

Osmotic Sensoria: Appropriating Technology that Stimulates the Bilateral Brain to Augment Human Creative Capacities

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ABSTRACT

In an ever-changing world, technological gadgets mediate social relations and global information flows; the generations to come need to learn flexible ways of thinking that enable them to organically, and creatively, adapt to unforeseen conditions, and become design-able, socially responsible, resilient citizens. However, in the midst of the 21st century, education is still based on the transmission of information, concerned with social credence rather than nurturing an expansive way of thinking, and giving the most value to information retention. Design education, and eventually education in general, has to embrace a holistic approach that primers the next generation of thinkers, of innovators; individuals able to envision better futures for humanity by tackling everyday problems in unexpected, creative ways. As a way to avoid narrowness and homogeneity in learning environments, and harness design-able, resilient minds, I have envisioned the *Osmotic Sensoria* as a multi-sensory learning space + design-based curricula that nurtures cognitive flexibility by dint of stimulating the whole brain—left and right brain equally, in both conscious and unconscious levels. In order to enhance students' innate creative capacities, learning through play, self-discovery, positive emotions, and serendipitous exploration is fostered.

Author Keywords

Creative insight, cognitive flexibility, everyday creativity, learning through play, multi-sensory space, neuroplasticity

ACM Classification Keywords

Design, experimentation, measurement, EEG/fMRI technology

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NEUROPSYCHOLOGY OF LEARNING: EDUCATION, CREATIVE INSIGHT, AND THE BUILT ENVIRONMENT

INTRODUCTION

When reflecting on the ways in which information navigates throughout our body in order to action a certain response, one cannot elude the intricate network of microscopic nerve cells that are in constant communication, firing bits of information, which trigger complex bodily changes—the nervous system being one of the most complex and pervasive systems of all; and the ways in which both our biology and our personal experiences define who we are, and who we are to become.¹ New ways of learning that engage both conscious and unconscious processes of top and down functions, and stimulate the bilateral brain—left and right brain equally—are needed in order to create a holistic education for all human populations. An education that ignites “Eureka” moments, fosters “everyday creativity,”² redefines the meaning of being human, and propels the growth of the *self* towards a constant *homeostatic state*—a state of self-regulated equilibrium that adjusts to changing conditions—as opposed to fragmented and unbalanced individuals, limited by a narrow knowledge of particular skills that perpetuate the status quo.

However, the current “Information Age” puts the highest value on information retention over understanding and thinking. Traditional, non-constructivist, or *existentialist*,³ education focuses on learning a set of skills by delivering information that is then memorized by students. Because of the focus on information retention that can easily become obsolete—such as technology skills—we are depriving our students from developing their natural abilities, those

1 Joseph E. LeDoux, *Synaptic Self: How Our Brains Become Who We Are*. Penguin.com, 2003.

2 Ruth Richards, coined the term “everyday creativity”

3 Essentialist education, such as the traditional educational system in USA strives for social homogeneity by teaching social norms and cultural beliefs as the base of instruction.

Bernard Neville, *Educating Psyche: Emotion, Imagination and the Unconscious in Learning* (Melbourne: Flat Chat Press, 2005).

human capacities that have been enhanced through evolutionary processes. This model is based on a pyramid structure of authority and control—the teacher being the authoritative figure who controls the type of knowledge to be learned; the obtained knowledge lives outside the student: in books, television, the Internet, and the teacher's own knowledge; this teaching style focuses on back cortex functions—temporal and occipital lobes—which are involved in information processing and integration in memory.⁴ This form of education is problematic because it stimulates areas of the brain involved in processing information disregarding other systems also important to learning, such as emotion, reasoning, planning, problem-solving and stimuli perception, all of which are located in the front cortex—frontal and parietal lobes—where information is analyzed, and applied to new situations. Likewise, an *existentialist* education does not engage all types of cognitive styles,⁵ in the sense that students who are more creative, more reflective, or lack a good memory, would not experience optimal learning, and hardly excel in these learning conditions. Correspondingly, this model is based on a system of punishment and rewards—of extrinsic motivations—where too much reliance on tests and grades is used as assessment tool, without considering the effects of external stressors. These extrinsic motivators negatively affect the learner because extrinsic motivators activate the amygdala, a system in charge of processing emotions, controlling freezing behavior, and other defensive responses in threatening situations.⁶ Also, there is a constant struggle between what students learn through experience by acting in the world, and the expectations of what they need to know explicitly—and make visible in their work—in order to get a high grade. In adulthood, vocational education aims to re-teach students some of the capacities they once had, and lost. Advisor on education, Ken Robinson, has also discussed this problematic in his book *Out of Our Minds* as a process that “educates” children to “unlearn” capacities, and then tries to make them “relearn” narrower, more specialized abilities once in adulthood; moreover, he stresses the need for new models of education that consider the learner's attitudes and aptitudes.⁷ Furthermore, social pressures for high-academic performance and professional success have led students to illegally consume and abuse amphetamine salts-based psycho-stimulants—such as Adderall and Ritalin—which

have become trendy amongst college students looking to gain focused attention, work long hours, and retain more information for short periods of time in order to have higher performance in test scores. Even more so, pharmaceutical companies have been developing psychotropic drugs to enhance brain function, such as *Neuroflexyn*, pushing to make them legal by labeling them as “vitamins for the brain,” and pushing them in the media to go mainstream.⁸ When looking at vocational education, the learning experience concentrates on narrower, specialized learning systems—such as art and design schools concentrating mostly on the visual cortex. When looking at vocational education, the learning experience concentrates on narrower, specialized learning systems—such as art and design schools concentrating mostly on the visual cortex.

These educational systems are unsuccessful in harnessing the kind of minds that could potentially envision, and build, better futures for the world. As a way to provide the conditions needed to better our future, multi-sensory learning environments have to be created in order to naturally augment creative insight, and exercise cognitive flexibility in the minds of new generations. In particular, design schools have to be frontrunners in re-framing education, and need to become *transitional-learning spaces*⁹—spaces for serendipitous exploration, reflection, and action—that foster the expansion of the self to reach students' full potential beyond a classroom setting into tackling real world issues; in creating what American sociologist and scientist, Herbert Simon, called *preferred situations*. An adaptation mechanism that nurtures these new ways of thinking, and helps us survive in changing conditions when encountering new situations, is the ability of the human brain to rewire itself through experience—known as brain plasticity or neuroplasticity.

