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Alfonsina Scarinzi

Editor

Aesthetics and the Embodied Mind: Beyond Art Theory and the Cartesian Mind-Body Dichotomy

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Preface

Because of its alleged noncognitive character, nothing connected with the aesthetic can have any role in meaning, conceptualization and reasoning! (Johnson 2007, 218)

In his work *The Meaning of the Body* Mark Johnson (2007) comments with these words on the reasons for the devaluation of aesthetics in mainstream Anglo-American analytical philosophy and philosophy of language, in which aesthetics is not considered to be part of meaning proper because the aesthetic dimension of experience and thought is neither conceptual nor propositional. Johnson points out that the influential aesthetic theory of Immanuel Kant has also contributed to relegating aesthetics to a secondary and devaluated status in philosophy and science. Kant adopts the mind-body dualism of Enlightenment faculty psychology, in which feeling as a bodily occurrence is contrasted with thought as an intellectual cognitive process. He reduces aesthetics to feeling alone considered to be nonconceptual and incapable of giving rise to knowledge.

Drawing upon John Dewey's pragmatist aesthetics and his "somatic naturalism," Johnson rejects the mind-body dualism in aesthetics. He claims that aesthetics is the study of everything that goes into the human capacity to make and experience the bodily pre-linguistic cognitive, emotional, and sensory-perceptual conditions of meaning constitution having its origins in the organic activities of living creatures and in their organism-environment transactions. It underlies linguistic meaning, which is parasitic on it.

Following Dewey, Johnson points out that the paradigmatic case of the pre-linguistic bodily conditions of meaning constitution is meaning-making in art. They culminate in aesthetic experience, which is not sharply marked off from other experiences. According to Dewey, an aesthetic experience is the integration of all the elements of ordinary experience that gives the experience a larger feeling of wholeness in the interactive flow of organism-environment transactions. The continuity of aesthetic experience with normal processes of living modifies and sharpens our perception and communication.

Grounding the aesthetic in the visceral processes of meaning constitution, Johnson points to the relation of continuity between mind and body, between the

higher and the lower, and hence to the relation between aesthetics and the embodied mind. This is the thesis according to which meaning is grounded in our bodily experiences and emerges from the nature of our brains, bodies, environment, social interactions, and practices. Our experience of meaning is based on our sensorimotor experience, our feelings, and our visceral connections to our world and on various imaginative capacities for using sensorimotor processes to understand abstract concepts.

The aim of this volume is twofold. On the one hand, it highlights the relation between aesthetics and the embodied mind thesis from a multidisciplinary point of view by taking into account philosophy of mind, American pragmatism, neuroscience, psychology of aesthetics, literary studies, and art. On the other hand, it contributes to reevaluating aesthetics in philosophy and science by presenting it as a field of inquiry of bodily mediated meaning-making in the interaction with the environment.

The introductory chapter to this volume consists in a general overview on the ongoing debate concerning the nature and kinds of meaning-making within cognitive science and related disciplines beyond the research interests of aesthetics. **Jessica Lindblom** integrates the theoretical framework of Distributed Cognition (DC) with more recent embodied approaches to social interaction and cognition playing a central role in the embodied and distributed process of meaning-making beyond aesthetics.

The first part of this volume with the title *Embodied Aesthetics: The Anti-Cartesian Idea and Aesthetics of Life* highlights the relation between aesthetics and the embodied mind from the point of view of American pragmatist philosophy, which can be considered to be the forerunner of the embodied mind thesis. **Mark Johnson, Jim Garrison, Thalia Trigoni, Tanya Jeffcoat, and Pentti Määttänen** discuss the anti-Cartesian view of aesthetics of life grounded in every aspect of human lives, in emotions, and in the pre-linguistic and visceral habits of human existence.

The second part with the title *Neuroscience, Aesthetics and the Embodied Mind* puts into focus the role of neuroscience in the relationship between aesthetics and the embodied mind. **Luca F. Ticini, Cosimo Urgesi, and Beatriz Calvo-Merino** refer to studies in cognitive neuroscience and investigate the human body as the object of aesthetic stimulation and as the subject of aesthetic experience. **Maria Brincker** highlights the role of a fruitful dialogue between neuroscience and philosophical investigations. She claims that neuroscience can be an incredible resource for aesthetics if indeed scientists take the dynamic, social, and environmental complexities of both aesthetic experience and brain function more seriously.

The third part of this work with the title *Art Beyond Art Theory and the Cartesian Mind-Body Dichotomy* highlights the embodied nature of the experience of art and of the interaction with visual and verbal works of art. **Mariselda Tessarolo, Kendall J. Eskine and Aaron Kozbelt, David Miall, and Tracie E. Costantino** discuss the role of the embodied mind, of embodied cognition and meaning in the judgment of, reflection on, and appreciation of works of art.

The fourth part with the title *Radicalizing the Anti-Cartesian View: Towards Enactivism in Aesthetics* stresses the relation between a more radical version of the embodied mind thesis called enactivism, which is traced back to the work *The Embodied Mind* by Varela, Thompson, and Rosch (1991), and aesthetics. **Daniel D. Hutto and Alfonsina Scarinzi** support a radical view of the embodied mind thesis that rejects the notion of mental representation or representationalism considered to be implausible in enactivism. **Ioannis Xenakis and Argyris Arnellos** present aesthetic experience as an evaluative process that influences the anticipation of stable and meaningful interactions with the environment. **Christian Tewes** puts into the foreground the scope and explanatory power of enactivism in the study of aesthetic experience from the point of view of neuroaesthetics.

The last part of this volume with the title *Creating with and for the Embodied Mind* outlines the role of bodily mediated interactions with works of art, digital media, and new technology in the 'embodied program' of reevaluating aesthetics. **John Haworth** presents his work on creativity, the creative artistic process based on the use of digital technology as a tool for art creation and the embodied mind. **Jennifer Hall** discusses an autopoietic model of interactivity and aesthetic generation. She focuses on the enactive notion of autopoiesis and its role in the interaction with art installations that involves how we relate to an artwork. **Sally McKay** focuses on embodiment in neuroaesthetics. In her chapter she conducts a neuroaesthetic investigation of the content of a video by Omer Fast.

