Report on Merlin Donald's *A Mind So Rare*

by Michael Keith

In this book cognitive psychologist Merlin Donald sets out to establish the place of consciousness at the center of human development. The mind so rare of the title is the human one, a unique hybrid in the animal world that for its full expression and recognizable identity among other members of the species has to assemble itself through a collective process called culture. Through evolving a collective and symbolic organization of the resources of consciousness, the species has overcome the limitations of the nervous system, freeing the individual mind from isolation.

In the initial sections of the book Donald outlines and argues strongly against the case that has been made by those who relegate consciousness to the role of a bit player in human evolution, especially over claims that humans are hard-wired or have innate capacities for such things as culture, language, and various types of abstract thought. He seeks the root of these phenomena in the attributes of conscious processing that appear in the mental lives of many other animal species, and, drawing from research and thinking across many disciplines, proceeds to map out the paths along which he believes the human mind came to evolve.

The paradox of consciousness

The subjective world of the mind can be viewed only from consciousness – by definition we can know things only by making them conscious. But vivid awareness is a momentary phenomenon. In this chapter Donald describes the paradox whereby the structure of our social selves demands resources of awareness in time and space that seem far beyond the scope of the tiny cognitive filter through which all conscious experiences must pass.

In many cultures, particularly in the West, we have placed great importance on consciousness and conscious experience. Our social organizations and value systems assume a level of awareness and self-control, an ability to take informed decisions and have personal responsibility for our actions, and to think freely. Yet the short-term memory capacity of the conscious human mind, as viewed by cognitive scientists in the laboratory, proves to be a very limited instrument to act as mediator for such finely tuned and far-reaching awareness.

Even under the best circumstances we cannot keep more than a few seconds of perceptual experience in short-term memory. Consciously reflective thinking is subjected to the same temporal limitations. Complex conscious thought has to be strung together in a series of these windows of awareness. And consciousness has no editing devices like freeze-frame, slow advance or slow reverse. It is unidirectional, unfolds in real time, and cannot hold more than a short highly selective sample of the world – usually the one currently projected onto our brains by the environment.

Laboratory experiments on consciousness aim to objectify the phenomenon in rigorously designed conditions and strictly enacted procedures. These break down mental operations into their smallest elements – their microcomponents: the cognitive equivalent of neurons in the brain. In such studies consciousness seems less like a searchlight offering illumination and more like a tunnel through which everything must pass, and a small, dark tunnel at that, affording a rather poor view. We live at its mercy most of the time, groping from one slow-moving, fuzzy moment to the other. We call this predictable envelope our routine, and it actually provides our awareness with a stable framework. Our dependency on it is thrown into high relief by studies of sensory deprivation – when we are denied it.

Consciousness places narrow limits on what we can attend to at any one moment, it is notoriously vulnerable to interference, and, when put under severe stress, it can cause our cognitive world to collapse in conditions such as "battle fatigue," "nervous breakdown," or "mass hysteria." Nevertheless, it is through this same tunnel that humans have become the extraordinary cognitive acrobats they are and have constructed all their individual and collective achievements.

The governor of mental life

In this chapter Donald broadens the working definition of consciousness to that of governor – one that places it in a central role in the life of the human mind, with a purview far beyond the limits of short-term memory.

The time scale employed in the paradigms of most laboratory experiments seriously misrepresents the role of consciousness. The time frame in which most human conscious action takes place lasts for minutes and hours, rather than the seconds and milliseconds of laboratory paradigms.

Donald offers an eight-person, post-movie viewing, café discussion as an everyday example of this. Debate on a controversial movie sets off a conversational exchange ranging wide over a variety of topics. Such an episode can extend over an hour or more, generating vast amounts of information, notions, expressions of feeling, personality conflicts, all of which, to remain a player, each participant must track more or less continuously. That challenge places a huge load on each individual's capacity for conscious processing.

At the same time, the episode is situated within a larger physical and social reality, with which each person needs to maintain normal contact, managing appropriate behavior and keeping in touch with location in time and space.

When compared with ape communication, even a mundane conversation, let alone an extended and complex one, emerges as a gigantic achievement of memory management, far exceeding laboratory estimates of human conscious capacity.

To account for this capacity, Donald offers a theoretical model of the intermediate-term working memory. It shares properties of both short- and long-term memory, but differs from both as usually defined. It is capable of rapid recall from long-term memory, instantaneous growth, and reorganization. While in use, it remains vivid and active. It contrasts with the patchy, slow-to-surface long-term records retained in memory later and with the concrete, literal nature of normal short-term recall.

This working memory can not only operate over an extended time frame, but in application it is also exceedingly nimble at recall from a huge working store. This can be seen in the conversational jousting of discussion, but it is not unique to language. Performance in dance and music require qualitatively similar intermediate-term conscious capacities. Sporting performance offers rich examples of large investments in conscious capacity, requiring continuous responses to ever-changing novel situations and very frequent updating.

Arguments against the efficacy of consciousness are often mounted from evidence showing that cognitive operations such as speaking, perceiving and thinking are automatized. However, automaticity is itself a by-product of conscious processing. The "demons" that execute automatic processing are installed consciously. Conscious processes are largely responsible for setting up the automatized cognitive routines of the human mind.

A clinical and literary view of consciousness and self-governance

Donald now presents the view of consciousness that comes from the experience of clinicians who have to assess its state in their clients. "Clinical judgment" has its roots in the human capacity for mind reading. This specialized form of social intelligence is a must to survive in human society. It is a capacity to assess both what other people are aware of and our own awareness, an ability to alternate between various self-perspectives and other-perspectives, and it constitutes a remarkable evolutionary innovation.

Clinicians harness mind reading, for example, in assessing patients' states in recovery from unconsciousness from trauma. Disorders of consciousness may reveal themselves in a standard mental status exam, designed to evaluate a person's capacity for self-supervision in the intermediate time frame within which we normally act and think.

A key test is the person's awareness of their orientation in space and time, so patients are asked to describe where they are, where they live, the date, the day of the week and so on. Difficulty with these questions often is regarded as evidence of disorder. Normal consciousness routinely tests and verifies the larger coordinates of space and time. It is a function more basic than either language or symbolic thought, one buried deep within the mammalian neural blueprint.

Physical self-familiarity is another cognitive touchstone – our capacity for self-identification. This combines a concrete, detailed, up-to-date image of the body with a rather abstract

autobiographical memory record. The nervous system usually expects to feel self-familiar and does not easily tolerate the absence of this feeling.

Donald gives two clinical examples to illustrate the role that consciousness has in governing mental life. First he cites the story of "Zasetsky," a Russian war victim with brain damage leaving much of his visual field disordered and loss of control over language, memory, and thought, resulting in an extreme fragmentation of his working memory and attention span. However, he could hear normally, his control of movement was good, he could still remember who he was and where he came from, and he could realize what he had lost. Zasetsky's clinician speculated that this was because his frontal lobes remained undamaged. Zasetsky's goals in life were still intact, sufficient for him to determine to recover some of his mental clarity. In this situation, the mental governor was still vigorously operating, despite the disabling of short-term aspects of consciousness.

By contrast, patients who have suffered injury to their frontal lobes (as in lobectomies) display deficiencies precisely opposite to Zasetsky's. They seem to have normal short-term memory and attention span, are usually fully time- and space-oriented, are able to plan over the short term, and have language and general knowledge intact. However, in the long run, they prove to be severely deficient in functions such as self-evaluation, prioritizing and planning, leading to a failure to monitor themselves and indifference to the future – a dramatic illustration of the breakdown of conscious governance.

