

The Choice-Making Theory of Consciousness and the Natural Selection of Choice-Making Systems

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Abstract: Evolutionary theory teaches that all modern biological functions have precursor forms. A growing scientific consensus holds that consciousness is a biological function and therefore a product of evolution. To understand human consciousness we must first understand its precursor forms. What biological function, present throughout evolutionary history, could have become consciousness? One answer is "choice-making." The first function of all life is the acquisition of nutrients necessary for survival and reproduction. The earliest choices were about selective ingestion of contacted substances. Following the line of animal evolution, choices about directed movement 600 to 700 ma enabled greater contact with nutrients through "search and find" food acquisition. The animal capacity for directed movement required a centralized function to mediate choice of direction. The modern self is descended from this function. Predation or "pursue and capture" food acquisition, following the Cambrian, increased choice-making complexity for both predators and prey. Animals began to cohere in social groups as early as 150 ma, requiring choices about social competition for food and mating. Sexual selection and choices associated with tool use and language may be largely responsible for the level of choice-making complexity in humans. All functions of the human mind-brain can be viewed as choice-making (option selection) or choice-making support (e.g. senses, memory). Choice-making is the evolutionary "purpose" of the brain. Human consciousness is hyper complex choice-making.

1 Introduction

Past studies of the human mind have failed to produce a scientific consensus about the origins and functioning of human consciousness . This paper takes a new approach, tracing choice-making as a universal life function from the beginning of evolutionary history to its present form as the basis for human consciousness

Darwinian evolution shows how great complexity can emerge from simple origins. The engine of evolution is selection pressure applied to replicators, like DNA, and their phenotypic forms and behaviors. The resulting complexity of life creates an illusion of design that evolutionary biologists can readily refute. It is possible to show how the complexity of any biological form has been built up by small increments over a long period of time. Dawkins (1996), for example, describes the evolutionary pathway of the human eye from light sensitive cells in early animal life. Dawkins notes that the eye has been separately “invented” more than forty times in different parts of evolutionary history. In the case of the eye, its development has been driven in part by selection pressure acting on the genes responsible for image quality. Higher image quality makes survival and reproduction more likely by allowing its owner to better distinguish important things in the world such as predators, prey, and cliff edges.

Each evolutionary development from eyes to claws to wings has a survival value against which it is tested. So what comparable survival value could drive the evolution of consciousness? The corresponding answer could be “quality of choice.” If our capacity to make choices has been evolving for four billion years, it is likely that the capacity to choose was itself subject to selection pressure, and that, over time, it became consciousness as we know it today. This would mean that human consciousness is something that developed gradually, like the eye, not a wholly new or exclusive function formed with our emergence as mammals, primates or homo sapiens. This paper presents a theoretical framework for viewing consciousness as choice-making and the natural selection of choice-making systems as the evolutionary pathway leading to consciousness.

2. Literature Review

The editors of the *The Blackwell Companion to Consciousness* note in their introduction that there are over 2,800,000 books and articles with the word "consciousness" in the title. (Velmans and Schneider 2017). The subset of this literature that addresses the evolution of consciousness is most relevant to the present thesis, and selected examples are discussed below.

The question of whether consciousness is a biological function, subject to natural selection and therefore a product of evolution, is no longer the subject of much debate. Polger (2017, p. 90) presents the case for consciousness as an adaptive trait concluding: "The sense in which consciousness is necessary for us is quite a contingent sort of necessity, but that is the only kind that evolution provides." Searle

(2017, p. 330) concludes with more certainty: "The thesis that all of our conscious states, from feeling thirsty to experiencing mystical ecstasies, are caused by brain processes is now established by an overwhelming amount of evidence." He goes on to state that "Consciousness is a higher level biological feature of brain systems." (2017, p. 333)

There is, however, no consensus about the mechanism of consciousness or how consciousness evolved. A wide range of answers has been offered. The anatomy of the human brain and the progression of human embryology display an accumulation of neurological structures that embody the evolutionary pathway from pre-reptile ancestors to homo sapiens. If consciousness is a biological function of the brain, then its evolution most likely conforms to this progression. But the compounding of anatomical structures does not answer the question of why these structures developed or how they combine to create consciousness.