Summing up, the present volume proposes a version of naturalism in aesthetics drawn from John Dewey's American pragmatism that sees human beings not only as embodied but as inseparable from the environment they interact with and provides a forum for authors from diverse disciplines to address specific scientific and philosophical issues within the anti-dualistic framework considering aesthetic experience as a process of meaning-making.

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Chapter 18

An Autopoietic Aesthetic in Interactive Art

Jennifer Hall

Abstract While autopoiesis can refer to biological systems that self-reproduce, autopoiesis also applies to non-biological systems that possess the characteristics of self-sustaining processes, making it a useful lens for critiquing interactive art. According to biologist and philosopher Francisco Varela, credited with creating the term autopoiesis, these controls can be identified in both artificial living systems as well as self-generating mechanical forms. When autopoietic systems overlap or blend with each other, they create new typologies according to their behavioral characteristics. This blending also produces a larger complex second level union of interaction that involves how we relate to an artwork and how we can critique those aesthetic experiences. Through the installation artworks of Ken Rinaldo and the robotic sculptures of Simon Penny, this chapter explores how these works are viewed within the autopoietic model of interactivity and aesthetic generation.

Keywords Autopoiesis • Art installations • Interactive art • Enactivism • Sensorimotor theories

Introduction

Autopoiesis is a system of self-creation. While autopoiesis can refer to biological systems that self-reproduce, autopoiesis also applies to non-biological systems that possess the characteristics of self-sustaining processes, usually by the use of internal feedback controls. According to Francisco Varela, credited with creating the term autopoiesis, these controls can be identified in both artificial living systems as well as self-generating mechanical forms. In biology, the autopoietic exchange is observed in different biological systems, from the co-evolved genomes of mitotic divisions in the eukaryotic cell [3] to the reward-anticipation potentials of holonomic brain theory [11]. In artificial life systems, such as the code for robotics [4] or the ecosystems of virtual modeling in artificial chemistry [1], we also see the

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persistence of the autopoietic functionality [8]. The integration of autopoietic biological and mechanical systems also creates phenomenological boundaries—or semi-permeable membranes of demarcation between objects. When autopoietic systems overlap or blend with another, they create new typologies according to their behavioral characteristics. Both transformative and destructive, these independent systems also become agents to and within other apparently unrelated systems. Autopoiesis is a new way to conceptualize our relationship to everything we come in contact with. This blending also produces a larger and complex second level union of interaction that involves how we relate to an artwork and how we can critique those aesthetic experiences.

Inherent in this structure is the re-evaluation of the idea that aesthetic experiences are singular events. No longer does an object stand alone in the world. Nor does an aesthetic experience belong only to an individual human. The aesthetic experience is now always autopoietic. In addition, autopoiesis exposes a common ancestry of all people and machines who participate in exchanging and merging life events. In this way, this perspective rejects both the Kantian view of aesthetics, according to which aesthetics is non-conceptual and incapable of giving rise to knowledge, and the mind/body dichotomy that underlies it.

Organ Distribution

A stunning example of an autopoietic union between people and aesthetic machines can be experienced through the installation artwork of Ken Rinaldo. In the multipart installation, *Enteric Consciousness 2010*, we see a group of large robotic tongues controlled by an artificial stomach that fills with the living bacteria *Lactobacillus Acidophilus* (Fig. 18.1).

The enteric system is the neurogastroenterological autonomous functioning of the stomach. As a subdivision of the autonomic nervous system, the enteric is where cells are a transient component to both the stomach lining and the spinal cord. In other words, the enteric permits a shared component to many parts of the body. Through the function of the enteric, the brain is directly connected to some 100 million neurons of the spinal cord via the intestinal lining of the gut: a kind of re-distribution of the brain, spinal cord, and stomach. Rinaldo's understanding of the enteric system informs his creation of an artificial stomach that extends the electrochemistry of the human body from the neural crests of the brain and stomach into the total body ecology of the installation. When the robotics deliver chemicals found in the human body to the artificial stomach, this action triggers performative events for the interactant to engage with, subsequently transforming the installation as a whole.

In one section of the installation, *Enteric Consciousness 2010* is host to large robotic tongues dipping in and out of bowls of melted dark chocolate, drip-feeding an artificial stomach with squirts of dopamine stored in the robotic tongue. In the

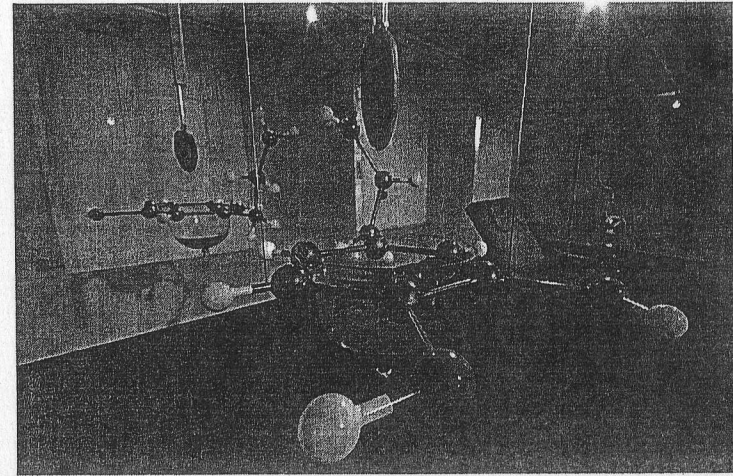


Fig. 18.1 Dopamine dripping from a robotic tongue. *Enteric Consciousness 2010*, Ken Rinaldo (installation detail). Commissioned by Maison d'Ailleurs, Musée de la science-fiction, de l'utopie et des voyages extraordinaires, curated by Patrick Gyger (Photo: Nicolas Nova)

human brain, the chemical dopamine is known to create feelings of enjoyment and even addictive pleasure, while in the stomach it has an emetic effect and can also cause severe constipation, literally stopping the flow of activity in the lower intestines. The body has a similar response to chocolate. So, the dual use of dopamine and chocolate is an aesthetic reflection on the enteric system, refocusing attention from the chemical dopamine, the tongue, or even the stomach as singular objects, to the behaviors of the entire system. Meaning becomes contingent upon these dynamic situations, rendering either pleasure or discomfort through the acts of chemical distribution. Furthermore, there are a variety of ways in which the meaning of Rinaldo's installation can change; the system in play references both pleasure and discomfort, implying that sometimes these outcomes can be a shared, rather than an opposing, experience (Fig. 18.2).

