Cultured Brain

BY: WARREN NEIDICH

The human brain weighs only about four hundred grams at birth and consists of a population of neurons that are highly variable in terms of their signal characteristics and stimulus specificity. Gerald Edelman has referred to this population of neurons as the "primary repertoire." He states that it is the product of genetic programming and intrauterine development, and that it consists of neurons that have sensitivities to stimuli that are essential and no longer essential to us.(1) "The neuronal manifestation of expectation or sensitivity appears to be the production of an excess number of synapses, a subset of which will be selectively preserved by experience-generated neural activity. If the normal pattern of experience occurs, a normal pattern of neural organization results, and if an abnormal pattern of experience occurs, an abnormal neural organization pattern will result." (2) Edelman refers to the establishment of the primary repertoire as "developmental selection" which results in extensive variability in the connection of individual and groups of neurons (Figure 1). As a result of this, developmental groups of spatially contiguous neurons form groups that are not only wired together but fire together. The production of this primary repertoire is followed by a period of "experiential selection." From birth, the brain is selected for by the specific environment into which it is born. This process, called epigenesis, is responsible, as we will see, for shaping the primary repertoire into the secondary repertoire that is made up of a highly selected set of neurons with specific links to external reality, the reality outside and apart from the body. Those neurons that are repeatedly stimulated over and over again develop enhanced firing capabilities beyond those that are infrequently stimulated. They thus develop a selected advantage. In a population of neurons, those that are repeatedly stimulated will be selected for above and beyond those that are not, and the resulting population of neurons will reflect this condition, being dominated by those that are frequently stimulated. "The concept that there are mechanisms that act to retain those pathways in which patterns of external stimuli induce activity and eliminate potential connections not so activated has been termed functional validation by Jacobson and selective stabilization by Changeux and Danchin." (3)

For example, in the visual cortex of the brain there are neurons that are sensitive to the color red, and these neurons will fire when they come across the appropriate wavelength combination. The more a neuron fires, the faster its reaction time to that stimulus. Since the color red is omnipresent in the environment, neurons with this signaling characteristic will be continually stimulated and will be selected for from a population of neurons as a result of the their speedier and more efficient firing patterns. The color red exists in a myriad of situation complexes; it colors living and non-living forms, it has emotional and psychological qualities that are culturally defined but are also based on personal experience, and it is therefore coded in the brain in thousands if not millions of what are called neural networks. These networks are assemblages of neurons, each with specific signaling behaviors, which are linked together in order to code complex qualities and entities. “When an axon of cell A is near enough to excite cell B and repeatedly or persistently takes part in firing it, some growth process or metabolic change takes place in one or both cells such that A’s efficiency as one of the cells firing is increased.” (4) Spatial and temporal signatures tie these neurons together through altering, organizing, and synchronizing their specific firing patterns together in ways that address these specified contexts. Neurobiologists have come up with terms like synchrony to address the way that neurons in very different parts of the brain fire together when stimulated by the appropriate object or set of relations resulting from the interaction of those objects. “Detailed studies on anesthetized cats...have revealed that synchronization probability for remote groups of cells is determined both by factors within the brain as well as by the configuration of the stimuli.” (5)

What allows for this synchronization of distant and globally (encompassing the entire brain) relevant maps, allowing them to be bound into circuits capable of temporally coherent maps, is the process of reentry. Although Edelman implies that it is a separate system apart from, but organized around, experiential selection, I consider it part of its process. I believe that the world, especially in the context of new media, is modeled into systems of networked relations that are linked, and that these linkages, through higher and more abstract selective processes, select for reentrant connections in the brain (Figures 2 and 3). In other words, just as neurons and neuron groups are selected for, the relations that exist between them are selected for as well. Reentrant connections in the world reconfigure reentrant connections in the brain. Neural networks are under the same selective pressures that we saw with individual neurons. Those that are stimulated repeatedly will be selected for at the expense of others not so stimulated. Those that are not will undergo apoptosis and cell death. Regression of nerve terminals is thus an integral part of the development of connections in the adult cerebral cortex. “The succession of a phase of synaptic exuberance (in which there is a heavy growth of synaptic connections) by a phase of regression of axonal and dendritic branches thus marks a critical period in the development of the nervous system.” (6) The resulting configuration of the brain will reflect the selective pressures of the outside world. How the history of objects and the environments they participate in affect the design of the sculptured brain will be the content of the next section and will, I hope, lead us to configure a model through which to address the problem of how art can investigate the brain.