Some authors bypass the mechanism question altogether and declare consciousness to be an "emergent property"¹ of the brain. Silberstein (2001, p. 61) states that "emergence is an empirically plausible and unique philosophical/scientific framework for bridging the ontological gap and the explanatory gap with respect to phenomenal consciousness." Trevarthen and Reddy (2009, p. 54) review the development of conscious traits from embryology to adulthood and conclude: "In an infant, a child, and an adult human, consciousness is developing or *emergent* [emphasis added] as knowledge and skills build their scope and power." However, Velmans (2009, p. 54) rejects "emergentism" as essentially equivalent to mind/body dualism: ".....the difficulties of asserting consciousness to be integral to the physical workings of the brain, yet at the same time something other than physical activity should be apparent." In the end, the classification of consciousness as an emergent property leaves consciousness and its origins as a black box.

Advances in neurobiology may eventually provide a picture of how consciousness derives from neural activity in the brain. If the functioning of consciousness circuitry can be definitively established, then the evolutionary argument might be reduced to determining when in the evolutionary record this circuitry first appeared. Crick and Koch (2009) address the "neural correlates of consciousness" (NCC), focusing on studies of visual neural systems, but fall short of a true conclusion by saying that not enough is known to answer the question of correlation, let alone causality. While progress in NCC research is reflected in Koch's later publication (Koch 2010), he ends with the same conclusion about the insufficiency of evidence.

Finally, there are a number of authors who directly address the matter of consciousness evolution. Several of these describe an evolutionary pathway starting in the relatively recent past. Eccles (1992) dates the neurological origins of

¹ Note the important difference between an emergent property and an emergent phenomenon. Emergent properties are perceived characteristics of matter that are psychologically or culturally assigned. "At room temperature, water is wet." Emergent phenomena are changes in physical state. "When frozen water is warmed to room temperature, it becomes liquid." Calling consciousness an emergent property bases the explanation on tautological human perception, not physics.

consciousness to the emergence of mammals approximately 200 million years ago (ma). Jaynes (1976) starts his description of the progression to modern consciousness a mere 3,000 years ago. Graziano (2016, 2019) argues for the evolution of consciousness in the last 500 million years. His Attention Schema Theory (AST) posits that consciousness is the evolutionary solution to the problem of too much information flowing into the brain. "The brain evolved increasingly sophisticated mechanisms for deeply processing a few select signals at the expense of others..." This corresponds roughly to the "choice of sensory focus" presented in the thesis below. But Graziano fails to recognize that the capacity for selective attention works in coordination with many other functions to support the higher purpose of choice-making. These three analyses all exclude more than 80% of the history of life on earth.

In contrast, Dennett starts his analysis, as this paper does, with earth's earliest life forms. In Dennett's "Consciousness Explained" (1992) his endorsements of global work space and multiple drafts concepts are consistent with elements of the thesis below, but lack the underpinning of choice-making as a continuous evolutionary function. His later work (2017) offers consciousness as a "user illusion" and focuses primarily on brain developments since the emergence of agricultural society.

Humphrey (1992, 2006) also begins his theory with the earliest single cell life forms. He makes the case for the evolution of sensation and sensory processing as the basis for human feelings of consciousness. But Humphrey does not consider the possible role played by choice-making as an underlying function from which, and for which, sensation itself developed.

The literature on the evolution of consciousness has largely ignored the role of choice-making. As an indication of how little attention choice-making has received, the phrase "choice-making" does not appear in the subject index of the *Blackwell Companion to Consciousness* (Velmans and Schneider 2017), and "decision-making" is given a scant two page reference. Yet choice-making is an operative paradigm underlying a wide range of psychological research methods and plays a similar role in research on animal cognition (Thorndike 1911). The natural selection of choice-making systems, as an evolutionary pathway for consciousness, appears to be a neglected line of inquiry that warrants further attention.

3. Growth in the Complexity of Animal Choice-Making

Choice-making has been a function of living organisms since the first appearance of life on Earth approximately 4.0 billion years ago (ba). The earliest distinguishable life forms were single cell organisms in the domains Archaea and Eubacteria, (Alberts et. al. 2008 and Dawkins 2016). It is estimated that Eukarya cells formed approximately 1.5 billion years later from the endosymbiosis of a eubacteria cell inside an archaeal cell (Lane 2015). In each case, it is nearly certain that these cells formed in a liquid environment absorbing nutrients that came into contact with their outer membranes. These organisms, like modern cells, used molecular protein structures

in their membranes to allow passive, and later active, transport of nutrient substances from the outside environment to the cell's interior (Alberts, et. al. 2008). This molecular structure constituted a form of programming by which some chemicals were chosen for entry and others were excluded. It may seem odd to call the chemically programmed transport of nutrient substances through a cell membrane a "choice." Lay definitions of choice (and decision) imply the presence of an intelligent deliberative agent. But not all choices require the presence of such an agent. Natural selection itself is an example of an agent-less choice system. If we consider choice to be "the selection of one option when two or more are present," then cell membrane recognition and differential treatment of substances is a choice. Alberts and his coauthors (2009, p. 9) state that the cell's plasma membrane "acts as a *selective* [emphasis added] barrier that enables the cell to concentrate nutrients gathered from its environment..."

