

# Final Workshop Report

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## **Art, Creativity and Learning**

June 11-13, 2008

National Science Foundation

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## EXECUTIVE SUMMARY

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The NSF Workshop on “Art, Creativity and Learning”, held at the National Science Foundation Headquarters in Arlington Virginia and The Phillips Collection on June 11-13, 2008, brought together a pool of the world's leading investigators interested in the relations between the enhancement of learning, the transfer of cognitive abilities, and art education. The **goals** of the workshop were (i) to establish if there is a sufficient basis for initiating a field of study of the **Enhancement of Learning through Art** to the Science of Learning, (ii) to explore the **current status** of related research, and (iii) to determine the **potential for future research** in this arena from the neuroscientific, cognitive and educational perspectives. There exist scattered studies on the effect of learning in specific fields of artistic endeavor, particularly in the case of music, but little systematic work on the issue of transfer from experience with the arts to proficiency in other fields of human activity. These interdisciplinary goals required the assembly of distinguished researchers from a diverse array of interrelated fields, including neuroscience, visual art, music, dance, sensory physiology, psychophysics, developmental psychology, education, and philosophy. The participants were selected as those reaching out from their traditional academic disciplines to study the role of art in enhancing learning capability and effectiveness throughout the stages of life.

### Organization of the Workshop

The **format** of the workshop was designed to enhance creative and effective discussions. Prior to the event, the organizers distributed **seed questions** to all participants to promote conceptualization of the issues; and in order to facilitate active independent positions, the participants were required to prepare and submit **one page projections** of their individual ideas for research.

At the meeting, fifteen short **20 min presentations** were followed by **Research Goals Brainstorms** in each topic area, which proved to be a very effective strategy. The Brainstorm sessions became a creative focus promoting integration of the diverse group, and generating significant reconceptualization in several of the topics of the preceding talk sessions.

The **Keynote Speaker**, principal dancer Jacques d'Amboise, has spent his post-dance lifetime developing formats in which engagement with the art of dance can promote enhancement of learning in other fields of life. The stated goal of his National Dance Institute is to use dance as a catalyst to engage children and motivate them towards excellence, including improved thinking ability, development of self-esteem and confidence, and higher order skills tied to cognitive, affective, and kinesthetic domains of learning.

A **Creative Social** evening session immersed everybody into a direct exposure to the creative artistic process. The renowned performer Parthenon Huxley from the classic rock music group "Electric Light Orchestra" came, and in an intimate format surrounded by the participants gave uniquely introspective answers to questions about the creative process of composing songs. He also generated a live composition based on ideas thrown out by the participants. This was followed by the experience of learning a group 'hora' dance, in which the participants discovered that there is a major difference between the concept and implementation!

On the final day the participants formed three ***Breakout Groups (Visual Arts; Music and Dance; Art and Education)*** to work on summarizing recommendations for new research directions in the neuroscience of learning enhancement by art training and experience. The diversity of the participants' backgrounds ensured that these discussions would not go entirely smoothly, however. There were significant debates such as: how parallel are the results across art modalities, how far particular aspects of emerging research have developed, and whether the experience of art was primarily a matter of processing within a particular sensory domain, (such as music or visual art) or was a full-scope multimodal learning process (as in a dance performance).

## **Main Outcomes from the Workshop**

### ***Evaluation of the Current Status***

The Workshop was motivated by the current expansion of interest in the science of learning and the expanded possibilities of conceptual interrelationships offered by training and exposure to the arts. As a high priority for the national interest, the difficult task of understanding and effectively enhancing learning across disciplines, ages and cultural specificities was thought to be particularly benefited by training in and even exposure to the arts.

Both the workshop presentations and discussions demonstrated how contemporary research is beginning to explore new neuroscientific hypotheses concerning the effects of learning in activities (such as musical performance, drawing, visual aesthetics, and dance) on learning in non-artistic domains. For example, early evidence suggests that experience in the arts may facilitate creative thinking and effective problem solving across a broad range of domains, and plausible neural underpinnings are beginning to be identified. Results were presented revealing that musical experience and short-term auditory training can enhance subcortical representation of the acoustic elements known to be important for reading and speech encoding, and that such learning outcomes can be objectively assessed. The presenters also described neuroimaging support for the idea that there exists a frontal brain region that processes the general property of 'structure', when that structure is conveyed over time (i.e., the property in common across musical structure, language structure or the visual organization of words conveyed through American Sign Language). Thus, experience with musical structure can be expected to enhance the learning of language structure. Moreover, long-term musical experience on development is known to last for years and it is possible that such experience may provide protective effects against aging and the disruptive effects of hearing loss.