An art object is a specialized form, a species of object with its own history and set of practitioners. Its form is shaped by the porous relation that this history shares with the history of other non-art objects that populate the world outside itself, as well as other art objects that share a common genealogy. They are part of a syncitium of relations that include political, social, economic, historical, and psychological factors that define the greater cultural context in which they function. These objects act on one hand as an instantiation of these relations, as each is a product of these changing relations

and their mutated summating effect, and on the other hand as instruments that feed back on the system to change it and to make it function better. Anytime you have a system of interacting relations that emerge from different discourses, you are bound to have "translational friction" that occurs as the language and specialized information communicated from one system is interpreted in another. Aesthetic objects act in some instances to reduce this friction; they can provide a surface for smooth and efficient interaction. That being said, each artist, informed as all artists are by a specific training, is made aware of a prescribed and proscribed genealogy of such art objects as they have migrated through the history of their own form. The history of such art objects and their relations function as a system of devices and mechanisms through which an understanding can be reached relative to the political, social, economic, historical, and psychological relations that, as we saw, formed them. This then becomes a model or anti-model through which to create new objects, non-objects such as the immaterial objects of conceptual art, new relations and anti-relations, and new spaces and non-spaces in which those entities live.

The history of painting is one such genealogy. (7) Each successive generation of painters layers upon the practices of its predecessor. Some authors, like Norman Bryson and E. H. Gombrich, claim these changes have implications far beyond the object, since they become a model to comment on the process of visuality itself. (8) Other art works such as installation art and performance have focused on prefigured object relations instead of simply the object. This work is more time based. Just as certain kinds of prerequisite technologies were needed before steel could be produced or the discovery of photography could be made, similar such discoveries in technique and materials needed to be made before time-based and contextually-based artworks could be invented. Cinema and new media are such discoveries, and they would transform the conditions of art forever. In my essays "Blow Up" and "Remapping," cinema's effect on architecture and its role in the development of what Paul Virilio calls "phatic" images was reviewed. (9)

I use the expression "centripetal palimpsest" to describe this process through which objects evolve as they pass through constantly evolving social, political, economic, technological, historical, and cultural contexts. Centripetal refers to ever-evolving outward movement like the ripples that form on the surface of an calm pool of water after a stone, thrown into it, breaks its surface. Palimpsest describes the layers that evolve, one on top of another, like the layers of an onion. Although this metaphor is positivistic in its notion of growth and development, it does exclude growth that occurs in opposition, that is inward and is about removal rather than addition. With these flaws in mind I think it can serve as a visually provocative analogy of how the process of change occurs to the art object and its relations, and how these changes then impress themselves on the neural network condition of the brain.

Upon the art object is deposited a kind of silt which the artist—who mediates these external relations through his or her own body, through a process of reified perception and cognition—carefully applies to the object's surface. The artist's specialized knowledge has two effects: On the one hand, the artist's attention is directed and diverted to special surfaces of the object through his or her aforementioned specialized aesthetic training, and it is upon these surfaces, or in opposition to them, that he or she directs changes. On the other hand, the artist's knowledge of technique allows an understanding of the internal structure and internal forces that hold the object together, and he or she applies the new applications in ways that do and do not disrupt the forces that hold the object together.