In shaping education for the 21st century, both neuroscience and design[ing] need to become the core of educational systems starting at an early age—neuroscience as the basis to understanding human innate capacities, and design[ing] as the means by which to develop and enact such capacities every day in the real world. In this paper I will discuss some of the complex systems that govern human behavior via learned experiences, and the ways in which those systems can be positively stimulated via technology

4 James Ellwood Zull, *The Art Of Changing The Brain: Enriching Teaching By Exploring The Biology Of Learning*. Stylus Publishing, LLC., 2002.

5 Of various cognitive styles, that Kirton describe as innovators, and adaptors; in order to achieve a natural balance, we need to be able to shift from one style to the other, organically, to meet the needs of the situation at hand.

6 Joseph E. LeDoux, *Synaptic Self: How Our Brains Become Who We Are*. Penguin.com, 2003.

7 Ken Robinson, *Out of Our Minds: Learning to be Creative*, John Wiley & Sons.

8 Consumer News 247 online, *Brain Power: “Is this the Most Powerful Brain Enhancer on The Planet?”* <http://goo.gl/0hhuij>; <http://motherboard.vice.com/read/brain-enhancing-smart-drugs-are-going-commercial>.

9 English pediatrician and psychoanalyst Donald Woods Winnicott used the terms transitional phenomenon, potential space, transitional object, and good-enough holding environment, interchangeably to refer to a transitional space (1989). Elizabeth Ellsworth, in her book *Places Of Learning: Media, Architecture, Pedagogy*, describes transitional spaces as places for learning what is that can also teach us what could be; Donald W. Winnicott, *Playing and Reality* (Psychology Press, 1971).

adapted to a multi-sensory learning space that I have named *Osmotic Sensoria*; many of those complex systems are automatic, unconscious processes that in many ways determine how we approach, interact, and experience the world. Organic ways of teaching and learning need to be developed to reach an optimal, and lasting, learning experience beyond information absorption and social conformism; it is a shared space of retreat from the constant, outside, information overflow of modern life. By means of integrating multi-sensory elements, different kinds of perceiving will develop *ways of knowing*—of learning—and help produced different *types of knowledge*¹⁰ that speak to an array of cognitive styles and personalities. In order to propel a robust organic, *osmotic learning*, to augment creative insight—the Aha! Moment—of *everyday creativity* through play, self-discovery, positive emotions, and serendipitous thinking, the *Osmotic Sensoria* provides an educational framework based on neuropsychological research as a way to develop new, open-ended, cognitive-flexible processes to stimulate the whole brain. The desired outcome is a new pedagogy—in the form of curricula, and a multisensory space of instruction—which boosts optimal learning through self-regulation, positive emotions, lateral thinking, and intuition via textures, visual projections, oral narratives, oxygenated air, smells, and kinetic play; a pedagogy that can be adapted by educators of all age groups, regardless of specific disciplines. Still in the conceptual stages, and ongoing research, I hope that the *Osmotic Sensoria* permeates traditional systems, and becomes a ubiquitous and pervasive form of teaching and learning.

Nature [plus] Learning: Embrace Play, Excitement and Movement for Creative Robustness

Many human traits come from the memory of millions of years of experience—our evolutionary imprint. Evolutionary theories explain the ways in which many automatized behaviors have become hardwired in our DNA encoding as a way to ensure survival. We are born with a set of genetic encodings as part of our evolutionary imprint, which are then tailored in the womb—both brain and body adapt to the environment in the womb; the genetic imprint is what makes us all the same—humans—and the experience in the womb—the learning process—make us all unique since each genetic imprint is configured differently based on those experiences.¹¹ Through

evolution, humans have developed new, more refined, capacities via learning processes stored in the collective memory of humankind. In other words, the brain is a social organ shaped postnatal via social interactions (epigenetics);¹² each brain is an experiment of nature and biodiversity, of genetics and evolution, and of social relations. We come out to the world with a series of preconfigured traits (nature) that are then shaped by our experiences through life (nurture); relationships trigger neuroplasticity and learning. Learning is a lifelong process; it is a process that modifies a subsequent behavior.

Our physiology, and how we think and feel about ourselves, is also the result of interactions between conscious and unconscious processes. Consciousness as we know it—as processes—is a fairly young evolutionary trait. Unconscious processes, on the other hand, have ruled all life through history. Unconscious processes regulate many bodily functions, such as breathing, heart rate, and muscle contractions. Understanding language involves many unconscious processes such as decoding sounds (phonology), meaning (semantics), grammatical relations (syntax), and knowledge about words (pragmatics). American psychologist, Julian Jaynes, in *The Origin of Consciousness in the Breakdown of the Bicameral Mind*, 1976, states that consciousness is not necessary for learning, thinking, or reasoning instead those cognitive processes—learning, thinking, and reasoning—could sometimes be hindered by judgment determined by cultural biases. In ancient human history, the bicameral mind, argues Jaynes, was split into two parts: the right, or mind of the gods, and the left, which was the mind of man. Consciousness came about as a learned cultural manifestation possible through language; invention that diminished the ancient capacity to listen to the gods' voices—what some call today intuition. Gigerenzer (2007) refers to gut feeling/intuition/hunt indistinguishably as “a judgment that appears quickly in consciousness, whose underlying reasons we are not fully aware of, and is strong enough to work upon”—intuition is not impulsivity.¹³ Learning starts in the womb as an unconscious process. Part of the process in making quick decisions is the response of the unconscious, and automatized systems; much of the knowledge we acquire through life is learned by the absorption of everyday experiences, without the need for direct, explicit, instruction.¹⁴ For instance, a child learns how to speak and walk through unconscious observation,

¹⁰ Daniel Tammet, “Different Ways of Knowing.” TED Talk (Filmed March 2011).

¹¹ Steven Pinker has argued that there is no “blank slate.” The conditions of a fetus in the womb prepare the unborn child for life, making it adapt to survive such conditions. For instance, if the fetus doesn't get enough food, he would be prepared for a life of scarce conditions. If conditions outside do not match the inside, that child could suffer from obesity later in life; Steven Pinker, *The Blank Slate: The Modern Denial Of Human Nature*. Penguin, 2003.