Donald then turns to the work of novelists for further illustrations of the depth and breadth of the operations of consciousness. A protagonist from a Henry James novel demonstrates the layerings of complex multitasking, observations easily verifiable alongside readers' routine experience. A passage from Stendhal illustrates the capacity to plumb internal depths – metacognition, a kind of self-awareness that involves an ability to monitor our own minds and to monitor that monitoring.

Fictional accounts such as these form part of the testimony that makes up a consensus on the nature of conscious experience and its importance in social life. Social awareness predominates in consciousness, something that makes sense of the updating function at its core and that gives rise to sayings such as "keeping one's wits about one" – that is, conscious wits, not automatic processes buried in inaccessible mental modules.

Donald concludes that experimental research has seriously distorted the reality of the timeframe of human consciousness. The major focus of our awareness's operations is the minutes and hours of the intermediate term. Neuropsychology and literature offer starting points for studying this phenomenon, for mapping these more enduring cognitive spaces. Working ideas about awareness also need to take account of the process of automatization as a necessary complement to advanced self-governance and learning capacity. They need also to keep track of the central unity of conscious experience, despite the word "consciousness" being used to group many disparate phenomena.

The consciousness club

Donald now moves on to explore the reach and roots of consciousness in the biological world through the metaphor of the consciousness club. He argues for the possibility that the peculiar kind of consciousness exhibited by humans, despite its seeming difference from that of other species, has come about through adaptation over several evolutionary stages.

First, consciousness needs to be seen as an aspect of complex material life. As complex life evolved from inert matter, it follows that consciousness did also. The physical presence on earth of what we call mind is a tiny fraction of nervous systems which are themselves a tiny fraction of living matter in the biosphere. It can be tracked from vertebrate nervous systems that emerged about 500 million years ago through to the emergence of our species about 200,000 years ago. The cluster of phenomena that we call consciousness is founded on some specific design features of the nervous systems in our genealogy.

Physically, however, the brain can seem an unimpressive organ, and many people are challenged by grasping the possibility that the entire human mental universe is contained within three pounds of protoplasm. But the brain is world of incessant activity and, depending on the scale of anatomy chosen, filled with infinite structures, which Donald proceeds to outline. Wrestling with the scale of miniaturization of the nervous system, he concludes, is as conceptually difficult as the scale of inter-stellar distances. Despite the brain's small size, its number and complexity of networks exceed those of the global electronic highway by many orders of magnitude, as do its speed and flexibility. Size and scale alone are not an obstacle to functions of the kind that human brains are up to.

Another prejudice against appreciating the materiality of mind shows itself in resistance to the idea that the brain has a vestigial structure. However, this is the reality of the human nervous system. Much of its underlying architecture is vestigial because evolutionary change must always be based on preexisting neural structures. The core design evolved over hundreds of millions of years, with new structures evolving out of existing ones, adding new capacities without interfering with the adequate functioning of the old. The blueprint is usually flexible enough to allow for considerable variation between species. An example of radical change can be seen in the transition of vertebrates from living in water to living on land. The aquatic brain design was eventually surrounded by and subordinated to a new set of brain structures that are today found only in land vertebrates.

The question remains: how does the slow-moving pattern of brain evolution account for the scale and rapidity of human cognitive and cultural change? Despite lengthy researches, nobody has ever discovered the neurological "magic module" that might explain human language and symbolic thought. Humans have a very typical primate brain design, albeit much larger than other primates relative to body size. Even in its expansion of size, the human brain has followed the same general pattern of primate growth. However, the regions that

have expanded most dramatically are known to be important for supervisory, governing and metacognitive functions.

Donald goes on to define the domain of consciousness. Consciousness encompasses at least three classes of definition. One defines it as a "state," as in the three basic states that mammals alternate between – asleep, awake, and alert. One is architectural in approach, where consciousness is defined as a place in the mind – not as a module with a singular location in the brain (it may be distributed across several anatomical structures), but as a central processor concerned with orchestrating thought and understanding. The third is an exclusively human-centered view of cognition and can be described as representational, in which becoming aware of something is synonymous with capturing it in symbolic form.

Donald then sets out some standards for including species in the consciousness club, on the basis that awareness comes in many different forms. We have no choice but to use ourselves as the normative species in this. (Who generated this debate in the first place?)

The simplest commonsense standard, he suggests, is to grant a modicum of consciousness to any creature that can achieve an independent mental model of the world, one that transcends its immediate environment and is capable of independently assessing what it sees, tastes, and feels. This would include even very small creatures such as ants, bees, dragonflies, and butterflies.

A more demanding standard may be the ability to perceive complex objects and events. This might exclude animals such as worms, but many insects, reptiles and fishes have this capacity in, for example, recognizing mates of their own kind and getting mating rituals right, albeit within a narrow framework. A given sequence must be perceptually "solved" by the nervous systems of the creatures involved.

The standard could be raised further by including the criteria of flexibility and adaptability. Birds and mammals, for example, have memories and learning systems that can map out and retain significant features of a large environment, or carry out a protracted chain of actions to achieve a goal or solve tricky problems. By this standard, rudimentary consciousness would be largely restricted to land animals and birds.

The standard can be set even higher by recognizing only a capacity for delayed response. This could be considered incontrovertible evidence of mental autonomy from the environment. By this definition aware minds are those that can carry around an idea or image (e.g., a source of food and the need to wait for its availability) for a period of time regardless of what the surrounding environment looks or sounds like. Just about the only members of this club would be mammals.

Other standards include: selectivity of attention, where the animal focuses its mind on a stimulus independent of competing stimuli; a capacity to update working memory; an ability

to cultivate and remember individual relationships within a working social group; and "mind reading" – understanding that others know things and that this has consequences for how they behave.

Across the different species, there is a tendency for more of these various capabilities to accumulate in certain lines of evolutionary descent, especially in higher mammals, and primates in particular. Human conscious capacity is the end product of a very long evolution, but other species share many component features of our conscious capacity.

Though consciousness is the product of many components, it is above all an ability to concentrate resources on whatever problem the mind is trying to solve. This capacity may be seen as an evolutionary adaptation in its own right, whose various functions have evolved to optimize cognitive processing in any novel, unusually complex, or fast-moving situation. The brain systems that provide support for this kind of flexibility reside outside any specific cognitive domain – they are domain-general.

A bear's fishing expedition is given as a typical example of mammalian resourcefulness enabled by such capacity – a combination of, among other things, attention focusing and splitting, sensitivity to environmental cues, goal setting and maintenance, correct sequencing, flexibility of action, and inhibition of irrelevant tendencies. Dexterity in navigating complex scenarios is testimony to brilliant coordination of executive resources.

Where in the brain is all this tied together? Consciousness may have no specific location in the brain, but is bodily experienced in a perceptual egocenter imagined by most people to be a few centimeters behind the eyes. This "homunculus" feeds on the many body maps registered in our brains. It is the integrated neural footprint that underpins our sense of embodiment – a unified physical selfhood. This phenomenon of perceptual self-awareness is rooted in our ancient evolutionary past. In humans it also encompasses complex external event representations – the foundation of making meaning, anchoring the base of experience within personal boundaries. Even the slightest partial disconnection of awareness from body-based feedback can cause great disturbance in the consciousness.

The homunculus is a psychological reality that in humans guides the self-construction of individual minds and supervises the countless negotiations that constitute the cognitive basis of human culture. It builds and then governs the human world through its ability to coordinate the actions of the executive brain.

Donald now compares human conscious capacity with that of other primates. He adapts the concept of the "zone of proximal development" – a term used in psychology to describe skills acquisition in children's development, a teaching/learning interface when a certain level of competence is established and new skills can be reached. In evolutionary terms, Donald sees this being applied to comparisons between humans and their nearest relatives to give a picture of how selection pressure might result in the development of increased conscious capacity.