The selective transport of substances through a cell's membrane is an example of "automated" and decentralized choice-making. In the case of nutrient transport, the program is written in the language of organic molecular structures embedded in the cell membrane. Molecular programming of this type is also evident in the structures that support metabolic processes within cells. We will call the collection of choice-making processes for any given organism its Choice-making System (CMS). It is worth pausing to note that, as a unit of analysis, the concept of CMS is a more inclusive base for the discussion of the origin of consciousness than the Cambrian and post-Cambrian neurological structures traditionally considered in consciousness literature. Sweeney, Boch, Johnsen and Morse (2011) show, for example, how coral reefs, lacking neurological structures of any kind, coordinate the choice of when to spawn. As the concept is used here, an individual cell possesses a CMS, as do animals, plants, colonies of cells, and colonies of organisms.

It is estimated that animal and plant life diverged approximately 1.0 ba ² At the time of this divergence, single cell animals, like their Eukarya predecessors, made choices about the transport of nutrient substances as these substances were encountered in the course of passive random encounter. We will call the method or methods that an organism uses to locate, select, and ingest nutrients its "Food Acquisition Strategy"(FAS). The passive-floating or random-movement encounter with nutrients will be called the "Encounter Strategy" (EN).

The characteristic that principally distinguishes animals from plants is the capacity for self-powered movement. An animal's ability to propel itself has definite survival advantages. Animals that could move toward food or through fields of food would be more successful than those that waited for it to show up. Such movement required new technology, like cilia and flagella, and the energy to drive that technology. But powered movement produced more nutrients and the energy tradeoff worked. Early movement was, no doubt, as random as floating had been. But the emergence of movement technology allowed selection pressure to act on choices about how to move. What specific movements would produce the most likely contact with food?

² Estimates of the divergence of animal and plant life vary widely across the literature from 1.0 ba (Alberts et. al. 2008) to 1.5 ba (Marshall. 2009).

Closely associated with the ability to move was the later ability to initiate movement using chemical signals. These signals and associated programming represent the first instance of what could be called "motivation." We will call an organism's chemically programmed motivation to initiate movement to enhance food acquisition success, "hunger." This is, of course, not hunger as humans know it, but hunger in its most elemental form.

Self-powered, self-initiated movement represented an important threshold in the growth of animal choice-making complexity. At this threshold, choices about the movement of the organism in space were made in parallel with food acquisition choices. From this point forward, selection pressure would act to improve both sequential and simultaneous choice-making abilities and the horizontal (inter-function) and vertical (intra-function) integration of those choice-making abilities across the CMS.

The point at which organisms advanced from random movement to non-random, or "directed," movement represents the next profound change in the structure of animal choice-making. It is not clear whether this happened first with single cell organisms or only later with multi-cellular organisms as there are examples today of both. Some single cell organisms exhibit directed movement in response to a chemical gradient or other stimuli (Alberts et. al. 2008). Some multi-cellular organisms appear to move at random. In either case, the advent of non-random, powered movement required some form of central choice-making function. With limited exceptions, an organism with directed movement abilities can not move in two directions at once. We will call the CMS programmed choice-making processes that emerged for the purpose of choosing between mutually exclusive options, the "Choice Making Core" (CMC). As discussed in more detail below, the use of the word "core" is a functional and not physical description. The first neurological structures devoted to choosing between mutually exclusive options were arguably the ancient precursors to the modern cortex and "self."

The appearance of multiple levels in the food chain created new survival challenges. Animals with the ability to flee from predators had superior chances of survival over animals without such ability. The molecular programming that enabled the choice to flee almost certainly required very little processing time. The better and faster this choice was made, the greater the chance of survival. The "choice of when and how to flee" would eventually include programming of the motivation "fear" with its associated damage warning system, pain.

The emergence of male and female sexual forms preceded the separation of animal and plant life. Chemically triggered sexual reproduction in multi-cellular animals evolved from chemically triggered sexual reproduction at the cellular level. For multi-cellular organisms, the choice of when to reproduce included a form of chemically automated motivation that could be called "sexual hunger."