Within another area of the gallery, a twist to the robotic system is introduced when a viewer takes the initiative to engage in the installation by sitting in a red tongue-chair. The viewer—now the interactant—participates to create a complex and dynamic feedback loop. When an interactant sits in the chair, the dopamine becomes a trigger to initiate the physical pleasuring of the human. The artificial stomach first controls and activates the robotic tongue and second, if the bacteria within the artificial stomach is healthy and reproducing, the robotic tongue-chair senses the presence of the interactant and reclines and delivers a 15-min massage. If the bacteria is not healthy, it severs the potential for the system to loop and the chair does not move. When the interactant leaves the chair the robot tongue returns to an upright position and the installation resets and awaits another interactant. The

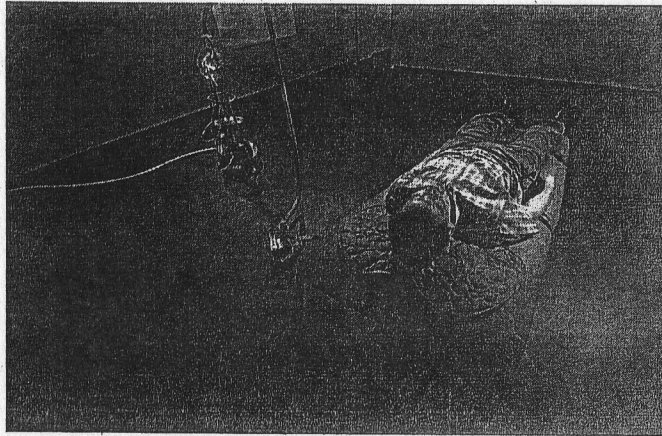


Fig. 18.2 Dopamine dripping from a robotic tongue. Enteric Consciousness 2010, Ken Rinaldo (installation detail). Commissioned by Maison d' Ailleurs, Musée de la science-fiction, de l'utopie et des voyages extraordinaires, curated by Patrick Gyger (Photo: Joana Abriel)

aesthetic impulse of the viewer is to interact—by sitting in the chair—and thus provides the larger autopoietic system to be set into motion. The conduct of each organism corresponds to a description of the behavior of its partner. The outcome provides the potential for a pleasurable experience to the body but does not guarantee this outcome.

This installation is full of experiential feedback loops. The massage helps to reduce stress hormone levels, which in turn, can actively reduce the incidence of intestinal disorders in the human gut. In this way, the installation strongly implies a medicinal relationship between pleasure to body and the aesthetic pleasure of art. Another loop is the embodied self-awareness of the installation's own activities through the expressed relation between perception and action. As Alva Noë reminds us:

For perceptual sensation to constitute experience—that is, for it to have genuine representational content—the perceiver must process and make use of sensorimotor knowledge ([9], 17).

Embodied knowledge must be active, Noë argues. This involves an aesthetic sense in action—a pushing out from sensorial parts and a soaking in of contingent parts. Furthermore, Noë presents the argument that normal vision depends not only on the movement of the body relative to the environment, but also on one's self-actuated movement. So we must do to know.

Rinaldo's installation positions the interactant to consider their own embodied behaviors. This self-actuated feedback loop is one that is created through the extension of the body with mechanical devices, the smell and taste of chocolate, and externalized dopamine triggers. As she lays in the chair, the interactant body

expands and contracts claiming prosthetic identity and altering physiological identity. Author of the blog Edible Geography Nicola Twilley, describes Rinaldo's installation as a negotiation of the human body with the bacteria that live within it. She writes,

As well as interacting with the mood-altering chemicals in food, the enteric nervous system also communicates with the trillions of bacteria that live alongside them in the gut, digesting our food and boosting our immune systems [12]. Rinaldo sees the robotic tongue and the massage chair not merely as mechanical trigger devices but as ways to support the enteric nervous system itself in an act of self-awareness. As the brain spreads down away from cranium through the spine and into the gut, the interactant experiences the phenomenological play of ideas as body. It is a bringing forward of our chemical consciousness, an undulation ripping up and down the central nervous system in our own internal massage. The brain of the gut radiates back up through the nervous system and fills our senses.

Within each human body, the living bacteria *Lactobacillus Acidophilus* outnumber human biological cells by ten to one. They are, unto their own, an autopoietic network: an entirely non-human and non-hereditary adaptive technology, seamlessly and symbiotically incorporated into our bodies to metabolize nutrients, regulate fat storage, and even train the developing immune system. When the bacteria in Rinaldo's installation are introduced to the artificial stomach, we can see these bacteria also reach beyond the behaviors of their own workings. While sustaining the integrity of their own system, they couple and negotiate with both the artificial stomach and the massage chair. Then, we feel it of ourselves. Just as the digestive state of our enteric system determines the circuitry of our own neurotransmitters and receptors, so does the digestive state of the installation control the symbiotic relationship within the autopoietic exchange.

Varela originally proposed the following question: To what extent can human social phenomenology be seen as a biological phenomenology? Rinaldo's work addresses this question by creating an environment where our organs no longer belong only to a singular functionality, and where the self-realization of an external circulatory system becomes an aesthetic pleasure. In this way, autopoietics surpass the realm of a historical biology and reveal aesthetics as a simultaneously autonomic and dependent process. To adequately understand living organisms in this paradox, Varela and Rinaldo both claim that living systems are self-producing machines. This leads to the observation that living beings are structure-determined systems. This may be a difficult concept to reconcile with our historical notions of artistic creativity, but it is essential in the critique of the post-biological aesthetic: what once determined beauty has once again transformed our relationship to our own selves. Consequently, this challenges us to rethink our assumptions about what "creativity" is and how it works. Creativity may be uniquely human, but it depends on individual agency. So, in the autopoietic understanding of Rinaldo's installation, creativity cannot arise for the interactant without the mechanical devices that make up a large component of the interactive event.