He calls the cluster of skills underlying human conscious capacity the hominid "Executive Suite." He sets out twelve domain-general skills that are highly evolved in humans and reviews evidence for their presence or potential in other primates. They all precede the development of any language capacity. The skills are:

1 Self-monitoring of success or failure
2 Divided attention – the ability to perform two or more tasks simultaneously
3 Self-reminding – the ability to repeat part of a long sequence in order to remind ourselves of the next part
4 Autocuing – explicit self-triggering of memory, the basis of complex recall as evidenced in human language capacity
5 Self-recognition – the ability to objectify consciously the perception of the physical self
6 Rehearsal and review of action – practicing to perfect skills
7 Whole-body imitation – remembering sequences and grasping the connection between the sequences imitated and the results of the actions
8 Mind reading – understanding that other minds know things and that this knowledge predicts behavior
9 Pedagogy – two-way mind reading, with the "teacher" regulating the "learner's" process of learning, while the learner tracks the teacher's intent
10 Gesture – creating a visual metaphor of something else, usually another action
11 Symbolic invention – spontaneous, unsolicited creation of novel expressions
12 Assembling complex skill hierarchies – self-installing a complex set of skills (e.g., playing the piano, driving a car)

It is reasonable to conclude that this whole suite of executive skills evolved as a series of adaptations in the hominid line to produce a uniquely human configuration of conscious capacities. The development of this increased capacity eventually allowed for the evolution of language, the acquisition and management of which is the most complex of all human skill hierarchies.

Three levels of basic awareness

In this chapter Donald focuses on some of the physical mechanisms that contribute to awareness in individual brains. But first he cautions about the limitations of studying the isolated mind (the individual "brain in a box") in relation to human consciousness. Human evolution, he suggests, could be conceived as an escape from the individual nervous system. The main difference between apes and humans is symbolic culture that distributes cognitive activity across many brains. Animal cognition rarely escapes the boundaries of its own embodiment. Each ape, for example, learns only what it learns for itself and dies with its wisdom sealed forever in its brain. By contrast, humans from infancy link with a vast cultural storehouse of knowledge and skill that has accumulated in cultural memory over many millennia.

In the metaphor of computation, humans use a mode of computation, symbolic computation, that is unique in the biological world. This is epitomized by the kind of symbolic programming strategy used in Artificial Intelligence, spelling out everything a computer must do and in what order. In the natural world, real brains work in analogue style – nonsymbolic, holistic, a bit like the popular concept of "right-brained" thinking.

Humans maintain a precarious balance between these modes, part analogue and part symbolic in our mode of operation. This forms the basis for what he describes as our hybrid mind. It combines the largely receptive mode of knowing of our basic animal awareness with a symbolizing mode, one that creates a sharply defined, abstract universe largely of its own invention. A conscious animal, one with a degree of cognitive autonomy from its environment, carries around a representation of the world unique to its brain and history – it "owns" its experiences. Symbolizing systems, no matter how sophisticated, can never have any degree of autonomy – they receive their codes from the surrounding culture. Symbolic culture is nothing without the human mind, while the human mind, without culture, remains locked incoherently upon itself.

The earliest emergence of symbolic culture must have depended on a radical change in the hominid memory system, specifically on our gaining voluntary access to it.

Impression-forming analogue minds rely on their capacity for pattern recognition to achieve intelligence. Large ganglionic nervous systems such as that of the octopus rely on gigantic networks of neurons, dedicated to specialized functions, that crunch through the patterning of connections that govern their actions. They have no voluntary access to the patternings. Memories are triggered by associative cues. Such creatures can be described as slaves to their environment, unable to conceive an agenda of their own.

The question arises, how could such a hierarchy of neural networks evolve the capacity of autocuing – the ability to self-trigger recall from memory? The key to humans crossing the computational divide was the expansion of the most abstract regions of the cortex, the so-called tertiary, or association areas.

Primary cortical areas are involved in the periphery of the nervous system, the interface of brain and world. They are chiefly concerned with sensorimotor functions, focusing on perceptions and immediate pragmatic reactions. Monkeys, apes, and humans have primary cortical areas of similar size.

Secondary cortical areas are further away from the periphery. They carry out high-level integration of data forwarded to them from the primary areas, performing advanced perceptual functions such as object and face recognition and the resolution of sound patterns, and supervisory functions such as executing motor programs and plans of action. Apes and humans have more highly evolved secondary cortical areas than monkeys.

Tertiary cortical areas lie at the greatest remove from the outside. They have become a gigantic dominant presence in the human brain, accounting for most of its evolutionary expansion. The special executive features of the human Executive Suite map precisely onto this expanded hominid tertiary cortex. The ultimate result of so much tertiary cortex is the human capacity to build mental models on a very abstract level. And the ultimate model of models, the human self-in-its-environment, is the most frequently and intensively rehearsed of our mental constructs. The tertiary cortex is implicated in our most wide-reaching mental functions such as long-term planning, self-evaluation, social judgment, and intermediate-term working memory.

Donald now looks at how scientists "chase phantoms" – track down the physical mechanisms of consciousness in the brain. Consciousness may be phantom-like, but the brain generates several kinds of electrical signals that can be identified with conscious processing. "Brain waves" are ionic currents that originate in neuron activity. They change with many variables, including excitement, depression, surprise, emotion, and concentration.

The basic trigger for asleep/aware states resides in our ancient brainstem arousal system. But very fine patterns of flickering between states have been observed in studies of people with low-level non-convulsive epileptic seizures, whose brief switches out of awareness are manifested in intermittent bursts of electrical spikes.

There are other aspects of awareness that are much slower-moving than the electrical discharges of neurons, which can talk to one another in at least eleven different ways. These involve electrochemical shifts as a result of highly complex neuron interactions. Slowness and complexity of this kind could account for the stable, lasting aspects of experience.

Still to be explained is why one neural network should gain advantage in awareness over another equally strong one or why the bottleneck effect of immediate awareness exists. Also how weak stimuli can dominate much stronger ones in awareness. These phenomena involve some kind of selection process. Studies reveal that every sensory stimulus leaves a particular signature trace in the brain, even if it doesn't reach consciousness. Those that reach consciousness leave a signature characteristic of awareness. Attention controls this process, possibly in the form of networks distributed widely across several brain areas.

One solid finding is that concentrated mental effort is accompanied by a marked increase in brain electrical activity. The more we concentrate on a task, the brighter the brain image burns, whatever the task. And brain scans show the same brain areas are activated whenever conscious capacity is engaged, no matter where it is directed – listening to the news, doing math, reciting poetry, mentally rehearsing a golf swing.

However, conscious effort also shows itself to be extremely flexible in structural terms, with the brain rearranging its circuits in distinct patterns for different kinds of performance and switching between them. Somehow conscious effort helps set up temporary functional

networks and assembles a strategy for dealing with the task on hand. And all this must happen within the strict confines of the brain's anatomy.

Donald now summarizes knowledge of the basic mechanisms of consciousness, looking at three levels of brain evolution, corresponding to three levels of capacity. These levels emerged in sequence and established the physical half of human awareness that enabled the Executive Suite to evolve, with its ensuing cultural revolutions.

Level 1 awareness: selective binding

Binding is the term given to the mechanism that enables us to attain perceptual unity – to perceive complex things such as objects and events. Objects and events, unlike stimuli such as color, loudness, and brightness, are not given directly to the eyes and ears. They must be sought out and detected from a barrage of raw sensation.

Without a binding mechanism, awareness would have no structure. Objects could not be perceived as constant coherent entities in a variety of conditions and contexts. Sophisticated perceptual experiences like events (for example, the synthesized perception that delivers the event "mosquito biting my hand" as a unit to awareness) are dependent on binding.