¹² In biology, and specifically genetics, epigenetics is the study of heritable changes in gene activity that are not caused by changes in the DNA sequence; it also can be used to describe the study of stable, long-term alterations in the transcriptional potential of a cell that are not necessarily heritable.

¹³ G. Gigerenzer, 2007. *Gut Feelings: The Intelligence of the Unconscious*. Viking: New York; pg. 16.

¹⁴ Deb Roy, *The Birth of a Word*. TEDtalk

pattern repetition, and mimicking—through a process of *osmosis*. As adults we learn moral values, and how to read social cues in the same manner; social beliefs become engrained in our brain, be it as followers of such beliefs or as rebels against the system.¹⁵ Language is another example of the robustness of unconscious learning; although we end up consciously understanding language when someone speaks to us, we don't consciously access the ways in which the background processes in our brain produce understanding,¹⁶ instead, the unconscious creates language automatically and, when processed, language reaches consciousness. Pavlov's theory of conditioning shows that the state of *being aware*—of conscious thought—could lower learning. In his experiments with "Signal Learning," conditioning happens below awareness; if the process is made explicit, the conditioning through learning does not occur. Learning is both conscious and unconscious; driving, riding a bike, and typing are activities learned through practice that become embedded in the brain and automatized. The automation is not about consciousness but about repetition. Similarly, thinking is an automatic process; when solutions reach awareness, the process of thinking has already occurred; in this process is where tacit knowledge becomes central. Creative thinking involves various stages of implicit processes; preparation, incubation without concentration, and illumination are cornerstones to solving problems.

As discussed before, learning processes—the selected information to be processed and integrated—are determined by motivations that could be internal or external, engage both conscious and unconscious minds, and can be stored in the short-term memory, or the more resilient long-term memory. Although memory is paramount in learning processes, when learning concentrates on mechanistic memorization—of facts and rules removed from experience—as a methodology, the social brain is turned off, which hinders the production, acquisition, and retrieval of knowledge; and the importance of memory in the learning process is precisely the ability to fix and remember past experiences, in other words, the process of knowledge imprint and retrieval. Additionally, the robustness and accuracy of memories—of the things we learn—is vastly influenced by emotional states; when experiences involve positive emotions, the process of transforming information and imprinting it in memory is more effective¹⁷ therefore,

"emotions are indispensable for rationality to occur."¹⁸ James McGaugh, a neurobiologist at the University of California at Irvine, advises to embrace emotion because "any kind of emotional experience will create a stronger memory than otherwise will be created."¹⁹ Emotions are unconscious and manifest through bodily response, such as sweating and accelerated heart rate, and feelings.²⁰ Also, extreme levels of stress and fear can deter formed memories while still affecting us unconsciously, which consequently results in impaired learning, and weakens processes of memory retrieval. Since humans strive for survival and wellbeing, the learning experience needs to be based on finding balance of the *self* as a whole where memory and emotions become the main actors in this new system.²¹ Because emotional centers can take over the centers for learning, students need to learn in an environment that removes feelings of danger and failure, lowers stress, and instead harnesses positive emotions, and excitement.

Learning also occurs both implicitly (unconscious) and explicitly (consciously). We can divide the information stored in our long-term memory into two categories: those that we are conscious of (explicit) and those that we aren't (implicit). But implicit memories exist, and they influence how we feel, how we respond, and what we can do. These are things that we do unconsciously like walking or reacting spontaneously in specific situations but that we are not aware of remembering them.²² Behaviors, beliefs, and feelings can all be stored in implicit memory, so when we want to help someone learn we must watch for these as well as for what they remember explicitly; people may know more than they are able to tell us. Explicit memories that are formed in emotional situations are recorded in the long-term, implicit, memory and are called flashbulb memories; these unconscious memories—also called non-declarative—help us mainly remember dangerous situations and act automatic to assure survival—emotions, in short, amplify memories²³ the amygdala is also involved in implicit processes, including learning, and the working

15 G. Gigerenzer, 2007. "Gut Feelings: The Intelligence of the Unconscious". Viking: New York.

16 Joseph E. LeDoux, *Synaptic Self: How Our Brains Become Who We Are*. Penguin.com, 2003. p11.

17 James Ellwood Zull, *The Art Of Changing The Brain: Enriching Teaching By Exploring The Biology Of Learning*. Stylus Publishing, LLC., 2002.

18 Taylor, E. W. 2001. "Transformative Learning Theory: A Neurobiological Perspective of the Role of Emotions and Unconscious Ways of Knowing." *International Journal of Lifelong Education* 20 (3 May/June): 218-36; pg. 218).

19 TIME 2009; pg. 78

20 Eric Kandel. *The Age Of Insight: The Quest To Understand The Unconscious In Art, Mind, And Brain, From Vienna 1900 To The Present*. Random House LLC, 2012.

21 Sylwester, R. 1994. "How Emotions Affect Learning." *Educational Leadership* 52 (2): 60-65; Greenwald, A. G. 1992. "New Look 3. Unconscious Cognition Reclaimed." *The American Psychologist* 47 (6): 766-779.

22 James Ellwood Zull, *The Art Of Changing The Brain: Enriching Teaching By Exploring The Biology Of Learning*. Stylus Publishing, LLC., 2002.

23 Ibid.

memory.²⁴ No-declarative memory has shown to be more resilient than the implicit, Declarative memory; it has been found that Alzheimer's patients, even though they forget important life events, experiences and even family members, they can still perform learned skills such as playing an instrument since these kind of tasks are stored in the Non-declarative memory, which engages in domain-specific learning; motor skills stored in memory—how to do physical things like riding a bike—are also imprinted in the Non-declarative memory; the case of H.M split-brain surgery supports this theory.²⁵ Emotional states are also related to creativity; it has been proven that fear of failure dismisses creative insight.²⁶ Due to the fact that humans are in a constant search for positive feelings, satisfaction and satiation of desires—processes connected to the anterior cingulate; personal satisfaction over extrinsic rewards—such as money, grades, and other forms of social validation—augments creativity. Bernie Neville, in his book *Educating Psyche* (1989) explains that education at its core means being excited about ideas. Alfie Kohn, in his book *Punishment by Rewards* discusses the idea that in offering an extrinsic reward, the chances of learning diminish.