Table 1 shows the set of animal choice-making abilities and associated programmed motivations that drove early increases in choice-making complexity from the time of

the first animals with directed movement approximately 650 million years ago.³

<p style="text-align: center;">Early Animal Choice-making Abilities (and associated programmed motivation)</p> <ol style="list-style-type: none">1. Ability to choose what to eat (hunger)2. Ability to choose how to move toward food (hunger)3. Ability to choose when and how to flee (fear)4. Ability to choose when to mate (sexual hunger)

Table 1

Any animal that was better at making any one of these choices would have had a survival advantage over another animal that was less good. After single cell organisms had taken more than 3.0 billion years to refine cellular level choice-making, natural selection began to act on the choice-making abilities of multi-cellular organisms. With animals competing for survival on at least four different dimensions of choice-making ability, the rate of improvement would have been exponential.

The competition to make the right choice at the right time would have benefited from something better than simple chemical triggers. An animal with any kind of information processing ability would have been able to make better choices about what to eat and how to move. Whether based in a network of specialized cells like neurons, or some other intercellular signaling structure, the ability to process information to drive choice-making had enormous survival advantages.

In addition to information processing abilities, the development of various forms of sensory apparatus would enable better choices. Senses connected to choice-making would open up new possibilities for survival strategies. The synergistic relationship between sensory ability and choice-making success would have created selection pressure for rapid, parallel improvements in sensory technology. Sensory improvements also led to the development of a new CMC function: the ability to concentrate attention on specific sensory stimuli, or the "choice of focus." This would have survival benefits both in relation to food acquisition success and the detection of danger. In later development, choice of focus would become the ability to "pay attention" to specific parts of the external environment and to specific activities within the CMS internal environment.

From simple beginnings, animal choice-making systems evolved to include complex neurological structures, sensory apparatus and information processing algorithms. While the pathway of this improvement can not be known with certainty, some elements can be inferred from the nature of choice-making itself. Some choice-making abilities confer powerful survival advantages that increase the probability of their discovery through natural selection. Just as the eye was invented many times in

³ Estimates of the emergence of multi-cellular organisms with directed movement range from 650ma to 800ma.

evolutionary history (Dawkins 1996), it is likely that choice-making support systems including memory, pattern recognition, and elementary forms of learning appeared repeatedly, and possibly independently, in different tracks of CMS evolution.

One less obvious improvement in CMS capability requires special attention. At some point, the CMS moved from the ability to make relatively simple automated choices to the ability to make relatively complex "open" choices. The distinction can be described in terms of the number of variables and range of possible values. With low variable choices, the permutations are small enough that the CMS can be effectively pre-programmed. A cell membrane allows some molecules to enter and excludes others. The number of different atoms and molecules is relatively small and molecular programming can account for the most important variations. With high variable or open choices, the number of permutations is so large that it can not be completely described in advance. Choices must be determined by the interaction of rule sets, the effects of which can not be fully predicted. What was the selection pressure that caused the leap from low to high variable choice-making? One hypothesis, posited here, is that the pressure was directly related to two structural thresholds in the evolution of animal food acquisition strategies. The first threshold was reached when animals began to search for and find food. Searching for and finding food required complex behavioral choices with too many variables for specific choice sequences to be fully pre-programmed. Search-and-find (SF) strategies superseded earlier EN strategies where food could be obtained with little or no movement, as in the case of floating microorganisms and sessile animals.

Although there is no known dating of the first SF animal, the work of Tomer, Denes, Tessmar-Raible and Arendt (2010) suggests that complex SF choice-making ability and associated neurological structures appeared very early in animal evolutionary history. Tomer and his coauthors found that certain annelid worms have a brain structure homologous to that of vertebrates, including analogues to the vertebrate palium (Tomer et. al. 2010). The authors claim that their data "date back the origin of higher brain centers to prebilaterian times" approximately 600 million years ago (2010, p. 800). Consistent with the concepts in this paper, the authors "speculate that the first function of these chemosensory integrative brain centers was to distinguish between food and nonfood, to decide about directed locomotion toward identified food sources, and ultimately to integrate previous experiences into some sort of learning." (2010, p. 807).

