- 293) states that:

> The atmosphere within which they are to solve problems should not be preconditioned with expectations that a right answer exists. Freeing the students to think openly about the situation and intuitively infer these solutions

inherent within it can, again, tap the chaotic dynamics inherent in thinking and problem-solving and encourage the optimal functioning and interaction of students' cognitive, affective/perceptive, and pragmatic mental processes.

Several important factors pertinent to NCAT and NAE are mentioned above. A sesitivity to initial conditions is recommended as a means to avoid producing engrained behaviors that ultimately become maladaptive/regressive mechanisms which impede future learning and development. Additionally, it includes focus on student generated solutions and honors self-organization. Increasing opportunities for creative mental functioning, rather than rote memorization or rule-based learning, is further promoted.

NCAT Processing Model

Bruer (2009) disputes the idea that "critical periods" during development, as related to synapse growth/death in the early years of life, is relevant to learning and education. He claims that neuroscientist have predominantly depended on experimentation with the visual processes/components of the brain as a primary model for brain function in general (see Kandell & Schwartz, 1991). Further, findings in neurobiology have not been supported by the behavioral findings from learning and educational studies (see Overman et al., 1996). Overall studies have shown that experience affects the "ease and efficiency of learning," rather than brain development or age. This is in-line with the tenets of neuro-constructivism and NCAT.

"Cognitive psychology attempts to understand the mental representations and processes that underlie expertise within learning domains." (Bruer, 2009, p. 49). "In the past cognitive models have been based on behavioral studies conducted by cognitive and developmental psychologist. In the last ten years, given the impact of unified mind -- brain research, other brain -- based sources of evidence have been brought to bear on cognitive models." (Bruer, 2009, p. 51). He states that what we need to find across various fields of behavioral, cognitive, and neuroscience is converging evidence that supports various models of cognitive processing.

The basic outline of cognitive concepts developed for NCAT and NAE are displayed below. A detailed discussion of these concepts is beyond the scope of this paper, but can be found in other works by R. L. Garner.

NCAT Concepts Related Brain Functions

Single Thinking = visual processing as it relates to visual arts

Double Thinking = visual and verbal processing as it relates to visual arts

Triple Thinking = visual, verbal and emotional processing as it relates to the visual arts

Quad thinking = visual, verbal, emotional and motor processing as it relates to the visual arts

The significance of these concepts, from an educational perspective, is that they require the teacher/researcher to comprehend content/curiculum in relation to underlying cognitive and sensory processes based on an understanding of brain

function. This is important because educators rarely recognize the complexity of their own behavior, not to mention the intricacies of their students. The complexity of the NCAT Processing Model increases developmentally resulting in a form of integrated/holistic processing relevant to a 21st century educational context.

Conclusion

For student's with disabilities to reach their greatest potential, changes and new insights are necessary. NCAT and NAE, as outlined in this paper, are a viable means to address the deficits of the current educational system. Developments of this methodology will continue to be made and refined in an effort to meet the needs of all students.

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