Using these findings as premise, my objective is to develop a new educational model driven by brain systems that go beyond pure memorization; a deep learning that emerges from sensing both inner and outer spaces, of conscious and unconscious processes.²⁷ I argue that in the mental and physical exercise of design[ing] and playing in a safe and relaxed environment, the serendipitous explorations of a multisensory environment that mediates social relations can promote the imprint of tacit knowledge in the Reptilian brain—the most primitive brain—making it automatic. By dint of activating the centers of the basal ganglia—of motor control—while engaging the amygdala located in the Limbic System, the produced knowledge can be retrieved, brought to consciousness by the Neocortex—the most evolved brain—as procedural, of how to perform, tacit knowledge.²⁸ In this process, the tacit knowledge becomes a

way of thinking creatively. The work of John Lehrer on creative insight similarly discusses the idea that solving wicked problems, the Eureka! moments, happen below consciousness. In order to approach problems creatively, the situations need to be reframed; creative thinking is about seeing the problem anew, unlearn what we believe as true, in order to retrieve different types of tacit knowledge from memory. This process of breaking learned patterns is known as cognitive flexibility—the ability to see situations in multiple ways. Nobel prize winner (2000), Eric Kandel, in his book *The Age of Insight*²⁹ argues that, in order for creative insight to happen, the brain needs to integrate information unconsciously, at certain rates, in specific parts of the brain. Subsequently, the Aha! moment is the result of right/left brain consensus, when in a process of conscious and unconscious feedback loops—Winnicott's inner (unconscious) and outer (conscious) space. EEG technology can be used to trace the moment of insight eight seconds before it happens, which has been found to be the moment when the brain reaches alpha waves. When in alpha waves, the attention goes inwards, allowing the person to access tacit knowledge stored in the long-term memory and retrieve collected content; when too focused, the attention goes outwards, and the mind concentrates too much on finding the correct solution to win an external reward, rather than exploring possibilities. The idea of a kinetic experience—of “thinking by moving”—is illustrated by Ken Robinson in his book *The Element*,³⁰ in which he discusses the case of the British ballerina, dancer, actor, and theatre director, Gillian Lin who at age 8, during the 1930s, was thought to have a learning disability. Instead, she had a different approach to learning—a different cognitive style: she needed to “move to think.” Her professional success as a choreographer of plays, such *Cats* and *Phantom of the Opera*, demonstrate Robinson's point, and furthermore, the importance of stimulating the brain's motor-sensory cortex. The space is what provokes cognitive flexibility on an unconscious level.

We need to develop a new kind of mind that helps us manage modern life stressors, restless changes, and external noise by encouraging self-compassion instead of self-criticism and guilt, to harness growth mindset³¹ as opposed to fixed mindset; self-regulation is a survival system to manage stressors, and selection and integration of knowledge become the main processes for the production and acquisition of knowledge. These processes have “adaptive value,” meaning that selecting and integrating

24 Ibid

25 Michael S. Gazzaniga, *Split Brain*. Insta-Tape, 1973.

26 Ibid.

27 James Ellwood Zull, *The Art Of Changing The Brain: Enriching Teaching By Exploring The Biology Of Learning*. Stylus Publishing, LLC., 2002.

28 The limbic brain emerged in the first mammals. It can record memories of behaviours that produced agreeable and disagreeable experiences, so it is responsible for what are called emotions in human beings. The main structures of the limbic brain are the hippocampus, the amygdala, and the hypothalamus. The limbic brain is the seat of the value judgments that we make, often unconsciously, that exert such a strong influence on our behaviour. first appeared in mammals, and was the first brain capable of emotion. the abilities to trust and love are learned traits of the evolved brain that have been stored in the long-term memory for centuries; Gred Gigerenzer, 2007. *Gut Feelings: The Intelligence of the Unconscious*. Viking: New York.

29 Eric Kandel, *The Age Of Insight: The Quest To Understand The Unconscious In Art, Mind, And Brain, From Vienna 1900 To The Present*. Random House Digital, Inc., 2012.

30 Ken Robinson. *The Element: How Finding Your Passion Changes Everything*. Penguin, 2009; TEDtalk

31 Carol S. Dweck, “Even Geniuses Work Hard. *Educational Leadership* 68, no. 1 (2010) : 16-20.

knowledge is what helps us adapt to new environments and situations. These capacities are part of the tacit knowledge from the collective unconscious; a system that evolution gave us, devoted to navigate the social world. Various contemporary theories of learning and creativity, such as the *Bilateral Brain Theory*, Reber's 1993 *Transformative Learning Theory*, and Epstein's 1994 *Cognitive Unconscious Theory*,³² should be adapted to general education, especially to early childhood education, to strengthen the learning experience in educational institutions. These theories converge in the idea that the whole brain is involved in learning, from left-right hemispheres, to levels of awareness and unconsciousness, and higher and lower order systems. Roger Sperry's split-brain (1981), Giacomo Rizzolatti's mirror neurons (1992),³³ and Paul McLean's Triune Brain, were studies that revolutionized brain science, and have shed light to the ways brain systems adapt to new conditions through learning. For instance, the theory of right-brain/left-brain dominance—known as the Theory of Lateralization³⁴—is the basis for vocational education. Gazzaniga and Sperry's studies on patients with split-brain surgery (callosotomy)—where the neural fibers that connect left and right hemispheres, called corpus callosum, are removed—have demonstrated the importance for right and left brain consensus³⁵ because, although each hemisphere has specific functions, they need to be in constant communication in order to function efficiently, and be able to perceive and act in the world.³⁶ New research has shown that the brain is made of complex systems, some of which work simultaneously—known as parallel processing³⁷—that specialize in specific types of learning, which work together to make sense of the acquired knowledge during the