Following the SF food acquisition threshold, a second and more powerful threshold was reached when the food chain included predatory animals pursuing and capturing prey animals with the capacity to flee, as distinct from passive prey or prey that could be subdued without pursuit.⁴ We will call this food acquisition strategy "Pursue and Capture" (PC). The choice-making demands of pursuit are iterative and

⁴ Note that passive prey or prey that can be subdued without pursuit are part of the Search and Find Food Acquisition Strategy. This distinction exposes the lack of clarity in traditional animal categorization schemes, such as herbivore, carnivore, insectivore etc. Food acquisition categorization is more precise. For example, grazing animals categorized as herbivores consume insects found on plants, which makes them also insectivores.

interactive and involve even greater complexity than SF strategies. At these two thresholds, low variable choice-making would have reached the limits of its adaptive advantage in helping organisms obtain food. While parallel automated choice-making would continue to regulate the basic machinery of organisms, this new class of open choices required a qualitative improvement in neurological structures and associated programming. The open choices of the first pair of PC predators and prey would pale in comparison to the open choices of modern animals. Nevertheless, the precursors of modern open choice-making abilities most likely had their origin in this early structural separation between automated (low variable) and open (high variable) choice-making functions. The emergence of open choice-making at the SF and PC thresholds may be one of the most important, and least recognized, transitions in evolutionary history.

The last major threshold in the exponential growth of CMS complexity was reached when animals began to cohere in social groups, possibly as early as 150 million years ago (Dawkins 2016). Survival and reproduction began to require the ability to make choices about kinship relationships and social competition for food, status and mating. These demands reached new heights of complexity in the evolutionary line of primate species that emerged approximately 65 million years ago (Dawkins 2016). Commenting on the cognitive selection pressure that drove primate evolution, Pinker (1994, p. 380) notes that "outwitting and second-guessing an organism of approximately equal mental abilities with non-overlapping interests at best, and malevolent intentions at worst, makes formidable and ever-escalating demands on cognition." The human line of descent diverged from our common ancestor with chimpanzees approximately six million years ago (Dawkins 2016). Commenting on chimpanzee cognitive skills, Wilson (1998, p. 143) observed that "chimpanzees solve complex social problems, including forming and breaking coalitions, manipulating friends and outwitting enemies" In the subsequent period, the natural selection of more complex choice-making systems is evident in the fossil record of increasing brain sizes of pre-human hominids (Dawkins 2016). Sexual selection and selection pressure acting on choices associated with fire, tool use, group hunting and language were no doubt largely responsible for the final progression to the level of CMS complexity evident in present day humans. Late in this process, sexual selection may have played a particularly important role in advancing choice-making complexity by promoting selection for intelligence, leadership, humor and artistic skills in addition to physical strength.

The evolutionary pathway of growth in CMS complexity described above is necessarily incomplete and warrants further elaboration. Nevertheless, it suggests that evolutionary history contains a complete continuum of simple to advanced choice-making systems from the earliest single cell life forms to each modern animal at the end of its evolutionary branch. Each modern species would be expected to have unique CMS characteristics in the same way that its other anatomical features are unique. Similarities should also be found in coexisting CMS structures across species just as there are similarities in morphology. After a billion years of evolution, multi-cellular animals display a diverse array of CMS structures that are complex

even in some of the simplest of modern life forms.⁵

4. The Human Choice-Making System and Human Consciousness

If the pathway of choice-making evolution described above is correct, we should expect to find choice-making conspicuously evident in the cognitive abilities of humans. And that is exactly what we do find. Large bodies of psychological research, from studies of sensory and perceptual discrimination, to research using personality inventories, depend on participants making choices. Studies in social psychology commonly address patterns of individual and group choices. The existence of choice-making abilities in humans is a foundational assumption in much, if not all, of psychological research, and in fields as wide ranging as sociology and economics.

The anatomical features of the human CMS include the brain, the nervous system, the hormonal system and the sense organs. The human CMS contains a full range of automated, semi-automated and open choice-making and choice-making support functions. Automated choice-making includes reflex and automated movement, autonomic regulation of internal organs, hormonal systems, microbiome influences, sensory processing, and pre-articulation language construction (Pinker 1994). Semi-automated choices include non-reflexive instincts, emotions, feelings, intuition, autonomous memory, and learned choices. (See the discussion of emotions and instinct in section 5.) Open choices include directed movement, sensory focus, word selection, sentence construction, memory interrogation, imagination, planning and logical induction and deduction. While these functions are not traditionally described in terms of choice-making, each can be readily re-interpreted as either a discreet choice-making function or a choice-making support function.