Vague Organ

An autopoietic understanding of individual parts of the human body fits neatly into their physiological functioning. Like the relationship between the gallbladder and the liver, they look to each other for their own functioning. But in human evolution, the use of the gallbladder as a biliary vesicle for the liver has proved to be somewhat outdated for the function of digestion. The removal of this organ in humans is usually easily tolerated, with the liver taking over the emulsification of fats. There are many organs for which evisceration does not kill or severely alter the overall functioning success of the body. As a profound example, it is not unusual for lobectomies to be executed on portions of the brain for the control of severe epilepsy; the reassignment of brain functioning to other parts of the brain after the removal is far more common than previously imagined. The brain can reassign many processes to other neural pathways or can create new ones to accommodate the altered load. This is a procedure that is done on a smaller scale every day to accommodate a myriad of functional changes like fever, stress, or depression. The reassignment of functions within our organs appears to be far more fluid than once imagined, making organs and their functioning evermore ambiguous and elusive.

Simon Penny, an interactive sculptor, produces works at the elusive edge of organs. Penny and his team build structures that emulate human non-speech vocal sounds, developing lung-like machines, larynx-like devices, and vocal tract-like structures that focus on the functionality rather than the forms of particular organs. In his Phatus Project, there are assemblages of disquieting devices that laugh, cry, moan, rage, and sigh. The relation between the embodied nature of affect are critical. Emotions are, in some sense, of the body first and of language second. And this is an important aesthetic focus for Penny. The creation of sculptures that act as primitive sound machines encourages reflection on the paradigms of our own embodiment without the abstraction of language (Fig. 18.3).

Phatus Project involves prototype lung/bellows machines, and microcontroller-based electromechanical process control systems. Penny claims twentieth century research has been preoccupied with communication through semantic means, largely ignoring other aspects of human vocalization [10]. Both the body and its parts hold multiple meanings that offer alternatives not only to language but also to full body expressions, suggesting a scalable aspect to the autopoietic exchange, surpassing the realm of biological functionality (Fig. 18.4).

The robotic artworks created by both Rinaldo and Penny present the intentionality of an aesthetic developed from post-biological or hybrid art. It is important that these artworks are not critiqued as simulations: Penny's sculptures are not models of particular organs, and Rinaldo's installations are not meant to explain how chemicals travel through the enteric system. These works are vague by design, allowing them their own place in the world. They are aesthetic objects that, when engaged with an interactant, create essentially the only experience of their kinds. It is within the acts of pushing and pulling with our own body forms that meaning emerges and a fresh act of participation is created.

Fig. 18.3 Phatus I Elephant Celibitaire. Part of Phatus Project (mechanico-pneumatic voice synthesis machines), Simon Penny. 2010–2101 (Photo: Simon Penny)

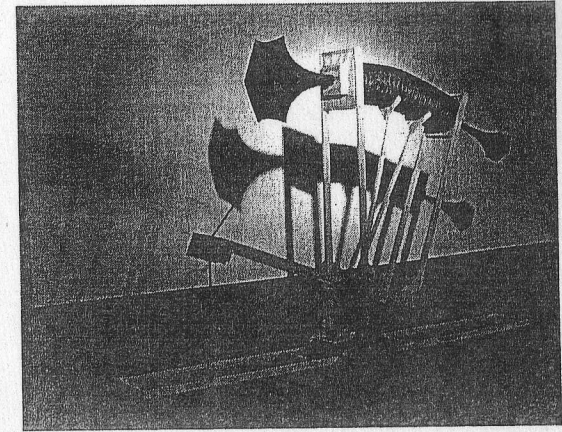
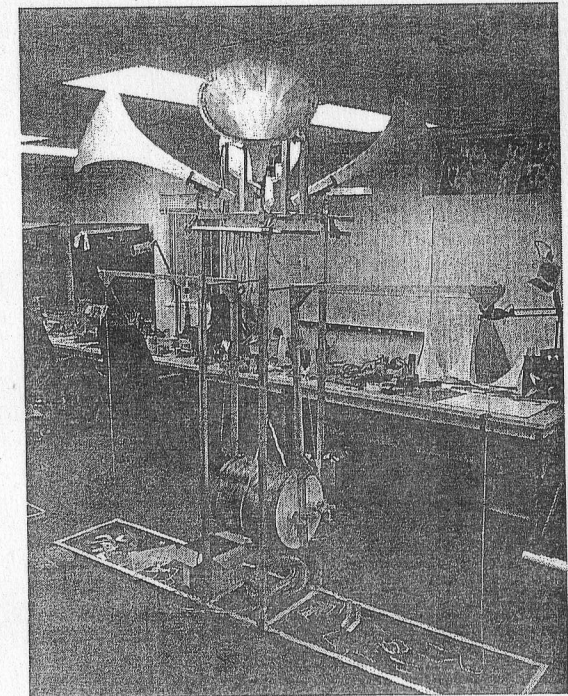


Fig. 18.4 Phatus II Part of Phatus Project (mechanico-pneumatic voice synthesis machines), Simon Penny. Work in progress, August 12, 1 2012 (Photo: Simon Penny)



Emergent Behavior

Applied to aesthetics, autopoiesis replaces an external "objective" view of art with an internal relativistic understanding of experiencing art. To a degree, the observer and the art object become co-organizers in an evolutionary system of patterns within the interactive artwork, creating an aesthetic or heightened appreciation of the ever-present phenomena of emergence. Heidegger's possibility of always becoming is at work in this relationship between interactant and artwork through its temporal and historical character of a coming-into-being. Placing aesthetics within a phenomenological ontology challenges the established relationship between viewer and object, a relationship that often keeps high art in a developmental stranglehold. For Heidegger, beings are not originally constituted in an individual consciousness. On the contrary, the starting point for every being is Dasein, an active bringing-into-being that includes the phenomenological locators of history and the embracing of temporality as in the experiences provided by the installations by Rinaldo and Penny. The interactant is always a participant and, as such, can never sustain a singular finality of form. The implications of this ontology suggest many pressure points between contemporary aesthetics as opportunity for social rupture, with autopoiesis as a system of negotiations. How we come to an event and what constitutes aesthetics is, in large part, what interactive artists are creating for their interactants.