The origins of the binding mechanisms in mammals seem to be related to the evolution of attention. Selective attention drives the process of integration that sorts out the relevant bits of perceptual information from the environment and ties them into a unified circuit. Even the simplest act of object recognition involves attention, so the appearance of conscious capacity may well have been an adaptation to increase the power of perception.

Level-2 awareness: short-term control

Simple binding mechanisms operate on immediate sensation – they can only synthesize and parse whatever the immediate environment offers to the brain. When they extend into a wider timeframe of a few seconds, however, they function as short-term working memory, pushing out awareness into the perception of simple events. This is the beginning of "controlled processing" as we know it in humans, granting a species some autonomy from the environment. It also enables the development of more than one active focus – not only on present sensation, but also on what's stored in the working memory. Taking in a landscape through a sequence of viewings offers a visual example of this. Pulling together a sequence in a social event such as a courtship ritual into a perceptual unit is another.

The presence of working memory is revealed in behavior such as a capacity for delayed response – sustaining a perceptual trace in the absence of stimuli, or, indeed, in the presence of conflicting stimuli. Along with active storage are developed some of the mind's executive capacities, evident in mammal brains – evaluation, selection, problem solving, and choice of response.

Studies of voluntary eye movements – the standard sequence of disengaging gaze, moving it, and enhancing its next focal point – illustrate the kind of complex governance system that has evolved in mammals even for elementary suboperations such as spatial attention. They demonstrate the ability of the executive system to arrange temporary networks to perform specific tasks, which are then switched to be set up in different ways after they have performed their function – what Donald describes as reshuffling the same basic set of neural cards. These routines once learned become automatized and serve consciousness without taking up working memory.

Another key component that has evolved in this kind of management is an inhibitive one – suppressing irrelevant or undesirable emotional, attentional, or other impulses that might compromise an agenda for action – in essence a capacity to deceive, one of the specialized adaptations that is part of humans' social weaponry.

Selective attention – the choice between many alternatives – is another crucial executive function. To become autonomous from the environment the brain must dominate the battery of sensations from the environment. Various parts of the brain work together to arrange and amplify the nonsensory activity so that working memory can compete with incoming sensation.

The Global Workspace is a name given by one group of researchers to the system of short-term conscious control. It involves a large area of neocortex that serves as a computational resource for many mental operations. The analogy for this is a neural blackboard on which many different brain systems can write. It operates in the parts of our brain that form a sort of cerebral International Monetary Fund that provides space for the intensive neural activity that sustains short-term working memory.

This system broadens the reach of binding by enabling the brain to extend its perceptual framework over several seconds, allowing the perceptual and conceptual world to expand. It also increases the complexity and length of the automatized routines that it can learn and off-load from consciousness.

Level-3 awareness: intermediate- and long-term governance

This level of awareness is concerned with the intermediate- and longer-term regulation of thought and behavior – minutes and hours, not just a few seconds. It builds on the first two levels of capacity but adds two new elements. It extends awareness into voluntary movement. It also expands the evaluative capacity to include supervising the executive function of level-2 awareness, immensely broadening the time and space horizons of perception.

The extension of awareness into voluntary control of limbs and vocal tract is a key distinguishing feature of human conscious capacity. It brings into play the self-conscious ego-center. In other mammals, with the possible exception of some apes, consciousness seems dominated by the perception of everything but one's own actions. The new capacity appeared

along with the vast expansion in the size of the tertiary cortex and in the traffic between the various brain structures involved. The hominid brain now had access to governance over action, resulting in our capacity for conscious, deliberate rehearsal, review, and refinement of action as well as an expanded capacity for automatized skills.

But though this expanded capacity might account for speed and power in conscious processing, how does it extend conscious control over a timeframe of minutes and hours, a continuing and updating activation such as we need to manage in an extended conversation, for example? This intermediate-term governance is always hovering in the background. It corrects, evaluates, and updates itself continuously, behaving quite unlike a long-term memory trace. Research is focusing on slower moving electrical traces, some shifting over as much as half an hour, that might account for the activation of this kind of processing.

Episodic awareness

The three-level hierarchy of the executive brain enables the capacity for episodic awareness – an elaborate integration of experience across many sources, including internal body feelings, organized into large-scale scenes that will be remembered as such. To achieve this, the brain must attend selectively not only to the outside world but also to its memories of similar episodes. This needs a highly effective working memory system.

In humans this kind of awareness was the foundation stone for the cultural edifice that the species built. In itself, however, the capacity cannot explain language or symbolizing capacity. It provided the raw cognitive potential for those things to prosper, but without culture, humans would have never become full-fledged symbolizing organisms. We might have become hugely powerful perceptual-motor systems, like those of a superprimate. To understand consciousness fully, the generation of culture must be explained.

The role of enculturation as a formative process in evolution can be seen in enculturated apes, who can do things that their species is not supposed to be able to do, whose skills such as a capacity to use symbols and understand some language has been implanted in their brains by the cultural influence of another species, our own. But there is a great deal more to generating culture than a sprinkling of words and a smattering of grammar. Language itself might be just another product of culture.

Condillac's statue

In this chapter Donald explores the links between an expanded conscious capacity and early development and cultural learning. A key element in cognitive development is attentional development. The cultural influence that comes from powerful figures in infancy, such as parents and close family members, is their effect on and channeling of attention. Perhaps the most important lesson they teach the infant during its first year of life consists of the basic rules of attention sharing. This process, once established, becomes a fast-track social learning instrument and a primary cultural guidance device.

Joint attention, the interlocking of two or more conscious minds, is the foundation of pedagogy. Basic interactive routines teach infants how to find out where to direct attention in a given situation and also what to remember and how to learn. Children acquire many of their basic mental structures through experience – their plasticity in this is revealed by what doesn't happen to children's minds in extreme cases of early deprivation.

Brain models may make brains seem like solid and static entities, but they constantly seethe with neuronal activity, and turn over their material parts rapidly. By the time we are adults, we do not have a single atom of our childhood materiality left. Yet the blueprint of the brain endures – the physical "we" still exists.

The cognitive entity growing at the center of this activity seems even more insubstantial. It starts with very little – gene kits provide the basic instructions for the brain to get going, but essentially the cognitive entity has to assemble itself, using only a blueprint, a few tools, and a certain built-in dynamism.

Another evolutionary feature of the human brain is its superplasticity. Neural plasticity is present to some degree in most nervous systems – it describes the flexibility in the way a nervous system might wire up during its development as a result of accidents of birth, hormonal influences, disease, or injury. In humans, for example, the visual cortex develops where the growing optic nerve collides with the cortex, wherever that collision happens to occur. If there are no eyes, however, there will be no visual cortex, and that region will be cannibalized by other regions such as those for hearing or touch. In fact, even in adult brains, sensory regions have been shown to expand or contract, reflecting their current level of use.

Plasticity is a design feature of the brain that can change in evolution. Human brains are an extreme form of this kind of plasticity. Learning and creativity are aspects of highly flexible cognitive strategizing. Most species have specialized cognitive strategies, fixed in their genes, that can change only at the rate of physical evolution. But a superplastic species can generate new options in fractions of a single lifetime. Some of these innovations will result in fitness gains, and natural selection will seek out and select the genes that nurture the most successful ones. The "runaway brain" concept related to humans suggests a positive feedback loop that welds physical evolution to cognitive evolution. This could account for the rapid expansion of human brain during the last half-million years.

The developing variety of expressive behavior has generated ever more variable cultures, which, in turn, have demanded even greater neural plasticity. But this superplasticity would not have much adaptive value outside the context of a highly unpredictable cultural world. In most species, it would probably prove a liability, leading to instability. For humans, it means that each new member must be crafted to fit the ever-changing mould of culture. For that, the human brain has evolved a maximally flexible, self-constructive, developmental strategy which can track a moving cultural target. Every human child is equipped to blend into its surrounding culture, however weird or wonderful that may be.