The concept of choice-making can be used to explain some of the characteristics commonly associated with human consciousness. While there is no agreement about what constitutes consciousness, most definitions incorporate the concepts of self and self-awareness as essential elements. There are many books and articles that link the concept of choice-making to the concept of self. Neiss et. al. (2005, p. 593), for example, defines the "executive self" as "that part of the self-system involved actively in monitoring itself, *choosing* [emphasis added] how to behave, and enacting chosen responses." Whereas Humphrey (1996) assumes the existence of an "executive I" in his theory of sensations, choice-making evolution provides an explanation for the existence of self in the development of the CMC from the ancient need for animals to choose between mutually exclusive options. While consciousness as choice-making seems to beg the question of who is doing the choosing, the human CMS does not require a separate choosing agent any more than systems of lesser complexity in earlier evolutionary history. The CMS is complete in itself and plays both roles of presenting and making choices. Under this construction, the self can be considered broadly equivalent to the CMS and more narrowly equivalent to the CMC. Self-

⁵ Fruitfly brains, for example, have been shown to have over 100,000 neurons supporting complex behaviors including navigating via visual cues, complicated grooming rituals, and sleep.
<http://blogs.discovermagazine.com/d-brief/2018/07/19/fruit-fly-brain-nanoscale-every-neuron/>

awareness can be defined as a characteristic of advanced choice-making systems where the CMC is able to perceive the body as part of the environment from which choices emerge and on which choice itself acts.

The concept of choice-making can also be used to explain consciousness at the level of individual experience. Humphrey (1992) concludes that the feelings of consciousness derive from sensation and sensation processing, but the concept of choice-making allows for a more complete explanation. The feelings / emotions of consciousness are arguably generated by the rapid-fire choices of the human CMS, including choices associated with sensation processing. Sequential and concurrent CMS choices blend together seamlessly in a process of continuous engagement with both external and internal environments. Pictures of a moving object, projected at the rate of 25 frames per second, produce the seamless image of a motion picture. The parallel choice-making systems and subsystems in the human CMS, operating at a much greater composite speed, produce the feelings of continuous consciousness as a similar effect.

Structured choice-making exercises can be used to examine and partially deconstruct the perceived continuity of conscious experience. A sorting exercise with cards, for example, can be deliberately slowed to reveal a sequence of discrete choices. Each movement of the hand, each choice of visual focus, each muscle movement to place the card in position show open CMC choices and automated CMS choices working together. As choice-making is gradually returned to normal speed, it is possible to observe a connection between the experience of sequential and concurrent CMS choices and feelings associated with consciousness.

It is reasonable to conclude that humans are the inheritors of a choice-making legacy, and that consciousness is a part of that inheritance. Choice-making abilities are a universally accepted characteristic of the human mind. The range and types of human cognitive abilities, including consciousness, are consistent with the choices made by our SF and PC ancestors. And choice-making can be used to explain present day characteristics of consciousness, including self-awareness and the feelings of continuous engagement with the world. These associations, in combination with the history of CMS evolution presented in section 3, support the conclusion that the natural selection of choice-making systems is a plausible evolutionary pathway leading to human consciousness.

5. Other Implications of the Choice-Making Theory of Consciousness

If consciousness is a composite of multiple choice-making functions, then it follows that an individual, making different choices under different circumstances, will feel differently conscious. This accounts in part for the widely varying definitions of consciousness and many different categorization schemes devised for its various forms and components. The concepts of CMS and CMC could be used to identify commonalities across this field and permit some greater clarity in defining types of consciousness. For example, the functioning of the CMC by itself could be considered

roughly comparable to the concept of "focused" consciousness. The functioning of the entire CMS could be considered roughly comparable to the concept of "holistic" consciousness. Sleep and other unconscious states can be seen as the functioning of the CMS with the CMC "turned down" or "turned off." Traditional schemes for describing human mental life can be re-interpreted using choice-making theory. For example, the ego could be considered roughly equivalent to the CMC. The id and superego could be viewed as semi-automated emotional subsystems of the CMS.

The Choice-making Theory of Consciousness provides a window on the relationship between the mind and body. (The word "mind" is used here to represent the range of CMS choice-making functions that lie toward the open end of the choice-making continuum.) Choice-making circuitry was the original connector between the senses and other bodily functions. The mind and body have never been separate. The linkage has been present from the beginning, with the CMS and the rest of the body evolving together. The mind and body can be seen as a single system for making and implementing choices. The early separation of automated and open choice-making may be the original source of the illusion of mind/body dualism. Open choice-making has come to be seen as a function of the mind while automated choice-making is seen as a function of the body. In fact these are two subsystems of the larger CMS, without sharply demarcated boundaries. The Choice-making Theory of Consciousness may enable us to dispense with mind/body dualism once and for all.