The autopoietic aesthetic arises, then, from interaction within an art system. This may include multiple self-propelled entities, such as mechanically-driven devices and other human participants, each of which is in negotiation to render out aesthetic expression. Expression can occur through a variety of systems created through the mechanical comingling of biological forms. The implicit order of an autopoietic aesthetic is the relation between the external coherence of a phenomenon to what is imagined as external or, in social terms, the other. This creates a kind of arena in which a variety of systems of thought and action may potentially communicate, cooperate, and engage in both conflict and negotiation. The autopoietic aesthetic arena can be understood, therefore, as a dynamic multi-functional set of systems with a variety of ways to create ideas and experience the world. The arena is implicitly process-driven, performative, and highly experiential because it is built on models of consciousness with properties that focus on the entire thought process rather than on a singular outcome. This arena constitutes a topological domain that shifts the subject of contemporary aesthetics from a thing to a situation—from an object to an intentionality. Without the need to distinguish life from the mechanical, physical, or virtual, autopoiesis deploys a design and purpose found in human action that is always coupled to an extrinsic system. As such, the autopoietic aesthetic arena is a fundamental shift from the traditional notion of aesthetics, in which aesthetics functions solely as the object of human appreciation. It applies a new understanding of aesthetics as a comingling and inherent function of systems that possess a multitude of purposes and outcomes. The aesthetic appreciation arises when we involve ourselves inside the system's processes—a journey to immerse within and to feel the participation of an aesthetically designed emergent function.

As it becomes increasingly difficult, and perhaps less relevant, to distinguish between the biological and the mechanical, an autopoietic perspective assists in the unification of these distinctions. From an autopoietic perspective, a form is not evaluated only on its material property, but also on the basis of its functionality. The autopoietic process involves individual entities negotiating a self-propelled exchange between demarcated systems, usually undertaken to provide each participant with some sort of self-sustaining or evolutionary opportunity. For instance, when the interactant enjoys the play of system participation in Rinaldo's installation, it creates a sustaining interest and feeds input to the artwork, which in turn keeps processing the tasks of its design to distribute dopamine. The pre-designed objective of the installation is to sustain its own level of activity—that is, to create potential for the massage chair. It is the interaction from the interactant that affords this as a kind of probe or stimulation. In this way, the focus is as much on the chair as it is the interactant, an essential component of autopoietic systems. The choices available within each autonomous system tend to be, upon initial evaluation, merely self-serving and leading to a solipsistic epistemology. Autopoietic systems, however, must interact in order to survive, and in doing so they must form a kind of negotiated space with others. This is key to the power of the autopoietic aesthetic, which is both autonomous and able to involve, or even entice, other systems to engage.

A self-organizing mechanical system has a self-purposefulness when it is intentionally designed with the foresight to sustain its own functioning. From this perspective, both machines and people have properties of self-motivation and self-action. Built on the ethical premise that humankind cannot own living systems, autopoiesis is an equal exchange for a living system to secure "the crucial qualities of autonomy and individuality" ([5], 142). In her argument for autopoiesis, Hayles reminds us that part of Humberto Maturana's original use of the term is that we would see all individuals as equals. As such, the exchange between a participant and an autopoietic work of art should be considered an equal relationship. Autopoietic artworks are therefore positioned within a larger system of evolutionary forms that struggle to coexist, rather than as part of a relationship in which one form takes from another. This struggle can be observed in the imperfections of equality inherent in any interaction, but one that Maturana argues is far more equal than that of the Enlightenment Subject.

In *Autopoiesis and Cognition*, Varela refers to both biological and mechanical forms as he argues for autopoiesis as a living presence:

Autopoiesis in the physical space is necessary and sufficient to characterize a system as a living system ... hence, the biological phenomenology is the phenomenology of autopoietic systems in the physical space ([7], 112).

The physical space that Varela references is also found in the autopoietic unity of what he describes as a living machine ([7], 112). When we, as observers of art, interact with an autopoietic machine, we see both its functioning and its exchange response, which acts as a register for presence. The exchange is both an instrument and an outcome. Built into the outcome is a functional quest to reach beyond one's

own sense of autonomy in order to search for a more complete experience. This exchange also moves the aesthetic experience away from the imperializing gaze of high art toward an exchangeable negotiation between participants.

In the pursuit of authenticity in the aesthetic experience, autopoiesis operates as a solitary state that looks to itself as a trigger. If a system refers only to itself, how does it interact with anything but itself? The key to unlocking the autonomous meaning, in this case, is to reconceptualize the notion of "interaction." The function of self-reproduction in a biological autopoietic system, such as a flower, for example, necessitates interaction between structural elements of the stem to grow tall enough to catch the sun. In order for this flower to sustain life, it must grow tall enough to catch the wind and lure the bugs that will use their locomotive abilities to carry the pollen away. Built into natural autopoiesis, then, is a state of negotiated action between agents. The cell membrane that makes up the flower stem is able to hold the structure together while being permeable, sharing in a thermodynamic exchange of matter and energy with both neighboring cells and the surrounding environment. In order to sustain its own autonomy, this permeable cell wall participates in an arrangement of interaction with the world while fulfilling its self-sustainable needs.