The special conditions of the readymade also fit into this model. In this case, the placement of the object in the white cube has a number of effects. First of all, this recontextualization reconfigures the object's original utilitarian functions into aesthetic ones. Secondly, the new meanings that adhere to it are a function of its relocation into a new historical lineage. Thus Marcel Duchamp's snow shovel in In Advance of a Broken Arm (1915) is first identified as a snow shovel but then is assessed as a challenge to other sculptural forms displayed in the gallery before and after. Thus it might be compared to something completely different in the past, such as Rodin's portrait The Sculptor Jules Dalo (1883), or something similar that came after it, like Claus Oldenburg's Green Beans (1964). In the case of the Rodin, the shovel hung from the ceiling challenges the solid sculpture resting on a pedestal. In the case of the Oldenburg, the readymade is reconventionalized as the found bean is now brought back into traditional sculptural display formats and production.

Architecture is another field in which we witness a history of subtle changes produced on its external morphology within the restraints of technological and structural integrity. It is hard to imagine recent buildings of Frank Gehry, such as Bilbao, without Corbusier and Jeanneret's Pavillon des Temps Nouveaux or Frank Lloyd Wright's Guggenheim Museum; but it is just as hard to imagine them without CAD-linked computer-generated drawings and new ways of conforming building materials that have the look of a flowing curtain or folded tissue paper.

But painting, sculpture, and architecture are not the only discourses to be affected by these historical rules. Fashion, design, and typography, to name just a few, are also affected. When one views all these disciplines together, one begins to appreciate the construction of an entire "visual cultural field" which is subject to similar but not exactly the same effects: a syncitium of networked relations that are changing synchronously through their adaptations to the same forces and to themselves.(10) One needs simply to pick up a fashion magazine to see that either the fashion designers are in collusion with each other, or that they are unconsciously responding to the same conditions independently. For instance, today the trends seem to be shifting from the influence of the sixties to that of the eighties. But the similarities do not stop there. One can find the same trends in art, architecture, and design. As many cultural critics, such as Manuel De Landa, have pointed out, those differences have as much to do with how goods were to be distributed, how cities grew and worked together, and even how disease was dealt with, as much as decisions concerning changes in brushstroke, palette, and available materials.(11) All these relations are bound together in a great syncitial organism of being. The human body is also subsumed and embedded in these sets of relations. First of all through the relation of the discourse of vision and anti-vision which has been an integral part of aesthetic philosophy and production in Western Civilization for many centuries.(12) Secondly, in the invention and use of optical technologies with which to visualize the products of culture, such as the stereopticon, photographic camera, zoetrope, cinema, and virtual reality. And thirdly, through the invention of devices to investigate and probe the body, such as the X-ray machine, CT scan, MRI, and FMRI. Fourth and most importantly for this text are the changes that occur in the brain as a result of interaction with culture.

A similar and parallel process of reconfiguration is also taking place in the brain. In the shift from the primary to the secondary repertoire there exists an envelope that limits the reconfiguration of the neuronal-axonal-dendritic population within certain boundaries. The primary repertoire is prefabricated along certain architectonic dispositions that sequester specific functions to specific anatomical sites. For instance, the visual cortex is primary for early processing of visual information; its columnar

micro-cellular organization, plus its regional diversification, create areas specific for color and motion. However within those constraints, external stimuli, some of which are aesthetically and culturally configured, can affect the spatial and temporal linkages that form between neural elements. Aesthetic styles affect brushstroke, color, and surface pattern that tether the parts of the work disjunctively along differing paths with different properties, for instance Gestalt properties, which are addressed by the nervous system differently. We all know this when we witness a form emerging from a dot diagram as we connect the numbers with our pencils and random dot patterns emerge into known designs. But even beyond these changes, the genealogy of changes that we previously commented upon in describing the history of the object and its relations could also express itself in a similar genealogy in the brain. Hypothetically speaking, a cybernetic loop of feedback and feedforward relations could link changes in the morphology of the art object to similar changes in the morphology of structural changes in the brain.