There are three factors involved in the development of our species – genes, environment, and, uniquely to humans, deep enculturation. Donald likens the latter to the Third Man in Graham Greene's novel, a mysterious presence whose whereabouts are unknown and who turns out to have been there, undetected, all the time.

Deep enculturation is distinct from the social environment in that it may lead to the installation in the brain of totally new architectures, such as the wiring that supports musical or mathematical literacy. These kinds of subsystems would not exist without the effects of culture. When broken down into their components, the skills acquired can be reduced to chains of algorithms that control attention and emotional valences. These establish the coherence and interconnectedness of conscious experience that forms its seeming continuity. The algorithms tell us what to look at, even internally and in what order, what comparisons to make, and what conclusions to draw. They give shape to everything, from basic events such as greeting relatives to esoteric ones such as reading a paper on electrophysiology.

The structural effects of culture are channeled through the window of consciousness. The child's consciousness is the hot spot of the human cognitive universe – the point at which each individual encounters and spars with the cultural colossus.

How might the emergence of this mental universe look? Condillac was an eighteenth-century French philosopher who speculated on how early experience might appear from the inside. He proposed a "Constructivist" view, still controversial, foreshadowing that of Jean Piaget, that the structure of mind is set up in experience and that its highest capacities are not innate but generated by appropriate sequencing of early experience.

Condillac held that our fundamental mental faculties are ultimately constructed from experience whose primary source lies in sensation, and our more abstract faculties are assembled from simpler ones. Condillac placed consciousness in the eye of this cognitive tornado. He distinguished between the process of consciousness (largely built-in) and its content, acquired from experience. He also recognized that with experience the process of consciousness could extend and elaborate itself, eventually with maturity building to a complexity of structure capable of formal thought.

In his *Treatise on the Sensations*, Condillac conceived a Statue as an experimental model of a mind whose sensory organs could be added and subtracted at the whim of the experimenter and whose ability to self-construct under various conditions could be explored. The Statue had two built-in components: a set of sensory pathways and a capacity to carry out certain operations with its sensations. This latter was given a tendency to take an active stance towards understanding the world, a bias towards noticing things and caring about what it noticed – a property of curiosity. The Statue also had an associative capacity to remember feelings of pleasure and pain connected with the sensations that accompanied them. His design was that of an "informavore," a creature that sniffs out the world's patterns and shapes

and finds the experience of simply knowing things pleasurable, tolerating neither chaos or boredom for long.

Condillac proposed that even limited to complete passivity and one sense such as smell, a mind with such a diffuse capacity buzzes with growth flowing from the stream of experience itself, constructing a world from the evidence it receives via sensation, memory of sensation, comparison of sensation with its memory, imagining of sensation, retrieval of memory of sensation to compare with new sensation. Even through such a one-dimensional experience the Statue can learn to distinguish between and operate with three major states of awareness – sensation, memory, and imagination. In the process it acquires the capacities of attending, recollecting, comparing, judging, imagining, and recognizing.

However, from this passive one-dimensional experience the Statue could know nothing of the event structure of the outside world or distinguish self from non-self. In his experiment Condillac tried substituting vision or hearing for smell. But none of these on their own or in various combinations allowed for a developmental route to distinguish between the self and the outside world. A mind limited to passive sensation could know experiences only as states of itself.

This changed once Condillac added action and touch – active and internal sensation – to the Statue's sensory capacities. Even without the other senses, the haptic Statue could become a far more knowledgeable being than the passive version. With the other senses added, the capacity for active exploration amplified and extended sensory experience into the discernment of events, actions, and objects beyond the self. But essential to shaping this awareness was the Statue's reliance on its attentional tools and working memory capacity that scaffolded the building of more and more complex executive skills – placing consciousness at the center the process of cognitive self-assembly.

One of the key things that Condillac missed in his model, however, was the significance of culture in connecting an isolated mind with a wider cognitive universe.

Condillac's notion of conscious self-assembly converges with a key idea of George Mandler, a founding father of the cognitive revolution, who proposed the essential linking of conscious attention with learning and knowledge. This can be clearly seen in laboratory studies of infants' learning. These track infants' attention through observations of eye movements and indications of what surprises and bores them, such as measuring their sucking rate on pacifiers.

The infant mind is revealed as restless, relentlessly curious, and driven by novelty. It attends, absorbs, learns, and moves on to the next interesting thing, cutting a swathe through the field of its own experience, processing impressions and ideas with extraordinary rapidity, but at the same time leaving a chain of markers for guidance in the advance through the cultural maze. The elements of conscious capacity are there from the start, directing the self-assembly

process and ordering the mind's growing world. As the mental world grows, so does awareness, and vice versa.

Children are active, vigilant, and deliberate in their approach to acquiring skills. Infants as young as eight months have been shown to be building a mental model of language in incremental steps. Things that are learned offer a scaffold for further learning, but once learning has taken place consciousness does not necessarily continue to play a part in the behavior.

Complex behaviors are assembled in stages. After extensive practice they become automatized so they no longer need conscious monitoring. A common example from adult life is the skill of driving, made up of dozens of routines and sub-routines, all of which, once mastered, can be practiced with little conscious supervision. The whole skill hierarchy has been sent "downstairs" to the unconscious.

Language is the ultimate example of such a complex skill hierarchy. It is assembled in stages and makes heavy demands on conscious capacity. Infants have been shown to intently and consciously study the communicative environment that surrounds them, gradually acquiring the repertoire of speech sounds that comprises their home language. But despite this complexity, once the speech hierarchy is acquired it goes "downstairs," becoming yet another automatized skill.

Reading offers another example, a skill hierarchy for which few suggest there is a built-in genetic program. An expert reader must be able to focus on the meaning conveyed by text, not the nuts and bolts of how to decode. Like language itself, the history of acquisition is soon forgotten.

Through these examples conscious capacity is shown to be a filter through which all significant cognitive developments must pass. This is not a passive process, but the active fashioning of most of the unconscious demons of mind, stored in the "basement" of the unconscious, ready to be summoned to awareness when required.

The extraordinary mind of Helen Keller

Condillac's Statue was pure fiction. But how do minds in the real world, trapped inside a body without sight or sound, cope with inventing a personal symbolic universe from minimal experience? Such people cannot see gestures and signs or hear speech, so they rarely develop language of any kind, often resulting in no significant contact with their culture and a lack of capacity for symbolic thought and awareness. The famous example of Helen Keller offers a striking illustration of an exception to this rule.

Helen Keller's two major channels of experience, hearing and vision, were shut off as a result of illness when she was eighteen months old. Her speech development not only came to a halt

but reversed. She retreated into a shell where, despite the attentions of a loving family, for some five years she remained. Yet she eventually went on to achieve remarkable intellectual feats – learning to read, write and type, learning several languages, graduating, becoming involved with debate on social issues of the day, propounding her religious beliefs. Her contact with the world was entirely through touch, taste, and smell, yet she was still able to use phrases such as "I see" and "I have heard" appropriately and perceive the nuances of social interchange. Helen's case brings the question of the nature of human abstraction into high relief – how can we understand and formulate such ideas in the absence of the usual sources of imagination and memory?

There was much debate both during and after her life about the extent of Helen's sensory limitations. Neurologist Frederick Tilney made an exhaustive examination of Helen in her forties – he found her totally blind and deaf, and he found her sense of smell and touch within the normal thresholds. However, in relation to touch, he may have overlooked the active element for Helen. As she described it herself, "My hand is to me what your hearing and sight together are to you … the world I see with my fingers is alive, ruddy, and satisfying." One exceptional area of sensitivity that Tilney did find was in her sensitivity to vibrations in the frequency range between zero and five thousand cycles per second – Helen apparently relied on this sensitivity to feel what people were saying by placing her fingers on the speaker's throat.