learning process.³⁸ In consequence, the whole brain needs to be engaged for the learning process to occur efficiently. Our brain looks to the future, makes generalizations about our environment, and develops strategies to enhance our opportunities and minimize dangers so we can survive. Even our highest mental achievements, our calculus, poetry, or philosophy, come from a brain that evolved these types of skills solely to survive.³⁹ The act of play helps us learn about our innate and acquired capabilities, exercising such capabilities enhances our capacity to adapt to our environment, builds confidence through practice, helps develop social skills, problem-solving, and tinkering; cognitive flexibility is part of play, since it is through negotiations with others that play can work out. Play reframes failure, and by embracing failure and mistakes as part of a learning process, an ultimate goal can be achieved; it values both the process and the final product, always driven by an intrinsic motivation of "success." Because of our survival capabilities, when feeling threaten we used learned skills to survive the threat, whereas when not in an immediate threat, our minds can engage fully to explore new ways of doing things and help others. Evaluations, tests and other grading assessments in school are perceived by the learner as a threat, and their minds concentrate on dealing with that threat to survive instead of excel.⁴⁰ The brain can be stimulated subliminally (unconsciously), using a common approach called "backwards masking" in which a neural stimulus is sent through visuals below the visual threshold, followed by a longer stimulus; the second stimulus is processed by consciousness while the first-masked one is process by the unconscious since it never reached awareness.

Design[ing] a New World: Stimulating Brain Circuits for Augmented Learning and Creativity Insight

In neuroscience, the *Activity-Expectant development theory*⁴¹ explains this phenomenon of seeing what can only be imagined; a research study conducted in rats found that not being exposed to "certain visual information, like vertical lines, in an important period of early development results in the inability to perceive such visual information."⁴² If we don't learn that endless possibilities exist and that we just need to develop the capacity to

32 Michael Tovey, "Designing With Both Halves Of The Brain." *Design Studies* 5, no. 4 (1984): 219-228; Arthur S. Reber, "Implicit Learning And Tacit Knowledge: An Essay On The Cognitive Unconscious." Oxford University Press, 1996; Samuel Epstein, "Integration of the Cognitive and the Psychodynamic Unconscious." *The American Psychologist* 49 (8): (1994) 709-724.

33 Mirror neuron systems: connection between sensory organs and motor organs to imitate; sensory motor link for simulation, resonance, imitation, skill building and coordination. Sensory affective light up for attunement, shared emotion, emotional contagion. Systems initially involved evolved to affective resonance.

34 E. W. Taylor, 2001. "Transformative Learning Theory: A Neurobiological Perspective of the Role of Emotions and Unconscious Ways of Knowing." *International Journal of Lifelong Education* 20 (3 May/June): 218-36.

35 Michael S. Gazzaniga, *Split Brain*. Insta-Tape, 1973.

36 Look up split-brain patients HM, JW, and VP; Michael S. Gazzaniga "The Cognitive Neurosciences." (1995).

37 Michael Tovey, "Designing With Both Halves Of The Brain." *Design Studies* 5, no. 4 (1984): 219-228.

38 Michael Tovey, "Designing With Both Halves Of The Brain." *Design Studies* 5, no. 4 (1984): 219-228.

39 McGuire and Troisi, 1998

40 *Psychology Today*, Peter Gray. May/June 2013. "The Enemies of Innovation", pg. 82, col. right, para 1. Psychologytoday.com

41 Daniel J. Siegel, *The Developing Mind: How Relationships And The Brain Interact To Shape Who We Are*. Guilford Press, 2012.

42 Daniel J. Siegel, *The Developing Mind: How Relationships And The Brain Interact To Shape Who We Are*. Guilford Press, 2012; pg. 26

imagine, we won't be able to create our desired future. As implicit processes have been proven to be more robust than the explicit processes, and engage various systems—such as unconscious and lower level executive functions—that are more resilient than conscious processes, I have used osmotic—implicit—learning as the foundation for the *Osmotic Sensoria*; in this multi-sensory environment, the type of tacit, acquired knowledge, is the source of human intuition,⁴³ and gut feeling⁴⁴ and it provides us with the capacity to adapt to new environments and situations, and find balance in Human Ecology.⁴⁵ When we learn consciously, we are limited by what can only be imagined—what we think is possible. Similar to learning basic skills like walking and talking—which are unconscious and, with practice, become automatic⁴⁶—students could learn ways of approaching the world in an organic, osmotic process, where knowledge is constantly integrated unconsciously in order to produce more resilient tacit-knowledge. The aim of the *Osmotic Sensoria* is to exercise in students a way of thinking that allows them to apply tacit knowledge automatically when interacting with the world, as a way to augment the moments of creative insight, and generate unconventional, innovative ideas, in everyday life.

The major objective of my exploration is to re-shape the learning experience in two levels: **Content (curricula)**: to deconstruct the creative process by developing game-like exercises that combine physical movements in space while mentally tackling everyday-design problems in order to connect the least evolved, instinctual—Reptilian—brain linked to motor skills, which works in an unconscious level, with the more evolved, rational—Neocortex—brain, which acts in a conscious level; what we could compare to the *brainstorming* and *mapping* part of the creative process. Exquisite Corpse exercise of hand-drawn *sketching* and *pictorial mind-maps* will allow students to share pre-verbal ideas and **prototyping and testing** will be a process of individual, introspective, exploration. **Form (space)**: Redesigning the traditional studio-classroom setting into a *transitional space* that enables students to augment brain capacities and develop *cognitive flexibility* that have shown to maximize the Aha! moments of creative insight. An important aspect of these two components—the act of *play* and a relaxing

atmosphere that stimulates the motor-sensory system of the brain—is the ability to engage the Limbic System⁴⁷—also known as the primitive, Mammalian or MidBrain, responsible for processing emotions, as a way to contrive *homeostatic emotions*, modulated by the ventral anterior cingulate cortex. Neurofeedback technologies, which are real time, self-regulation systems (i.e., wireless electroencephalography or EEG) will be used to track electrical activity in students' brains as a way to both collect neural field potential data and provide feedback for self-regulating the environment of the *Osmotic Sensoria* space (e.g., change of light intensity and wavelength, temperature, sound, etc.)