It is conceivable that the evolution of the brain as it is reconfigured in the ascent to man is based on waves of changes that took place in the configuration of the brain as a result of being sculpted by concomitant changes of the outside world, which as we know today are culturally configured. This is based on the belief that networked relations in the real world are reconfigured as networked relations in the brain. This does not mean that if you could one day do scanning of neural networks you would see a pattern of connected responses that would mimic those in the real world. But it means that using its own code system of representation, the brain would create a pattern of neural networks that would subsume into its own materiality those network changes that its response is linked to.

This model implies an understanding of brain development that could explain changes in the gross morphology and complexity of the brain in an evolution that is delimited by skull size, shape, and vascular markings on the endocranium. As we witness the evolution of civilization we also witness an evolution in the complexity of networked relations that man creates and gains knowledge of. In other words, as man evolves from a gatherer to a hunter-gather to a sedentary agrarian culture to a city dweller, one is impressed by the amount of information that it is necessary to understand and use. This complexity is subsumed in networked relations that are inscribed in culture and in the environment that links this information together so that it can be used and processed more efficiently (Figure 4). On one hand it allows the culture to operate more smoothly, and as such has direct consequences on the infrastructure of the living settlement or city through the building of roads, bridges, convention centers, and markets, all of which help to facilitate the distribution of goods and information. On the other hand it allows the brain to bind information into bundles that can be perceived and cognized as a whole rather than individual parts. The model of neuronal group selection elucidates ways in which neural networks are selected for by a constantly reconfigured environmental context, which is aesthetically and culturally modified. For our purposes, let's say that one way or another, the plastic brain is capable of reorganizing itself adaptively in response to the particular novelties encountered in the organism's environment, and the process by which the brain does this is almost certainly a mechanical process strongly analogous to natural selection. Each generation of humans must "reenact" the interaction between the brain and the environment of its predecessors; because when an individual dies, so too do the neural maps that the individual has spent a good deal of his or her life creating. That is to say that the brain is not equipped at birth with an a priori set of tuned neurons and configured neural networks. With the exception of the face, the brain is set up as a system of fragment detectors. The brain one is born with must wait for its interaction

with the world to attain its full functional capacity, which occurs when these bits of information are linked up through temporal signatures, through processes like reentry, to form representations. The superimposition of many of these depictions, one on top of another, form maps which are either local, when they involve a single sense modality, or global, when they link widespread areas of the brain. The complexity of the world is mapped into that neural biological complexity. This could account for the brain's increased mass as well as the development of cortical structures such as the forebrain to deal with this evolving world.

Culturally configured stylistic changes occurring over time, as we saw in the example of the centripetal palimpsest, remain embedded in the underlying structure of the object and its relation to other objects and the space it occupies. Future generations, upon perceiving and cognizing those same relations, some of which have been subsumed in the interior foundation of it, will undergo similar neurobiological changes as their forefathers, either in a direct or indirect way: directly because the same object may remain unchanged or marginally changed from its original design, and indirectly in the way deeper morphologies which have become internalized—so-called secondary and tertiary structures—may have an effect in the manifestation of its form and thus affect the neural network that it may help to inscribe. Secondary and tertiary structures may exist in the brain coded as temporal algorithmic functions. In this way the genetic load, which each generation must hold and transmit, is diminished. It is no longer necessary to code a priori for any object or any possible object. The world retains a multiplicity of forms, each with their own histories that lie waiting for a cognizing brain to receive their transmissions. They form a repository of cultural genes. I am not talking about memes here, although the term has been used incorrectly to stand for this type of cultural transmission. There is a big difference between a tune that is transmitted through a culture and embedded in the brain, and a history of aesthetic forms created and recreated in a multitude of forms awaiting generation after generation.

So what does all this have to with the development of the brain?