The age at which she became sick is also important. By eighteen months children often have a well established understanding of emotional and gestural aspects of language – knowing what various stock phrases mean, whether utterances are questions, commands, or declarations, as well as the use of pointing and eye contact for controlling or gaining attention, imitation, playacting, games, amongst other things.

At the age of six, Helen came under the tutelage of Annie Sullivan. At that stage she had no language as such – the only remnant of oral language that Helen continued to articulate was her word for "water." Before her illness she had acquired many basic nonverbal communication skills, what Donald defines as mimesis – an analogue style of communication that employs the whole body as an expressive device. Mimesis manifests itself in behaviors such as pantomime, imitation, gesturing, sharing attention, ritualized behaviors, and many games. By the time Annie Sullivan came on the scene, Helen had mastered most of the mimetic games of childhood, absorbing most of the body language, custom, and ritual of the household, taking its measure, even challenging and rebelling against it – all this without words, sentences, or explicit symbols. Her parents identified some sixty mimetic signs she had for identifying people in her surroundings, basic needs such as water and eating, familiar places, and regular activities.

But this knowledge and her facility were apparently not sufficient in themselves to permit her to cross the Rubicon to language. She needed a cultural link-up to achieve this – without that she was trapped in a world without words, grammar, or inner speech.

Annie Sullivan initially set about establishing a trusting relationship and a firm routine with a by now essentially wayward child, clearing out habits of behavior that might have forever prevented Helen from understanding the communicative attempts of her teacher. Like Condillac's Statue, Helen had only a few openings through which knowledge could enter – touch, smell, and feelings. Acquiring self-discipline and a habit of compliance provided the kind of attentional structure needed to enable Helen to perceive what her teacher was communicating – to get on the same wavelength.

Deaf-blind communicators, unlike sighted and hearing people, do not share a non-verbal framework that operates parallel to language. Their messages must be lined up, in single file, for sending and receiving. Annie's role in Helen's life became that of systems manager, to sort out her communications with the rest of the world. The basis of symbolic language that she taught Helen was a simple touch alphabet on the hand, originally developed by an order of monks who lived under a rule of silence. For Helen this was at first an elaborate game, but after many months it dawned on her that a particular pattern of touches was a sign with a meaning – in this case the word "water."

This was her breakthrough into the world of symbolic communication with the culture beyond the self. Beginning with this proto-language – of words but not grammar – she gradually assembled the repertoire of skills that comprises full language acquisition. As well as learning to sign, she learned to handwrite, to read Braille, to type (in several languages), and to lip read with her hand by tracking a speaker's vibratory signals from the neck, lips, and nasal area.

The manner of this learning, via its unusual sensory route, argues against the idea of a dedicated language module. Rather it must have been managed by a truly amodal system – one that could capitalize on any available input or output channel. And without the enforced attentions of her teacher, the enculturation that conveys symbolic language would not have happened. The framework had to be established from the outside. Helen's isolated mind could not invent language as an internal means of thinking and representation. She developed nothing of what we would call inner speech, or reflective intelligence, until she was guided through the long, convoluted labyrinths to its symbolic core.

All Helen Keller's depth and richness as an adult came from the emancipating effect of symbolic culture. The dilemma of this in the evolutionary story is that such cultures cannot function without languages, and brains cannot generate languages without preexisting symbolic cultures. How could such a symbiosis have started? Short of invoking an evolutionary miracle, expressive culture must have taken the first step – seemingly impossible on the principle that cognition leads and culture follows.

An answer comes from Vygotsky, from whose studies of children he proposed the so-called Outside-Inside principle, observing that children always copy the externals of language first and do not have inner speech or silent forms of symbolic thought. Thus, every function in a

child's development appears twice: first interpersonally and then intrapersonally. The evolution of human symbolic skills must have emerged in a similar way, because even now our modern brains cannot gain symbolizing skills without going through an externalizing phase. The first symbolizing algorithms must have been impressed on our brains from outside the nervous system, presumably from communication patterns that developed out of group behavior and were gradually internalized. The origin of these patterns forms the scope of the next two chapters.

The first hybrid minds on earth

In this chapter Donald looks at symbolic thought and language as inherently network phenomena. He calls his theory of their evolution biocultural – that they evolved from cognitive communities, the interconnected and distributed activity of many brains, rather than solipsistically, from the development of a complex language module within individual brains which then went on to create cultures.

The formation of human cognitive communities seems to have been caused by a relatively simple expansion of the executive brain with a corresponding change in developmental plasticity. The form that human consciousness took was fixed by the demands of this adaptation. The nature of our awareness has produced culturemongers, driven to seek refuge and solace in community. Donald sees the evolutionary origins of language as tied to the early emergence of knowledge, feeling and memory networks, all of which form the cognitive heart of culture. Language evolved under conditions that favored those hominids who could make their shared cognitive networks more and more precise. The first priority was to bond as a group, to learn to share attention and set up the social patterns that would sustain such sharing and bonding in the species.

Language is not an isolated module; it is embedded in a wider set of instincts for culture and blended into the cognitive system as a whole. Human ancestors could not have evolved an ability to generate language unless they had already connected with one another in simple communities of mind.

The relationship between consciousness and culture is a reciprocal one. Enculturation dominates human cognitive development, necessitating the early differentiation of working memory into multiple fields of awareness, as well as a linking of its powers of recall to the appropriate cultural subroutines. From observing the limitations of wild-reared apes and feral children, we know that if these are not programmed into the brain early enough, the system will be impossible to train.

A key step in the process is the interlinking of the infant's attentional system with those of other people – the development of interaction through the channels of eye contact, voice, touch, building from the early mutual imitations of parent and infant, through elaborate exchanges of facial expressions, voice and gesture, to playacting and games. A hierarchy of

habits for shared noticing, caring, feeling, and remembering are cultivated in this way, preparing the way for more ambitious forays into the wider culture later.

If the child learns how to read these signals, evaluate them, and respond to them, it can learn to navigate the cultural labyrinth and in turn become a cultural guide later in life for someone else. This training is all domain-general – virtually any cognitive module can be recruited to it. But without it, children will not acquire language normally nor achieve fully human consciousness later in life.

Human cultural evolution in the form of collective mentality could not have progressed far without some means of dividing working memory into different streams of awareness such as self and other, and past and present. Successful pedagogy in particular requires a multilayered system of mutual cognitive control if teacher and learner are to keep track.

Skills manifested among early hominids – such as tool manufacture, spear throwing, or group coordination for big-game hunting – attest to the development of a capacity to switch between subregions of awareness and, if required to parallel process, compartmentalize their conscious mental activities and run them simultaneously. This adaptation is typical of our human cognitive style, and language in particular is highly dependent on it.

The key to such multifocal, multilayered consciousness was management by the executive system. Modern symbolic technology capitalized on this capacity and radically transformed our knowledge networks in the process. Thanks to those changes we can now play faster and more complex games in awareness.

Donald now details the stages of the increasing tethering of culture with human cognitive evolution over the last two and a half million years. The acceleration of the rate of evolution over this time he describes as the result of a Baldwinian strategy. This sees the normally slow-moving rate of natural selection hijacked by communities being better able to store and disseminate knowledge.

He describes three major transitions over this period in a scenario of tension between culture and conscious capacity, with culture steadily pushing that capacity to the edge, resulting in the emergence of a symbolizing mentality.

The first transition: establishing the mimetic framework of human culture

The first human-like culture emerged with a new species, *homo*, just over two million years ago – a culture equipped with mimetic expressive skills. Mimesis took the primate mind a step further in the direction of improved social coordination and collective cognition. The group was primary, thus having an accurate sensitivity to group feelings was a survival related skill.