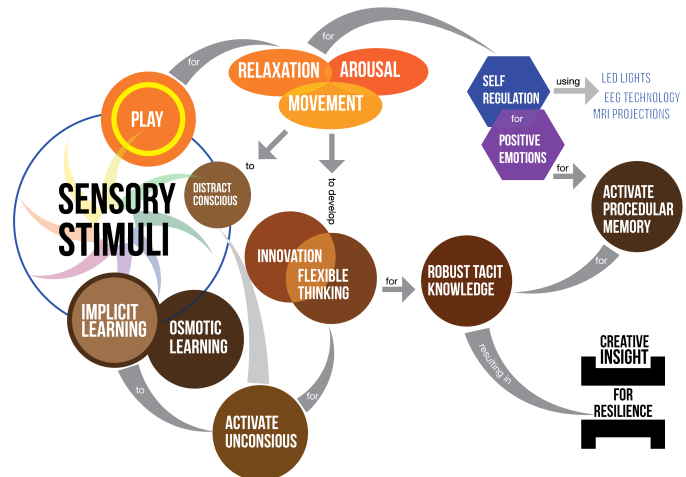


Figure 1 *Osmotic Sensoria Concept Map*; analysis of elements, technology, and brain circuits integrated in the Osmotic Sensoria pedagogy (Source: © Polo, 2014, “*The Osmotic Bubble: Creative Insight by Dint of Synchronized Atmospheres*” p.56)

The concept map (figure 1) shown above, visualizes my approach to the *Osmotic Sensoria* as a new framework for education, covering covers the WHAT, WHY, and HOWs of my project, which I have broken down as follows:

43 Intuition is the ability to understand something immediately, without the need for conscious reasoning.

44 G. Gigerenzer, 2007. “Gut Feelings: The Intelligence of the Unconscious”. Viking: New York.

45 Arthur S. Reber, *Implicit Learning And Tacit Knowledge: An Essay On The Cognitive Unconscious*. Oxford University Press, 1996; Ken Robinson, *Out of Our Minds: Learning to be Creative*, John Wiley & Sons, 2011.

46 Arthur S. Reber, *Implicit Learning And Tacit Knowledge: An Essay On The Cognitive Unconscious*. Oxford University Press, 1996.

47 American neuroscientist, Paul McLean, in 1970 developed the theory of the “triune brain.” 47 In this theory he explains the evolution of the human brain in three stages: the protoreptilian, constituted by basal ganglia, mid-brain, cerebellum, and brainstem; the paleomammalian, formed by amygdala, hippocampus, hypothalamus and other structures in the so-called limbic system); and the neomammalian, or neocortex.⁴⁷ This triad narrates the story of human evolution through brain systems,⁴⁷ from the bottom up. The protoreptilian, or reptilian brain, being the oldest and least evolved of the three brains, is the survival system in charge of controlling automatic bodily functions such as breathing, temperature, and balance,⁴⁷ motor skills, and of instinctual action planning such as exploration, sexuality, and dominance; unconscious—tacit—knowledge is maintained from here. The paleomammalian brain, or Limbic System, is constituted by the hypothalamus, the hippocampus, the amygdala, and several others nearby areas, and has been called “the emotional brain;” it is responsible for processing emotions as a way to contrive homeostatic emotions—attention-demanding feelings that motivate behavior. Lastly, the neomammalian, or neocortex is the most evolved brain and it is the system that made us aware, that gave us consciousness; declarative knowledge derived from sensory input, especially that coming from sight, sound, and touch, is processed in the neocortex.

1. Exercise cognitive flexibility and intuition in order to develop students' innovative thinking and everyday creativity, through constant adaptation/dishabituation to the space. Creative insight in every day life, what Ruth Richards calls 'everyday creativity', entails creativity, originality, intuition, emotion and divergent thinking. As a result of developing flexible ways of thinking, intuition and self-regulation also develop. This will be achieved by multisensory stimuli (walls combined materials for texture, sound augmentation/cancelation, smells) in a self-regulated space (wireless EEGs worn by each student to control color-coded LED lights and overall space temperature). | 2. Propel positive emotions and relaxation, and embrace failure, as part of the learning experience as a way to create a sense of a safe atmosphere, known to enhance creative insight, and reduce latent inhibition. Using the act of play by integrate brain games printed on the walls of the *Osmotic Sensoria* explored through physical movement, students will exercise visual and lateral thinking, spatial relations, and memory, (i.e. an interpretation of the 9-dot puzzle: 9-dots added as scattered protuberances on walls, and large-scale sticks, thread, and markers, to create combinations). | 3. Promote both individual thinking and collaborative work to engage different cognitive styles⁴⁸ and explore both psyche and collective unconscious by doodling on all surfaces: as individual brainstorming, and Exquisite Corpse⁴⁹ sketching as collaboration. | 4. De-focus attention from a problem that needs to be solved to explore non-verbal ideas inwards, as a way to retrieve tacit knowledge accumulated through life experiences; Delivered information/class content implicitly, in the form of various visual projections—text and images—on walls and oral narrative during the exploratory play (the first 20-40 min.). The exercise is given after exploring space for 35-50 min., and solution needs to be delivered in 10-20 min. (i.e. Deliver a lecture on color theory in the projection, and then ask students to create a piece with "high contrast (complementary colors), or harmonies (simultaneous colors). | 5. Encourage the ability to imagine as a powerful tool to create desirable futures; to produce an array of unconventional, and unexpected solutions using synthesis instead of analysis. Define goal-oriented exercises that frame open-ended problems where the act of "design[ing]" is an integral part of the solution. Practice both the solution-driven approach (synthesis) used in design, and the problem-driven approach (analysis) used in science. (i.e., invent a devise to produce fresh air). Along with multisensory stimuli, physical movement is an integral part of this new pedagogy because it is through movement that we perceive, experience, and act in the world. My argument is that, in moving to explore the space while playing—

activating the motor cortex—innovative thinking can become imprinted in the reptilian brain—the oldest and less evolved part of our brain that automatizes motor skills to transform them into unconscious reflexes. Once this new way of *thinking* is imprinted and automatized—like learning how to ride a bicycle—students will become innovators naturally, in an organic process of osmotic, ongoing, unconscious learning. The goal is to empower students to practice this new way of thinking in everyday life experiences.