Dance integrates the rhythmicity of music and the representational capacity of language. Neuroimaging studies of dance were presented that have examined brain areas involved in both the production and perception of dance. Perception studies have evaluated neural "expertise effects", demonstrating brain activations that occur preferentially in people who are competent to perform the dance movements. Neuroscientific evidence was presented suggesting that music and dance may activate two parts of the same motor-action-imitation system through mirror neurons. Music and dance also evoke emotions and stimulate visual images that expand the scope of the material being learned by maintaining attention and allowing a higher level of memory retention.

Visual art learning is reliant on a complex system of perceptual, higher cognitive and motor functions, suggesting a shared neural substrate and strong potential for cross-cognitive

transfer in learning and creativity. For instance, recent neuroimaging studies have started to reveal that the process of drawing shares cortical processing areas with many specific cognitive processes, such as those involved in writing, access to the semantic system, naming, imagery, constructional abilities and the ability to estimate precise spatial relations. A case study was discussed that has revealed significant processing differences between the brains of a professional artist and a novice during drawing in the scanner; the comparative analysis of the activation patterns suggests a more effective network of cognitive processing for the brain of the artist. Neuroanatomical underpinnings of visual art production and appreciation from observations of brain damage in established artists were described, as well as the relationship between art and other communicative displays by biological organisms, and the role that beauty plays in art.

Speakers introduced some of the principles of visual neuroscience and showed how artists have implicitly (and occasionally explicitly) taken advantage of these principles in developing works of visual art. On that basis, a specific undergraduate syllabus was proposed, with the goal not only to advance an understanding of the neural systems that underlie vision but also to cultivate observational skills and critical thinking. It was emphasized that more sophisticated and contemporary models are needed of what art is, models that should also be based on the tools of psychology and psychoanalysis. Art should be regarded as a cognitive process in which artists engage the most perplexing issues in present experience and try to find a way of symbolizing them visually so that they can bring coherence to their experience. In consequence, the definition of art is constantly changing in relation to its time. Understanding how we symbolize our experience, how we use symbolic form to organize our thinking processes, and what are the neuroanatomical corollaries to these processes, will have obvious implications for learning.

From pre-historical times, visual art has been a form of communication deeply embedded in human nature. The participants discussed how compositional universals govern the design of visual artworks across ages and cultures, and how the act of art experience and appreciation in the “receiver” also has the power of cross-cognitive effect during any time point in individual development. These findings have implications not only for biomedical sciences, but also for learning, pedagogical principles and general social and educational policies.

## ***Recommendations for Future Research***

### ***Strategic Principles***

Are there **general strategic principles** that should be applied to future research in the enhancement of learning through the arts? Some of the principles that were brought out in the discussions were:

- Art is fundamentally a **communicative medium**: the processes of creation and appreciation of art constitute a special kind of communication; thus future research needs to study both the creators of the art and the consumers (enjoyers) of the artistic products; a focus on one or the other alone would be incomplete.
- Such a **dual focus** is fundamental to understanding and developing theories of how we *learn to create and appreciate art*. An adequate theory must account for both the holistic and componential factors that contribute to activities in the arts.
- Both art learning and art production involve a complex interplay between multiple sensory-motor and higher cognitive mechanisms. To achieve full understanding of the processes involved in any art, as well as the way they influence learning in other domains, the focus of future investigations should **not be restricted within one level of**

**the system**, but include consideration of the whole complex of interactions between the levels of learning, art creating and appreciation.

### Key Research Directions

Consensus was reached in terms of agreed sets of the most worthwhile research questions to pursue in three areas: i) music, dance and the science of learning; ii) visual arts and the science of learning; and iii) the role of the arts in learning strategies.

From the extensive array of questions that were identified, certain **common themes** emerged from the Breakout Sessions, encapsulated by broad questions as the following:

- How can the dimensionality of the domain be scientifically defined in each of the arts? An important step is to develop common vocabulary and operational definitions in each domain of enquiry.
- What are the measurable cognitive and biological underpinnings of learning in specific art forms, such as visual arts, music, dance, theater? How can the relative importance of those learning components be quantified and understood in terms of the neurobiological mechanisms?
- What processing “modules” does art learning “share” with other cognitive functions, in particular such as those known to be involved in learning and creativity in non-artistic domains?
- What are the implicit benefits and cross-cognitive transfer effects of training and experience in the arts? How can the transformative process of the art experience be studied?
- What is the plasticity of the component abilities across the lifespan? What aspect(s) of art training help(s) people become better artists?
- What is it that the learner in the arts is actually learning? What specific skills do musical, visual art, or dance training impart? What is the link between such training and outcomes in language, social, and cognitive functions?
- Neuroscientific studies have identified “mirror neurons” forming a mirror-matching system that responds similarly when an act is performed by the individual studied or when observing a separate person performing the same act. Does the mirror neural system form the neural substrate of the embodied cognition experienced when viewing a work of art? Can the positive or negative valence of the art-induced form of empathy be harnessed to enhance learning in related fields of endeavor?
- Inspiration is an aspect of mental experience that involves not just cortical circuitry but its integration with the limbic system and medial frontal structures that are understood to mediate the experience of emotions, motivational rewards and the appreciation of the aesthetic values of the impinging stimuli. What is the mechanism underlying the role of inspiration in long-term learning? How is inspiration related to the mechanisms of attention and reward?
- Does learning in an art form always “transfer” to learning in science? (e.g., does the learning of drawing foster the ability to learn geometry, or the learning of music foster the ability to learn language or mathematics?) What factors support or invalidate the operation of such a transfer process?