Mimesis is the result of evolving better conscious control over action and is epitomized by four uniquely human abilities: mime, imitation, skill, and gesture. The most basic of these is mime – the imaginative reenactment of an event, exemplified by the pretend play of children, and extending ubiquitously into adult social life in many forms of role-playing. Precise imitation can be seen as an attempt to replicate an event that has some instrumental purpose, requiring the imitator to understand the other person's objective – for example, a child can mime spear sharpening long before it can actually copy it with understanding. Skill is closely related to mime and imitation and results from rehearsal, systematic improvement, and the chaining of mimetic acts into hierarchies. Whether we are learning to weave, make tools, or cook food, we must learn a set of basic action sequences, generalize them, and rehearse them until they become second nature. Gesture is a natural derivative of the first three and is usually defined as an explicitly communicative or intentional act.

Mimetic capacity produces a layer of cultural interaction based on conventional, expressive non-verbal actions such as eye contact, facial expressions, poses, body language, self-decoration, gesticulation, and tones of voice. Mimetic culture is the world that children first encounter, and the level on which we assume a basic tribal identity and become conscious of ourselves with reference to our primary social group. It evokes and enforces patterns of consensual action – identification, role playing, and social organization function by mimetic actions, as part of the group theatrical production that we call social life.

The emergence of mimesis was our first step toward evolving an effective distributed knowledge network, which could coordinate the actions of groups of people. Mimesis is logically prior to language – it is basic to all education and training, and mimetic gesture, at its most advanced, is a direct precursor to grammar. The phonology of speech is, in fact, a hierarchy assembled from tiny "articulatory" gestural components. Without mimetic capacity such a hierarchy could not be assembled. However, mimesis was a self-sufficient cultural adaptation in itself. Its vestiges persist today as the unspoken foundation of all cultures.

The underlying cognitive basis for mimesis is an integrative capacity that can bring the body's various motor systems under unified command. This requires a centralized brain map, a virtual space where the actor can review and modify every action in imagination – a "model of models," an image of self-in-world. The existence of such a controller is evidenced by dancers, actors and athletes who have to bring their entire voluntary musculature under unified control in their performances, rehearsing a scenario and reviewing their efforts again and again until they meet their criteria of success.

Donald considers that hominids' break with their primate past came from a newly evolved capacity to direct their attention inward, away from the external world and toward their own actions. This overall form of body awareness, born of the need to refine actions, was the first rung on a distinctively human ladder of consciousness. Physically, it could be accounted for by brain changes including an expanding prefrontal cortex, the seat of the executive suite. In

humans this radiates greater control over the many brain areas that regulate action than it does in apes and monkeys.

Kinematic imagination is a product of such processing. This is what enables us to envision our body in action and is the cognitive basis for varying and refining any action. The sequence for doing this is the same basic process of intermediate-term governance: generate the intended action, observe its consequences, remember them, and review the original action pattern in imagination to, in turn, generate the action again.

This kind of imagination is a human specialty, and the switch in conscious processing that enabled the envisaging of the self-in-its-environment generated among groups of the species the complex theater of convention, without languages or symbols, that formed the universal mimetic framework for human life.

The second transition: the spiraling coevolution of thought and symbol

This transition started with the arrival of *Homo sapiens* about half a million years ago and culminated in the evolution of our subspecies *Homo sapiens sapiens* about 125,000 years ago. During this time the brain and vocal tract underwent a great change, and human material culture showed signs of accelerated innovation. This was the era that saw development of spoken language, which produced oral culture and was, until very recently, the universal form of human culture.

Language is a collective product that must have evolved as a group adaptation, in the context of mimetic expressive culture. Like mimesis, language proceeds from outside to inside, and children must master its public forms before internalizing its use. It also imposes conformity and welds a group of people into a cohesive entity. Its arrival, however, set off a whole new level of cognitive-cultural interaction.

Modern culture runs on language and symbols like economies run on money. Language is usually equated with full consciousness, and the notion of fully human consciousness is inconceivable without language. Putting events into words, for example, seems to sharpen awareness of the events. However, words are but the cognitive surface, the form of language, and open to many interpretations, and in the kind of cognitive games we play, language regularly proves inadequate to the task of capturing what it is supposed to capture. When language stays close to its original adaptive purpose, its bread and butter functions, it is more successful.

This inadequacy, and our ability to perceive it as such, is in fact a tip-off to the engine of thought process that stands outside any symbolic product of the cultural system and evaluates its success. Thought happens without language – language is the child of thought, its amplifier and mediator, invented to serve thought, but never functions as inspiration, interpreter, or

final judge. The region of mind that evaluates symbolic expressions is different from, and much more powerful than, the reach of any consensual expressive system.

Donald now describes the evolutionary strategy whereby humankind has progressively offloaded as much cognitive storage as it can to the "cultural attic" to be retrieved when required. Language itself is a secondary level of storage in this system, unable to be replicated without using other culturally stored information. As the physical environment generates the complexities that our visual equipment perceives, the communication environment is the storehouse of what the brain must learn. The brain needs to have the innate capacity to find, filter, and remember the essential features of that environment.

The grammars that have evolved in language seem to have emerged from the episodic cognition that is our mammalian inheritance. At the earliest times languages were tied to the representation of concrete events and episodes – and this deep cognitive dependency of language is reflected in the relationship between language and metaphor. The universal elements of language, the set of linguistic conventions that appears in all languages, are shaped by their mimetic origins. The brain's language instinct, insofar as there is one, is a domain-general one for mimesis and collectivity. This is impelled by a deep drive for conceptual clarification.

Individual brains do not have to have a simulacrum of language built in. If language emerges at group level, brains need only to adapt as parts of a distributed web. Customs, languages and codes are distributed across many individuals and a multitude of external devices that constitute our material culture. Cultures and their brains have advanced by interlocking with each other. Language can be evolved and replicated only by means of this piggybacking strategy.

Symbols of all kinds are the playthings of an intelligence – fantastically clever, irrational, manipulative, and largely inarticulate – that lives deep inside each of us. As with other mammals, this intelligence is what makes meaning of our conscious experience of the world. But it cannot symbolize without access to culture. Donald describes the relationship between this intelligence and cultural symbolic systems as a boxing match – a state of tension that determines the quality of our uniquely human modes of consciousness.

Our consciousness resides in the intermediate-term governance of mind, but it also runs an elaborate cultural machine from which it draws its very particular notions of selfhood. The cultural matrix with which the individual awareness engages is the product of generations of human conscious activity. The patterns of culture form the mazes we must penetrate. These patterns are as real as the physical interactions of migrating birds. They also dominate the cognitive universe that defines what "reality" is.

Donald uses the analogy of money-laundering to describe the mediation of language between thought and symbolic expression. He uses a young child's communicative learning to

illustrate the process in operation: a child loops a thought into primitive symbolic form, produces an external utterance or gesture, evaluates the feedback obtained, modifies the expression, and continues until "clarity" ensues in the networks that produced the idea.

The process of self-clarification and verification is not unique to humans, but the loop through a collective cognitive process is. Our semantic beast within employs the public loop to evaluate its own expressive performances. The key difference between us and other primates is that our mental networks have become much better equipped to understand and navigate the idea-laundering environment – that is, our expanded capacity for intermediate-term governance that guides all our adventures with culture, including language itself.

Donald now turns his attention to how words function in this scheme of things. Every word is a cultural invention and individuals must learn the consensual maps that every culture uses to graft word forms onto meanings. The roots of the invention of words lie in the theatre of mimesis, the driving force behind that invention is the need to make the vagaries of mimetic expression less ambiguous. And vocalization offers an additional and concurrent channel to the visual ones of gesture, pointing, and gaze.