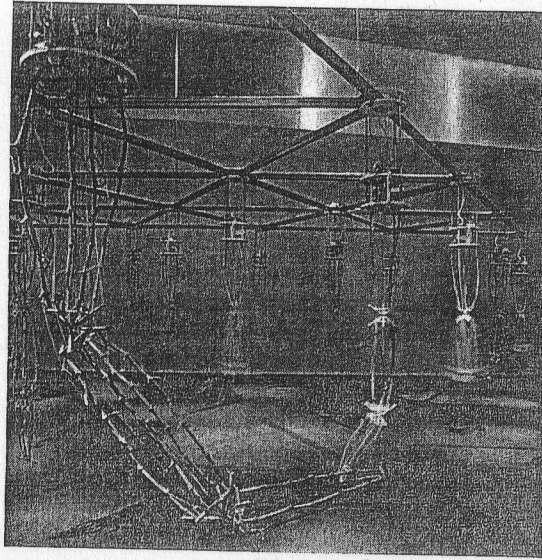
An aesthetic autopoietic system therefore, focuses on the process rather than the form of the object. The aesthetic autopoietic system also positions the art observer as part of the evolutionary emergence of everything that is part of our own identity. In a similar process and in the action of experience, we are both an autonomous self (unique in form and character) and an interlocking self (created by relationships) though the effects of engaging with interactive art. Art-as-life can be viewed as an endless search for exchange. Acts of exchange allow moments of consciousness and the reflexivity of introspection. In neuroscience, one can detect that it is gesture that leads to a kinetic resonance in each individual brain cell. As one brain cell makes contact with other brain cells, there is a compulsive need to create ordered relationships—the gesture that creates the patterns that form from groups of cells. Through a physical gesture, a single excitable cell resonates outward into the larger primordial openness of the life world and literally turns on neighboring cells. This openness is full of potential is what neuroscientist Daniel Dennet calls the qualia, and what phenomenologist Merleau-Ponty describes as the *Lebenswelt*. At the same time, each cell receives life force from the larger social sphere. If we can accept this phenomenological exchange of human experience, existence may be essentially perceived as co-existence. Interactivity becomes the choice and the aim of this coupling, and works as a trigger to awaken consciousness. Interactivity is therefore, both an instrument and an outcome: it is a desire to reach beyond one's own sense of autonomy in order to establish contact with the general condition of reality. Interactivity is also integral to the mechanics of self-sustainability. It is the aim of coupling, and works as a trigger to awaken a system at both the level of individual introspection and that of a whole world relationship. Perhaps we have come to a historic moment that rejects distinctions between the life of the viewer and the life of the artwork. The life of the mechanical and life of the biological can appear similar, particularly when viewed from within the dynamics of autopoiesis. From this post-biological position, a new symbiosis of interactivity in art has emerged.

Investigation

The installation *Autopoiesis*, an earlier work by Rinaldo, is a collection of interactive robotic arms that connect to each other through a closed software system. In this artwork, autopoiesis refers to a system that can be considered part flesh and part machine. Robotic arms built from twigs and mechanical parts stay busy communicating with each other through a distributed computer network. When multiple robotic arms interact, they do so in ways analogous to higher-order, structurally based systems, such as the relationship among neurons structuring cognitive activities. The gesticulating arms of Rinaldo's artwork use telephone tones as a "language" to "communicate" among themselves. On each arm, a series of light-emitting diodes signals the status of information input and exchange among the group. Computer-controlled feedback loops, smart sensor configurations, and randomization algorithms produce and control movement. As in the biological, neural, and growth structures found in evolution, the artwork creates its own internal stasis, the effect of which is a continuous exchange. The arms need to know where they exist in space so that they do not collide into a visitor in the installation space. For this reason, they track anything or anyone that enters the space. Their domain is defined by the spatial limitation of the installation, which they are unable to physically extend. This spatial domain is not unlike that of rooted organic systems, such as a forest of trees or a cluster of synapses connecting the cells of a brain. The systematic and distributed communication mechanisms of the arms provide a complex comingling of resources and information. The individual arms can see and feel through cameras and sensors and are able to make autonomous choices on where to go and how to expend energy. At the same time, the system as a whole is able to strategize, remaining a singular entity that is self-contained and self-motivated. This autopoietic drive, the ability to negotiate an improvised coupling with the observer's determinant input, becomes a central agent in the production of the aesthetic experience. The need for interaction propels the autopoietic beyond homeostasis into acts of investigation. The system works of its own accord—the internal equilibrium of the meta-system is full of adaptive responses that cannot be accounted for at any given time. While control mechanisms function to affect internal steady states, there is always the potential to move into the improvisational unknown of the interactive moment (Fig. 18.5).

All autopoietic systems must give way to how living entities move through time. At each moment, they remain in constant negotiation with any other systems that they come in contact with. When interactants approach Rinaldo's *Autopoiesis*, the system breaks out of its own repetitive behavior of looking at itself and reacts to something outside of itself. The robotic arms inspect the bodies of visitors using on-board cameras and sensors. One arm communicates with the next until all of them are aware that there is a foreign body among them. Each arm moves close but is careful not to actually touch the interactant. The robotic instinct is one of invasion and survival. The experience of interaction is one of care and uncertainty. The parts as a whole—human, machine, software, and triggering devices—come together in a state of uneasiness. The machine can be described as a unique independent entity, as can the human observer.

Fig. 18.5 Autopoiesis, Ken Rinaldo. 2000. The intra-action of robotic arms connecting with each other through a closed software system (Photo: Ken Rinaldo)



Rinaldo's artwork is generally placed within the movement of generative art, a system-oriented practice in which the common denominator is the use of living systems as a production method. Unlike many art movements that have focused on the natural form, generative art relies upon the structurally coupled relationship of a self-sustained internal processing and an external mechanical functioning of the artwork. Rinaldo references aesthetics within a biological schema. His aesthetic systems behave in ways that alter how we physically interact with them. Although the closed system of Autopoiesis can be experienced as complete within itself, the interactant can also alter this system. This physical interaction, in turn, enfolds the interactant within the totality of a new sensory-motor system that is a hybrid of both the mechanical autopoietic system and the open potential of a biological system. In this way, a seemingly closed system can acquire permeable boundaries, opening up to the larger phenomenological world. When stimulated, this artificial "living" system will reorganize internally, making itself unique, reflexive, and self-perpetuating—all in response to the diverse actions of the given interactant. As illustrated by Rinaldo's work, an autopoietic system is a closed system with permeable boundaries that functions autonomously. This type of system becomes an operationally open "life form" when coupled with its phenomenological environment through interactivity. As both a closed system and an open life form, the mechanical and structural elements of Autopoiesis mimic biological processes, making those processes, in turn, the subject of aesthetic reflection.

In describing the biology of cognition, Maturana begins his introduction to a description of autopoiesis by saying that:

The space defined by an autopoietic system is self-contained and cannot be described by using dimensions that define another space. When we refer to our interactions with a concrete autopoietic system, however, we project this system on the space of our manipulations and make a description of this projection ([7], 89).