In this same way, the conscious mind is no more separate from the unconscious mind than the mind as a whole is separate from the body. Again, the need to make choices is the connector. Gladwell (2007) provides numerous examples of lightning fast intuitive choices made from a set of options with a very large number of variables. Intuition can be described as a semi-automated subsystem of the CMS, making choices unconsciously and feeding the result to the CMC and other parts of the CMS. Emotions arguably support CMC choice-making in the same way. Emotions can be seen as modern recombinant versions of the oldest and most elementary motivations (hunger, fear and sex drive), plus new motivations related to new survival challenges associated with living in social groups (e.g. love, anger, hate, jealousy, sadness etc.).⁶ The number of possible emotion combinations, further differentiated by degree and context, appears to be effectively infinite. Similar "human infinities" can be found in taste and other sense combinations, posing limitations on any categorization schema.⁷

The speed and efficiency of emotion and intuition subsystems aid survival and reproduction by considering information that the CMC does not have time to process directly. These subsystems signal what **type** of action to take, leaving the specific actions to be determined by the CMC. Semi-automated functions, like emotions and intuition, may have evolved for precisely the purpose of handling the CMC information overload from senses and other sources. These functions have survival

⁶ See Parrott, W. (2001) *Emotions in Social Psychology*, Psychology Press, Philadelphia. And the work of Pei-Ying Lin <http://peiyanglinglin.net>.

⁷ Consider this intercultural emotion schematic as one of the best examples http://uniquelang.peiyanglinglin.net/visualization/Other_Languages_b.png

value to the extent that they identify important, but otherwise missed, information or patterns of information that allow the CMC to make better choices.

Viewing consciousness as choice-making may provide a new perspective on the problem of qualia. Choice-making systems must have certain operating characteristics in order to function effectively in the real world. Among the most important of these is the capacity to represent external reality in a form that is useful to survival. The human CMS produces such a representation. The CMS represents object properties, including their surface characteristics and spatial relationships, in ways that support choice-making about what actions to take. The classic example used in explaining the concept of qualia is the distinction between the objective perception of the color red and the subjective experience of "redness" (Humphrey 2006). Finding red berries as food would be more difficult if we did not "objectively" experience the difference between the surface characteristics of berries and the surrounding leaves. But subjective redness is also useful in choice-making. Redness is made up of complex associations that are both epigenetic and learned, such as associations with heat, danger and sexuality. The compounding of such adaptive associations over millions of years could easily account for the ephemeral nature of qualia. The fact that red appears to be red has no meaning other than as a convention developed by the CMS for coding electromagnetic wavelengths. We experience red as a red sensation and not a green sensation because some convention was required. Bats have an entirely different set of CMS conventions about the surface characteristics of objects. If bats had a language ability similar to ours, they would no doubt have words for the important differences. There is little point in debating whether red is experienced differently by different humans or different species. The experience of red or anything else is dependent on context and the CMS configuration of the particular species and individual.

From the Choice-making Theory of Consciousness, it is arguable that free will is real. Chaos and complexity theory tells us that it is impossible to predict outcomes far downstream in complex systems. In even moderately complex systems, the number of divergent possibilities quickly becomes exceedingly large. Eddington (2010) estimates the number of protons in the universe to be approximately 2 to the 83rd power or the number of choice combinations where at least two options are available for 83 consecutive events, a common occurrence in daily life. It is quite literally impossible to predict with precision what people will choose to do based on a set of initial conditions, weeks, days or even seconds in advance. It is also impossible to completely describe the initial set of conditions from which these choice sequences devolve. This does not mean that there are not patterns for psychologists and social scientists to study. But each of us, individually, makes real choices in each moment, the outcomes of which are not predetermined. In this same sense, less complex life forms also have free will, but fewer choices.

The Choice-making Theory of Consciousness has possible implications for clinical practice. Mental illnesses could be viewed as choice-making impairments, with treatments organized to improve choice-making ability and functioning. CMS choices are not necessarily matters of CMC "intention," or "will." Many CMS choices are

automated or semi-automated and not easily controlled by the CMC or are outside of its control entirely. Treatment can be tailored to the full range of dysfunctional choices that emerge from the CMS, assessing each differently depending on where it falls along the automated to open choice continuum.

Finally, the concept of CMS can be applied to phenomena above the level of the individual organism. Just as phenotypes have been shown to extend beyond the body and behaviors of the individual (Dawkins 1982), so, too, choice-making systems can extend beyond the boundaries of the individual CMS. This is evident in the use of cognitive aids such as books and computers. It is also clear in the choice-making systems that derive from collections of individual organisms, such as insect colonies. For humans, this phenomenon takes a multiplicity of forms under the general rubric of collective decision making. The power of such higher order choice-making systems is evident in such phenomena as wiki constructions and "crowd sourcing" approaches to problem solving and design.