What I am basically saying is that if you accept the initial premise of the selectionist paradigm, that the brain is sculpted by the external reality in which it is embedded, and if you accept that those material relations, as they express themselves in art, architecture, and media culture, are the result of the social, political, economic, and technological relations that interact to produce them, then it is not a difficult leap of faith to accept the position that the neuronal structure—neural networks as they express themselves as local and global mappings—have been indirectly prescribed by those immaterial relations. That is to say that culture, encoded through aesthetic relations, inscribes itself upon the brain. The implications of this statement are, I believe, immense. The "culture war" is no longer simply a discourse of limited importance relegated to a marginalized art world but becomes incorporated—or should I say "incorporalated"—into a more fundamental discussion of forces concerning how culture is reflected in the organization of neurobiological tissue at the microsynaptic level. "Our brain is not the seat of a neuronal cinema that reproduces the world: rather, our perceptions are inscribed on the surface of things, as images amongst images."(13) As we discussed earlier, the genealogy of the changing morphology of objects and their relations, the "centripetal palimpsest," results from an ebb and flux of different but repeatedly cultural flows. The changing political, social, economic, and technological relations become inscribed on the surface of objects in the context of deeper tectonic structures, which are themselves the result of rules prescribed by these same relations of earlier times. Only in revolutionary times, like those surrounding the Russian Revolution, are those immaterial relations so different as to necessitate absolutely new

forms—like Malevich's Suprematist Composition: White on White (1918) painting—which may or may not seem to relate directly to the history from which they emerged. Thus we arrive at what I referred to recently as the "cultured brain." For the sake of argument, I am looking at, for the most part, that part of the equation that goes from right to left, from culture to its effect on the brain, rather than from left to right, or how the brain affects culture (others have made this argument quite forcefully and I refer those readers to the work of Paul and Patricia Churchland). The growing number of artists from China, South America, the Middle East, and Africa represented in the finest art museums and galleries must impress anyone who has recently visited them.

Art historically I see this trend as an outgrowth of two forces. On the one hand it is the result of what I call the second phase of postmodernism. The first phase challenged modernism's notion of material specificity with works like those of Rauschenberg and Warhol, in which works of art broke down the barriers that separated painting, photography, film, and sculpture from each other. The second phase challenged modernist barriers that excluded individuals of color, women, and explicitly homosexual art. One of the most significant contributions of the art of the much-maligned eighties was that it created opportunities for these groups to gain a foothold in the art world. This trend would continue into the nineties and manifest itself in an interest in what is now called "global art." The barriers, which had formerly excluded artists from countries outside the artistic fovea of Western Europe and the United States, are finally coming down. On the other hand, global art erupted from interest in the postcolonial discourse centered around Homi Bhabha and others who have filled the intellectual void left by the fall of Conceptual art.

Viewed from the perspective of the "cultured brain," the significance of this contribution becomes more important. With the advent of media culture, ideas once locked away in small circles of influence find an expression in generalized culture almost immediately. As one views a Madonna video or a Diesel ad, one is amazed by how much of the visual language is adapted from what is going on at that moment in the galleries or museums. In a recent Diesel ad, a model reenacted Bruce Nauman's Self-Portrait as a Fountain (1966-67/70). There is no longer any temporal disparity between the art world and the real world. They are porous to each other, with ideas flowing very rapidly back and forth. Ad executives and video producers are obviously looking at art magazines and attending exhibitions; some, like Saatchi, have tremendous art collections. Our world is becoming more and more saturated with these expressions of visual culture as they articulate themselves in what has been referred to as the mediascape. The fundamental motivation that drives these designs is based on a desire to capture the attention of their viewers. Success or failure is based on how many people view a specific campaign and how many are motivated to change their behavior in accordance with its message.