According to both Maturana and Varela, autopoiesis is a homeostatic circular system. A self-sustaining property of autopoiesis is built directly into Rinaldo's installation within the physical and technological elements. Each is configured to allow communication with and for the other, using only rule-based procedures provided by software. The system of arms in Rinaldo's installation functions to communicate with itself; the movements that emerge from the arms of the sculpture are outcomes of an action set upon itself.

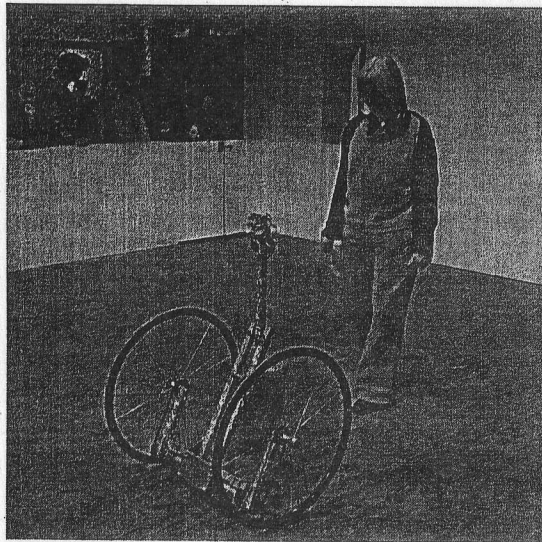
Interactive art, such as Rinaldo's, suggests that the patterns of interaction that serve as the foundation of the phenomenological field are also found within structural patterns of the body. It is the "interactive gesture" of the interactant that relies upon the embodied patterns of action and reaction. Contemporary artists, such as Rinaldo, appear to intuit these internal patterns and develop artworks with interactive elements that complement these patterns in a way that elicits and engages the viewer's patterns of cognition. This is substantiated by the ability of these artworks to induce sensorial experience in viewers. Through the autopoietic lens, the interactive aesthetic relies less on what an artwork looks like and more on the phenomenological embodied patterns of action and reaction the artwork stimulates between the viewer and sculpture. By such means, experience becomes physically accessible for contemplation and enables us to perceive ourselves perceiving.

Control

Simon Penny's *Petit Mal* is, in some sense, an anti-robot because it is truly autonomous. Most conventional robots are elaborations of John von Neumann's notion of the universal machine, in which the physical machine is simply a void to be filled with software content. This attitude within robotics is an unfortunate application of the Cartesian idea of the mind-body split, wherein the mind is imagined to produce intentions that the body then fulfills (Fig. 18.6).

Petit Mal is a very busy machine. With only two wheels and a counter balance, it is in a constant state of trying to keep its own body upright. This balancing is a way of existence for the machine—the constant checking and adjusting just to remain upright uses most of its possessing power. *Petit Mal* also has a secondary function, which is to find any physical obstacles in the room that may make this work of staying upright more difficult. Things that do not move, like walls or stationary objects, are observed with a camera and calculated as structures to avoid. Moving objects such as people, are less manageable. The robot must spend time calculating the location of the moving object, as coming into contact, or even coming too close, may potentially throw off its balance. This, however, is processing time taken away from the functionality to stay upright. Within this paradox is the irony of the robot's existence. It must search to survive but this very search makes it ever more difficult to sustain its own balance. This is an autopoietic conundrum: for existence, every system must look away from its own self and in this way, *Petit Mal* opposes a dual system of experience as it must do both. In other words, when *Petit Mal* is roaming about, it is impossible to distinguish where the interactant leaves off an action and where the robot picks up a response.

g. 18.6 Petit Mal A robotic
momentary loss of
consciousness, Simon Penny.
1989–1995. Smile Machines,
ansmediale 2006.
Academie der Künste, Berlin.
Curated by Anne Marie
Duguet (Photo: Simon
Penny)



You could say that Petit Mal is an autonomous agent and a realization of an artificial life entity. Not simply in the sense that it manifests some behavior that is life-like, but that it has a bottom-up logic – it doesn't conform to a traditional artificial intelligence way of viewing the world, sometimes referred to as the sense-plan-act paradigm. It is reactive in the way that an insect or an animal is active. It is consistent with reactive robotics, which was a response to the over-engineered over-complex computational solutions of the previous generation of artificial intelligence [6].

Penny explains that the behavior of the robot is built upon a reactive paradigm and this is not something that can be described by software or hardware alone. Petit Mal's behavior arises from the dynamics of body within the world—a notion that introduces the phenomenological aspect as a seminal component of the system's functioning. In other words, it takes a dynamic world of situations to make sense of action. While hardware and software work in a seamless continuity consistent with autopoietic systems, it is the evocation of body sensations and operations that fulfills the desire of action.

A cognitive reading of Petit Mal would present the artwork as temporalizing voluntary participation in the world. The artwork is not projected from the gaze, as we see in Rinaldo's installations, but rather actively disrupts the gaze, intentionally generating disequilibrium. The artwork's action implicates both the sculpture and the participant in the search for stasis. In neurological terminology, a petit mal inhibits and mimics momentary loss of consciousness. It is important that the Petit Mal sculpture presents itself as just a little out of control. Petit Mal's always becoming is a reaction to oppressive theories of control. In fact, Penny (personal communication with author, September 23, 1992) describes this robot as an engineering

nightmare. Although Petit Mal's mechanical structure is inherently stable, it has a chaotic motion generator at its heart, with a double pendulum offsetting its center of gravity, thereby creating a range of unpredictable motion. By design, the robot relies on its own movement through time and space to find balance. At any given moment, it is wildly out of balance and barely in control. But when Petit Mal meets up with an interactant, a new kind of phenomenon occurs that takes the individual out of its own sphere of potential. Cooperation between robot and interactant helps to release the egocentric bias in individuals. Indeed, the pull of mimicry in one's actions is such that the other's actions seem invitations for the self to participate. Often applied to contemporary aesthetics, this participatory model allows cooperation, rather than mastery over the object, to become the reflexive and preferred act of aesthetic exchange.