6. Further Research

Deutsch (2011) argues that the beginning of new knowledge lies in speculative theories that are judged to be good explanations and then "distinguished" by evidence. In this view, the standard against which to judge whether a new theory is worth consideration is plausibility not proof. By this standard, the Choice-Making Theory of Consciousness deserves consideration by the scientific community. Research to test this theory could proceed along the following seven lines.

(1) Building on the work of Tomer, Denes, Tessmar-Raible and Arendt (2010), further examination of the neural anatomy of different species should show a pattern of homologous neurological structures associated with choice-making that follows the line of descent from common SF ancestors. Researchers should also find discontinuities in the size and complexity of neural systems in transitions from EN to SF and SF to PC food acquisition strategies, not evident in the descent lineage of animals where food acquisition strategies do not change.

(2) A thorough analysis of species at the phylum and sub-phylum level should show a correlation between complex food acquisition strategies (and complex social behavior), and the species' total neuron count or encephalization quotient (the ratio of brain to body mass) as proxies for CMS complexity. Such analyses should also provide a more complete picture of the evolutionary descent of food acquisition strategies including other forms such as scavenging, parasitic, and trapping behaviors.

(3) The search for the neural correlates of consciousness could employ a taxonomy of choices built on the choices and motivations evident in all animal life, shown in its early form in Table 1. Neurological scans could be used to compare subjects making mutually exclusive choices over a range of choice types and circumstances. Such studies could lead to a picture of the distributed architecture of automated, semi-

automated and open choice-making structures in the CMS and CMC. This method could also be used to create the first strange-attractor picture of the self. This might allow us to see, for the first time, the physical neurological structure of the CMC. The long evolutionary history of the CMC and its role in regulating choice of movement, makes it likely that the CMC/self in vertebrates emerges from the top of the spinal column.

(4) Experimental subjects should be able to perceive discontinuities in choice-making tasks. More formal study of such activities as sorting should reveal simultaneous and sequential choice events that correlate with a subject's feelings of self awareness and consciousness. Researchers may also find useful insights through the development of disciplined introspection. Other studies may shed light on changes in consciousness caused by progressively taking away available choices and choice-making abilities. Such studies could inform the design of NCC investigations in (3) above.

(5) If the Choice-Making Theory of Consciousness is correct then every brain injury should directly affect choice-making abilities. A meta-analysis of clinical and experimental neurosurgery could show the relationship between brain injury and a diminished ability to make choices along the automated to open choice-making continuum.

(6) Psychological disorders could be analyzed as dysfunctions in automated, semi-automated and open choice-making subsystems, and new or modified treatment methods that follow from these analyses could be tested for efficacy. Meta-studies of choice-making disorders across all psychological research could help clarify the role of choice-making in understanding psychological pathology and distinguish effective therapeutic approaches.

(7) It can be argued that the Choice-Making Theory of Consciousness provides the architecture on which all other natural theories and related research can be joined. This meta view might take years to construct but may finally bring coherence to the field of consciousness studies. In other words, the Choice-Making Theory of Consciousness does not replace all other theories, but creates a way to understand how they are connected. The question to be asked is, "How does each theory contribute to understanding the evolution and current functioning of human choice-making?"

7. Conclusion

Consciousness is not an illusion or supernatural phenomenon. It has a continuous lineage of natural precursor forms that date back to the earliest life on earth. These precursor forms are systems for making choices. Choice-making subject to selection pressure is inherent in the evolution of all life. The natural selection of choice-making systems has led to human consciousness, which is likely to exist in related forms throughout the animal world.

The human CMS is so complex that its very nature as a choice-making system has become obscured. All human mental faculties, from emotion to imagination, have developed as parts of a choice-making system that promotes survival and reproduction. The CMS function, most simply stated, is to choose what to do next. The same choice-making abilities are at work whether the choice is where to camp for the night or where to point the telescope. Viewing humans as choice-making organisms does not devalue the marvelous achievements of human life. Art is still beautiful. Love is still compelling. Music is still moving. The achievements of science and philosophy are still impressive. The act of choice-making is simply the underlying unifying function. Choice-making may be the only way to see the brain as a coherent whole.

Consciousness has defied explanation, in part, because there is no corpus delicti to examine. The eye has at least done us the service of being visible. Consciousness is invisible and difficult to describe, let alone explain. But it should not be surprising that the experience of possessing a very fast, personal, portable, invisible, hyper-complex choice-making system leaves us struggling for words. The experience of consciousness is what it feels like to have such a system in the same way that soaring is what it feels like to have wings. Describing the experience of consciousness will always be about poetry, even if the science must be about evolution.

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