Artists from formerly marginalized cultures are creating works of art that have their roots in different traditions. The genealogy of cultural changes that have become inscribed on and in the objects they produce reflect the nuances of cultural difference. Artists make choices when they make a work of art, and some of these are visual. What the surface looks like, what colors are chosen, and the distance and size relations between objects or between figures on a canvas are the result of decisions that are culturally determined, and they sometimes can be discovered in each artist's heritage. When these works are displayed in a public forum—such as biennial exhibitions or "Documenta 11" recently held in Kassel, Germany—in which they are contextualized within a specific discourse and are set next to works of art that are more culturally familiar to the viewing audience, these cultural differences become linked to specific

aesthetic practices, sometimes in ways that can dilute their specific meaning. However, with the emergence of a political, social, economic, and cultural context in which cultural difference is embraced and which as a result of its new-found status has developed value as an art commodity, the above-mentioned culturally based aesthetic choices become significant and form models which other international artists working in film, music, or advertising first co-opt and then adapt into their own practice. Documenta has stimulated a flow of interest in postcolonial practice, with museums all over the world sponsoring exhibitions with links to this discourse. Using the prestige of this exhibition and the artists who contributed, curators can now convince museum boards to sponsor these types of exhibitions. Since many of these artists are involved, as we saw, with web design and advertising, the aesthetic configuration of the urbanscape, mediascape, and cyberscape will reflect these changes. It is important to add that these producers and art directors are from these former colonial outposts as well, and the aforementioned indirect effect may supplement a more direct affect.

As I have argued in "Visual and Cognitive Ergonomics," mediated images are configured in ways that make them more attractive to the developing brain. They are more vivid, seductive, and are more easily resolved by the nervous system. They are connected to technologies and apparatus for their distribution and dissemination, and as a result they are selected for over other forms of visual stimulation without these characteristics. I mean selected in two ways: First of all, in the public domain there are networked relations that bind objects, object relations, space, and buildings together. We can all identify Chinatown in New York City when we enter it past Canal Street. Some of us have no difficulty telling modern architecture from postmodern architecture. Mediated images have redefined space and the images and styles that define that space, and have been imbedded onto the surface or skins of buildings that inhabit these spaces. As I suggested earlier, they are engineered with the nervous system in mind, and as such are called "phatic" images that have been constructed to attract attention. In the world of mediated images, these images compete with each other for the mediated spaces of television, billboards, magazine covers, and recently the internet. By building relations with other phatic images, either through design compatibility or dissemination, certain such images develop stronger attracting potentials. They are thus selected for in the context of this now-transformed real/virtual interface. Dissemination in media is now world wide, reaching huge audiences, and works of art on the web are not limited to geographic space and time, but exist simultaneously globally. Second of all, these kinds of images are selected for in the brain. Networked relations in the now real/virtual interface select and reconfigure network relations in the brain. That is to say that these phatic images, as they attract attention better and are disseminated diffusely throughout the visual landscape, recurring over and over again, over and above their naturally occurring organic counterparts, will have a selective advantage for neurons and neural networks that code for them. Phatic images, beyond attracting attention better, have one other advantage: they allow the neuron and neural network to attain maximum coding efficiency faster. This gives those neurons and networks that code for phatic stimuli a greater advantage over those that do not. Thus, in the competition for neural space they will be successful. Just imagine the effect of linked networks of phatic stimuli on the summated activity of the brain. As a result they have tremendous potential to sculpt the brain.

The cynic could be very disturbed by what I am implying. For just as nuclear science and gene therapy simultaneously offer tremendous opportunities and devastating calamities, the theory of the cultured brain contains opposing discourses: on one hand, there is the potential for a global culture with a concomitant sharing of cultural diversity; and on the other hand, there is the possibility of global manipulation and

control. The culturally diversified message is now democratized to incorporate strategies that can hail the multiplicity of global subjectivities. The power of that message to tether desire to the object fetish is magnified as a multicultural crystal whose plethora of cut surfaces catch and hold the attention of diverse populations. Implicit in this idea is a kind of neo-colonialism in which territories and natural resources are now substituted for by the regions of the brain and brainpower. The seemingly benign and liberal impulses that drive the art world towards ever greater inclusion of minorities and marginal cultures can also provide a formula though which commodity culture finds increasingly easy egress into the corporeality of the human nervous systems with its machinery for desire.

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