(Auto)Reaction

Penny's Petit Mal creates a simulation through action. Because the (auto)action of Petit Mal is consistently unexpected, the viewer positions herself in a manner that poses the physical first. Anne-Marie Duguet delineates this dynamic in the introduction to the catalog of the 2006 Transmediale exhibition. In Duguet's view, the action of constant adjustment to the viewing state brings out the humanness of the viewer, triggering emotions and a desire for connection. Moreover, the viewer is placed in the position of playing "catch-up" to the interaction and becomes subservient to the nature of the robot's behavior, another unexpected reversal:

...a trace of autonomy is perceptible, all this non-resemblance falls into oblivion and a "human effect" is activated, inciting the viewer to project endlessly. Thus, the object of humor may become the viewer himself interpreting a slight step back as fear, and a step forward as curiosity. Sensitive to the environment, capable to diversify and to involve its reactions, the robot tries to have a relationship to the human being, and this relationship is constituted from the beginning as a human relationship, one of domination or of sympathy. The robot is no longer the slave, it enslaves the other. This kind of reversal is a satire of human psychology and of the expression of the platitude of the threat that represents the development of such autonomous "creatures" for the human being [2].

According to Duguet, the viewer must rely on the action of Petit Mal for the aesthetic experience. It is the "stepback/stepforward" positing of the viewer, however, which creates an uneven projection oscillating between fear and curiosity. Confusion arises from this unexpected negotiation and a dance to find a homeostatic balance ensues. Duguet defines an interaction that is far from one of cooperation—she continues to rely upon a dual system of experience by setting the robot up against the interactant and vice versa. The traditional narrative that underpins human psychology is not well equipped to take on the subtle attributions of the robotic aesthetic. This is an excellent example of why an autopoietic aesthetic is a valuable lens for critiquing contemporary art. In neuroscience, the physical action of reaching and pulling within one's own body is also a brain-generated simulation, a feeding back

of experience into the temporal regions. The temporal regions are believed to be the caretaker of our senses and our emotions. In these regions, what we feel is neurologically mapped with what we experience. Petit Mal reminds us that behavior evolves. Perhaps, in the play between the two sentient forms of robot and interactant, we realize that each is reliant upon the other for mutual evolution. We also come to understand that interactive art leaves the viewer to experience certain things that lead to reflection and, then, to other experiences. Through the intelligence of embodiment, such installations highlight how the enactment of the physical shapes the psychological and constitutes another way in which we express ourselves.

Using this neuroscientific ontology, interactive art develops through the systems of self-reflexive connections that exist between the forms of the autopoietic object and the observer. The use of an autopoietic mechanism, along with the observational learning that occurs with structural functions provides a method for identifying material for thought and new knowledge. In this way, interactive aesthetics moves cyclically from the outer manifestations of human action to inner meaning and back out again to the aesthetic interface, in endless circulation without loss of autonomy. It is evident that experience and expression cannot be neatly separated. The singularity of perception dissolves as meanings emerge into the world of experience through biophysical co-evolution. The many varieties of exchange describing the autopoiesis aesthetic are entangled within this force.

Autopoietic Experience

It is only in response to perturbations by the environment or medium in which it exists that a cell will adapt or evolve to maintain the structural integrity of its components. A mechanical autopoietic system also goes about its business until human interaction creates a disturbance within that experience. Contemporary art deploys some of the same phenomena that neuroscience has shown us about brain functioning, such as coherence, long-range interactions, non-linearity, self-organization, self-regulation, communication networks, and non-locality. Interactive art matches the cognitive attributes of a coming-to-being in an already expected moment. The reflexive experience of an aesthetic consciousness can be understood as a fast forwarding of the mind's activities to catch up to that which is about to occur. In the collapse between the object and the observer, on this new modeling of an event, there is a transformative negotiation of the interactive moment embodied in both machine and biology. Because Varela's embodied mind is directly associated with the embodied machine, we have an expanded understanding of self or, perhaps, more precisely, a distributed self that occurs within a system of individuality.

Arguments about embodied minds, to some degree, are still weighed down with an implicit dualism because of the focus on the body as thing rather than agent. The idea of the distributed self posits that the self exists within, because of, and with affect upon, various networks of relative agency at large. The self does not exist in this context as an identifiable thing but rather, as Heidegger offers, an ever-emergent phenomenon that appears to have only some degree of coherence.

Autopoiesis offers us a kind of co-evolution among species and living/non-living systems in which art and viewer are part of the same system of experience. In that way, autopoiesis poses a question about the end of simulation, because we can understand experience as an interacting system, rather than one being a reflection of another. As hybrid systems that must interface with the larger environmental arena systems of autopoiesis can no longer be considered simply another kind of other. Some aspects of their functioning may reference only their internal qualities, but total success relies on the materiality of a larger existence, beyond insular feedback mechanisms. The interactions of Rinaldo's individual robotic arms, for example, are defined by a set of rules for their behavior, both individually and collectively, which can be considered their structural identity—or, as Varela states, "The structural identity in this physical sense is what defines the structural identity of actions" ([13], 101). This identity brings together two tenets of autopoiesis. First, nothing is a model for anything else; everything has its own essence. Second, locomotion of the singular always comingles with the locomotion of the other. Through this, the mind being internally coherent, the world "comes up" to being through the sheer confusion of experience. Yet, the sensation of a stable reality emerges from the clash of the internal and the external. The brain looks for these points of placidity in every moment to create a stable arena of perception.

According to Varela, evolution has less to do with getting better through adaptation and more to do with what we choose through experience. The tempo-spatial mechanisms of material form, such as a brain cell or a kinetic sculpture, give the moment its character and behavior. As a cell grows and lives, it develops all of its necessary life functions and continues to do so until it dies and the autopoietic cycle ceases. One similarity between a living cell and a mechanical autopoietic system is the cell's inability to make qualitative judgments about survival without an external connection. For instance, the cell takes in chemicals for growth, but to the cell's components there is no real difference between food and a toxin. They are both intrusions that effect the efficacy of self-propagation, favorably or not. In both cases, the autopoietic system must also be reflexive upon the larger arena of interaction. Aesthetic autopoiesis is a contemporary observation that simultaneously presents this multiple truth. The autonomy and resiliency of art as part of its own identity is also, to a certain degree, its own non-identity.

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