Drawing inspiration from soap bubbles—in their interlocked structure, translucent qualities, and temporality—multiple, interconnected, chambers of various sizes create the structure of the *Osmotic Sensoria*; I refer to these spaces as *synchronized atmospheres*.⁵⁰ Constructed in an array of translucent materials, the chambers provide various sensory stimuli—textures, smells, augmented or canceled sound—which enable visual projections on the walls coming from LCD projectors.

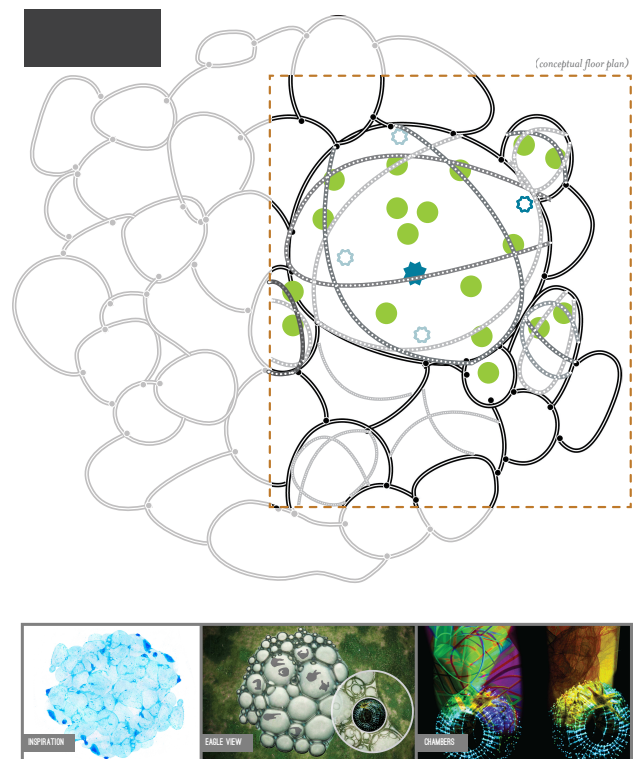


Figure 2 Osmotic Sensoria floor Plan, Niberca Polo ©2014

This structure aims to give a sense of playfulness and openness, away from the feeling of restraint that spaces

⁴⁸ Look up: Howard Gardner's Multiple Intelligences, Michael Kirton's Adaptors-Innovators; Paul Brocca's hemisphericity.

⁴⁹ Exquisite Corpse Pedagogy, <http://www.exquisitecorpse.com/definition/About.html>.

⁵⁰ I use the term synchronized atmospheres as meaningful experiences happening simultaneously, and not being governed by laws of cause and effect. See Carl Jung theory of synchronicity for more details.

with corners might provoke, since we, as humans, react more positively to curves than straight lines.⁵¹ The intimate atmospheres—achieved by modulated lighting and temperature, sound distortions, and the playfulness of the space—enable a deep connection with one-self, emotions, and intuition—mediates the conversation between the bilateral brain and the cognitive unconscious; the intimacy of the space is conducive to positive emotions by overcoming doubts and fears, of being wrong, and of failure; in this process, introspection is key. Projected images from students’ brain waves using wireless EEG and fMRI/MRI technology create a womb-like space where pre-verbal images arise to enable intuition to flourish through a process of organic information retrieval and processing—of *osmosis*—to stimulate the collective unconscious. The visual representation of internal thought is meant to entice collective, non-verbal, brainstorming; with eyes wide open, an amalgam of colors and narratives materialize in an endless conversation with personal history and imagined futures. The semi-transparent surface of each chamber has a certain texture: of its original material, of text, and visual stories, taken from already-tested and validated psychological brain games that were developed in the 19th century as a way to measure cognitive abilities. An array of brain games, used to develop divergent and spatial thinking, and enhance cognitive flexibility, will be transferred to the surfaces of the chambers—sometimes using two-dimensional color transfers, sometimes using only texture such as protuberances in the material, or in some instances integrating both color and texture—will augment the visual and tactile experience of the space.

Technology as Assessment Tools and Self-Regulating Space/Students Interactions

1. **Wireless EEG to control LED mini lights;** neuro-feedback device to self-regulate space, and also teach students how to self-regulate. Devices currently available in the market: [Ibrain](#)⁵² and [NeuroSky](#)⁵³
2. **fMRI, and MRI**
Projecting images during individual idea-generation (ideation) session, of pre-verbal communication, on wall surface by adapting technology from the “Brain Movies” research at the [Gallant Lab, UC Berkley](#)⁵⁴
3. **MOTION TRACKERS and EYE TRACKERS**
Students’ interactions, self-reflections, and

explorations of the space are mapped out using real-time motion tracking technology.

All these devices can be used as assessment tools, in that all of them collect specific data, which can registers the interactions within the space; also the students’ productions can be used as assessment over time.

CONCLUSION

Throughout this paper I argued that we, humans, have the potential to augment our innate creative capacities in an organic way. Similar to learning basic skills like walking and talking, through a process of “osmosis,” knowledge can be integrated unconsciously in order to become tacit knowledge, and automatically brought to consciousness when needed. Since nowadays, most scientists think that the influence of nature versus nurture on brain development is a 50-50% split; our genetic imprint and environmental factors could, at any given moment in live, become triggers that ignite new pattern formation. These findings support my idea of learning spaces as environments with agency, as they affect the learners’ experience and consequently, their behavior in the world, beyond the confinements of the classroom space. The brain sees everything anew when acting in the world, always learning and producing new knowledge, that would be utilized inside the *Osmotic Sensoria* to produced more knowledge without being blocked, and instead being embraced, retrieved, and applied in real-world situations. The *Osmotic Sensoria*, as a built-space, beyond being a container with no agency uses the space of instruction as a mediator of the learning experience. This new environment facilitates interactions amongst students *with*—instead of *in*—the space, that propel self-discovery and serendipitous thinking, and becomes an igniting element to achieve students’ full potential. Instead of perpetuating the traditional educational system, new ways of learning that stimulate the brain as a whole are needed in order to create a holistic experience that propels the growth of the self, as opposed to fragmented individuals whose lives are limited because they learned a very specific set of skills. A new breed of *neuro-educators* have been called to the front—those who integrate scientific knowledge into educational systems and pursue a radical change in education, a new paradigm that strives for the expansion of minds beyond grades, tests, and drugs. We have arrived to an important moment in history; President Obama’s BRAIN initiative (acronym for *Brain Research for Advancing Innovative Neurotechnologies*) opens up new possibilities, not only for scientists in the quest of answers but also for educators in general.⁵⁵ This is the time for designers, educators, and scientists to make an impact in the future of

51 Fast Company, 2013 “Why Our Brains Love Curvy Architecture”
<http://www.fastcodesign.com/3020075/why-our-brains-love-curved-architecture>.