- When the arts are integrated with other related disciplines in schools, is there evidence that learning in these other disciplines is enhanced? Does the answer to this question depend upon the type of learner (e.g., learning disabled; typical)?
- There is a need to evaluate the underlying processes to determine what specific mechanisms for such transfer of learning the brain has developed. What are the main principles of learning transfer and how could they be implemented to effectively enhance educational strategies?

### Methodological Recommendations

Key **methodological issues** need to be considered, such as what kinds of neuroscientific and behavioral research would qualify to provide a rigorous basis for advancing the role of artistic endeavors in the enhancement of cognitive capabilities. The participants proposed a set of methodological recommendations, including the following:

- To understand the cross-modal effects of art training, it is necessary to study the basic perceptual processing of the artistic objects that give rise to these experiences. The extent to which different key parameters play a role in the artistic experience should be investigated parametrically, and it should be determined how these functions map onto the spectrum of artistic expertise.
- Non-invasive neuroimaging techniques and transcranial magnetic stimulation to generate a reversible blockage of neural activation should be used to address the questions of learning transfer, enhanced creativity and enriched aesthetic experience.
- Causal network modeling of the information flow amongst cortical regions should be employed to provide new insights into the neural mechanisms of brain plasticity, which are important for the development of cognitive training strategies.
- Integration of advanced methods must be utilized to measure psychophysiological reactions to the artistic experience. New analytic techniques will be necessary for understanding the whole physiological reaction, and open the opportunity for converging approaches
- An appropriate set of standardized measures and vocabulary for studying how non-professionals talk about and describe different aspects of the arts should be developed. Formalization of such categorization is fundamental to any meaningful integrative work.
- Future investigations should recognize that art is a dynamic cognitive process in which the definition of art is constantly changing in relation to its time. A more comprehensive approach should be used to explore the physiological characteristics and learning functions of this inherently chaotic modality.

### ***Consensus for a New Field of Learning Enhancement through Art***

The overall consensus of the group was that, despite our professional diversity and the short time available for us to work together, we achieved substantial coherence, common language and integrity. The communication and mutual interest in the work of each others' specialized disciplines, and the wish to embrace the complementary frameworks were impressive. The final sense of the group was that this Workshop represented a worthwhile opportunity to derive

the maximum benefit from the deep need of art that is inherent to the human nature to enhance the learning capabilities and cognitive skills of people at all aspects of society.

The main focus of the Workshop, the enhancement of learning, remains a challenge, particularly in the school setting. While direct explanation seems the best approach to teaching any specific subject on the curriculum, the ability to absorb facts and concepts is greatly enhanced by placing them in a broader context of the quality of life and human advancement to a more evolved status of society as a whole. It is these larger goals that underlie the mission of NSF (*"To promote the progress of science; to advance the national health, prosperity, and welfare"*) and that evoke the need for research in the relationship between learning and experience in the arts. The Workshop successfully brought together an interdisciplinary group of leading thinkers in order to determine whether is a sufficient basis for initiating a new domain of **learning enhancement through art** within the Science of Learning, and to identify appropriate directions and methods for research in this arena.

**In summary**, the main large-scale result from the ACL Workshop was the achievement of general agreement that the emergence of a new field of the effects of art training in the science of learning can play an important role in the future development of a globally effective society. This communal enterprise would simultaneously transcend the borders of professions, countries and continents. Moreover, this meeting itself represents the initiation of art/science community that can effectively communicate through a common language of cross-disciplinary interaction, that is timely and meets a significant need in the contemporary learning environment.

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## **Acknowledgment**

The organizers and the participants of the "Art, Creativity and Learning" workshop are very grateful to the National Science Foundation for the extraordinary opportunity to explore and discuss the future of this new interdisciplinary research domain of learning which opens a great potential for enhanced learning, and especially to Soo-Siang Lim, Program Director for the Science of Learning Centers, who suggested this new domain of investigation.