52 Ibrain, Neurovigil.com <http://neurovigil.com/index.php/technology/ibrain-device>

53 NeuroSky.com, <http://neurosky.com/products-markets/eeg-biosensors/>

54 Gallant Lab, <http://gallantlab.org/brainviewer/cukuretal2013/> “Brain Movies”
<http://newscenter.berkeley.edu/2011/09/22/brain-movies/>

55 Thomas Insel. “New Views into the Brain” NIHMH, April 10, 2013,
<http://www.nimh.nih.gov/about/director/index.shtml>.

our society by collaborating in creating new learning environments, as valuable assets in the creation of a better world. The *Osmotic Bubble* is not aiming to be an instrumental intervention to change behavior and capabilities by affecting the brain's built systems but instead, it is a model for spaces of instruction that naturally stimulates and harnesses the brain's innate capacities, while empowering students in being active participants, and co-creators, of their learning experience; a space sensitive to individual differences, and various cognitive styles. In order to stay away from artificial manipulation of brain chemistry through the use of psychotropic drugs, the *Osmotic Sensoria* stimulates the brain natural chemistry through a multisensory experience.

REFERENCES

1. Bernard, Neville, 2005. *Educating Psyche: Emotion, Imagination and the Unconscious in Learning*. Melbourne: Flat Chat Press.
2. Brown, Stuart L., 2009. *Play: How It Shapes The Brain, Opens The Imagination, And Invigorates The Soul*. Penguin.
3. Carter, Rita, and Christopher D. Frith. *Mapping The Mind*. University of California Press, 1998.
4. Chan, Dr. Tak Cheung and Dr. Garth F. Petrie. 1988. "The Brain Learns Better in Well-Designed School Environments." *Classroom Leadership On Line*. Vol. 2, No. 3, November. 16-19. www.acsd.org/readingroom/edupdate/1995/1sep.html
5. Cross, Nigel G., 2001. Designerly ways of knowing: design discipline versus, *Design Issues* 17 (3): 49-55.
6. Colzato, Lorenza S., Ayca Szapora, Justine N. Pannekoek, and Bernhard Hommel, 2013. The impact of physical exercise on convergent and divergent thinking, *Frontiers in human neuroscience* 7.
7. Dweck, Carol S., "Even Geniuses Work Hard." *Educational Leadership* 68, no. 1 (2010): 16-20.
8. FastCompany.com, 2013. "Why Our Brains Love Curvy Architecture." <http://www.fastcodesign.com/3020075/why-our-brains-love-curved-architecture>
9. Gardner, Howard, 2011. *Frames of Mind: The Theory of Multiple Intelligences* (3rd Edition). New York, NY, USA: Basic Books.
10. Gray, Peter, June 2013, *The Enemies of Innovation*, *Psychology Today*, pg. 78-87, May/June 2013. Psychologytoday.com
11. Gazzaniga, Michael S., R. Ivry, and G. R. Mangun. "Fundamentals Of Cognitive Neuroscience." (1998).
12. Groves, Philip M., and Richard F. Thompson, 1970. Habituation: a dual-process theory, *Psychological review* 77, no. 5: 419.
13. Kandel, E., 2012. *The Age Of Insight: The Quest To Understand The Unconscious In Art, Mind, And Brain, From Vienna 1900 To The Present*. Random House LLC.
14. Kohn, Alfie, 1999. *Punished By Rewards: The Trouble With Gold Stars, Incentive Plans, A's, Praise, And Other Bribes*. Houghton Mifflin Harcourt.
15. Lehrer, Jonah. *Imagine: How Creativity Works*. Houghton Mifflin Harcourt, 2012.
16. Ludwig, Arnold M. *The Price of Greatness: Resolving The Creativity And Madness Controversy*. Guilford Press, 1995.
17. LeDoux, Joseph E. *Synaptic Self: How Our Brains Become Who We Are*. Penguin.com, 2003.
18. McGuire, Michael T., and Alfonso Troisi. *Darwinian Psychiatry*. Oxford University Press, 1998.
19. Reber, Arthur S., 1996. *Implicit Learning And Tacit Knowledge: An Essay On The Cognitive Unconscious*. Oxford University Press.
20. Siegel, Daniel J. *The Developing Mind: How Relationships And The Brain Interact To Shape Who We Are*. Guilford Press, 2012.
21. Richards, Ruth Ed., 2007. *Everyday Creativity And New Views Of Human Nature: Psychological, Social, And Spiritual Perspectives*. American Psychological Association.
22. Robinson, Ken, 2011. *Out Of Our Minds: Learning To Be Creative*. John Wiley & Sons.
23. Roy, Deb, "The Birth of a Word" TEDtalk: http://www.ted.com/talks/deb_roy_the_birth_of_a_word
24. Sylwester, R., 1994. How Emotions Affect Learning, *Educational Leadership* 52 (2): 60-65.
25. Tammet, Daniel, "Different Ways of Knowing." TED Talk (Filmed March 2011).
26. Taylor, E. W., 2001. Transformative Learning Theory: A Neurobiological Perspective of the Role of Emotions and Unconscious Ways of Knowing, *International Journal of Lifelong Education* 20 (3 May/June): 218-36.
27. Time Magazine, Your Brain: A User's Guide. 11/06/09.
28. Tovey, Michael. "Designing with Both Halves of The Brain." *Design Studies* 5, no. 4 (1984): 219-228.
29. Wagner, Tony, 2011. *Creating Innovators: The Making of Young People Who Will Change The World.* SimonandSchuster.com.
30. Winnicott, Donald W., 1971. *Playing And Reality*. Psychology Press.
31. Zull, James E., *The Art Of Changing The Brain: Enriching Teaching By Exploring The Biology Of Learning*. Stylus Publishing, LLC., 2002.