Archaic hominids would never have heard anything like a word or a sentence, but, say, in teaching tool making teachers would have included prosodic cues as well as visual ones to direct their students' attention to certain points in the sequences. In the transition to language, those prosodic cues would have developed from utterances that were shorthand for whole chunks of meaning (like infants' use of a single word to express what might be a comment or a want) to labels and sequences specifying relationships more and more precisely – the rise of an elementary grammar.

The demands this kind of semantic differentiation made on conscious capacity were huge – at all stages of its development. Language came late in our evolution, coinciding with the last great expansion of the hominid brain, and increasing its executive requirements massively: a greatly extended and differentiated working memory; a capacity for multifocal attention; lifelong plasticity; huge expansion of long-term memory capable storing and instantly retrieving thousands of neural word systems; a greatly increased space devoted to semantic representation accompanying the refinements of language capacity.

Access to language changed the nature of conscious experience itself – words and sentences clarify the experienced world, placating the semantic beast within, and driving it, conjointly with other conscious beings, to seek greater clarity in culture. A common language allows us to share mind by defining a common representational framework – a stock exchange of mind where ideas and impressions can be traded, tested, and recombined at will.

Language gives us a cognitive zooming facility with which we can alter at will the scale of an experience and conduct evaluative review of our cognitive realm, with enormously increased powers of abstraction. In oral culture the main by-product of this capacity is story. Stories are

the imaginative fodder of self-identity, morality, class and status. They can become so influential and deeply rooted in culture's daily operation that they assume a special cognitive status, that of myth.

Narrative traditions have become a governing force in human thought, and the collective leap into the narrative domain has in itself expanded human conscious capacity. Words and grammars are the entry-level skills without which such traditions cannot exist, but once acquired become secondary to the stories themselves. Stories and myths can completely reshape our mental semantic spaces, leading to a consensual definition of a shared virtual reality that is the core of oral culture. In traditional societies power lies with language and the common cultural myths it generates.

Oral-mythic culture, as Donald terms this distributed cognitive system, has generated linguistic invention at a frantic pace as migrating groups of humans have spun off, through language and its mimetic foundations, their own versions of the system. The creative drive of the process can be illustrated by the huge Indo-European group of languages, spoken by over a billion people today, which can be traced to a single common tongue that existed less than 8,000 years ago. When oral cultures first appeared, they constituted a revolutionary force. Their oral and mimetic traditions generated thousands of fully developed mythic civilizations, effecting a transformation of human culture in less than 100,000 years. The influence of such traditions continues to be strongly felt in today's world

Collectivity has become the essence of human reality, giving our minds a corporate dimension. Our cultures invade us and set our agendas – once we have internalized their symbolic conventions, we can never be truly alone in semantic space. Culture influences what moves us, what we look for and how we think for as long as we live. Collectivity of mind is what constructs and maintains the vast distributed mental network that is manifested in culture's institutions, organizations and workings. And though the creative spark of cognition depends on the individual mind, creativity and its successful incorporation within culture depends both on how talent is defined and what value is assigned to it by a culture.

This process has generated the complex web of habits, customs and beliefs that define human culture, much of which, as with the products of individual cognition, has become automatized. However, the essence of human mentality is to harness itself to the collective organizing energy of culture – humans seek culture as birds seek air. With culture we have broken out of the isolation of individual mind. But with our interlinked nervous systems, newly powerful in their electronic extensions, we are now playing cultural games that are challenging the supremacy of the natural world, subjecting our brains to forces that are far beyond our control.

The triumph of consciousness

In his final chapter Donald looks at the third transition in consciousness, one that began about forty thousand years ago. This involved a revolution in the technology of symbols, leading to the employment of a huge number of external devices to store and retrieve memory in the form of human cultural knowledge.

Enculturation now has a formative influence on how a human mind develops. The most striking example is that of the effect of literacy. Literacy skills change the functional organization of the brain and deeply influence how individuals and communities of literate individuals do their cognitive work. To become fully literate, the individual must acquire a host of neural demons that are completely absent from someone who lacks literacy training. The complexity elaborates if you consider the case of multilingual individuals, or those schooled in the symbolic literacy of technical, mathematical, scientific or musical fields.

The demons of literacy reside in networks that are a cultural add-on to the normal pre-literate state of the brain. Like the demons of speech, they make great initial demands on conscious processing, but eventually become automatic. Literacy is neither natural nor universal, yet the children of all human cultures can become literate if given the chance.

The third transition: the invention of symbolic technologies

Literacy skills are a response to the invention of external symbols. Internal symbols such as the words of spoken language are stored in the brain. The same words typed on a sheet of paper become external symbols stored on the printed page. Symbolic technology is the enterprise of manufacturing and crafting external symbolic artifacts and devices, designed specifically to help us think, remember and represent reality. Symbolic technologies liberate consciousness from the limitations of the brain's biological memory systems – they complete the great hominid escape from the nervous system.

Preliterate cultures have only two means of constructing cultural memory – narrative and mimesis. These traditions can be maintained across the generations only by rigorous social enforcement. When external symbols first appeared, they probably had little impact initially – their cognitive potential could only be realized with massive social change. The first major systems of writing and counting consolidated very old ideas and customs rather than generated radically new ones.

Art, inscribed tokens for tracking trade goods, and symbolic technologies for navigation, construction, and measurement are examples of the various forms of external storage manifested over some thirty thousand years. Some of these came together in the great classical civilizations, which also produced evidence of literary work. Urban society could not have progressed without the massive use of such symbolic storage. These technologies may have developed from the inventions of single minds, but their full exploitation came about

only through collective enterprise – a collective awareness of the tools and the procedural habits to use them effectively.

The origination of symbolic technology comes from the interface between the conscious mind and symbolic environment, a two-way influence – thinker to symbol, symbol to thinker – and an open-ended process that carry on over generations, enabling human culture to conquer time and space, with its intellectual adventures permanently preserved for anyone with the codes to decipher them. Combined, conscious mind and symbolic technology generate a powerful chemistry and all the innovations in culture have arisen from the coincidence of mind and symbol that enables what was previously unthinkable to be thought.

Donald now looks at how consciousness operates with the external memory field. This is a description of the various symbolic entities, for example, books, computers, bulletin boards, outside the brain available to consciousness. The existence of these things has transformed the relationship of consciousness to its representations. We can store and arrange ideas in the external memory field where they can be examined, classified, assembled into complex arguments, played with, and crafted much more easily than in biological memory.

This external field creates a mirror world for consciousness. The interface is the vivid conscious core – the immediacy of levels 1 and 2 awareness. Surrounding that inside the brain is the level 3 intermediate awareness and governance, more enduring and layered, which draws on the long-term memory system in the background as needed. A symbolic device like a book or a computer offers an external memory field and links to the permanent external storage system created by symbolic culture. An encounter with this device means that awareness is juxtaposed between two storage systems, one internal and biological, the other external and technological. Thinking links these two simultaneous locations, and the same bob-and-weave boxing match that takes place between consciousness and spoken language is played out with external symbols.

The external storage system far exceeds the capacity of the internal system, changing the total storage capacity of humans, both as individuals and as a species. The mirror system that enables us to have sharper and more durable mental representations also changes the power of the conscious mind, allowing it to reflect on thought itself, evolving longer and more abstract procedures. This leads to qualitative changes on what we can achieve with limited mental resources, again both as individuals and as a species.

The fact that conscious states can be imposed from external symbols allows for the programming of experience – something modern cultures have taken to in manufacturing the virtual realities of print and moving image. It is a power that can lead to the scripting of individual awareness, a power that can both enhance and manipulate thought.

For the literate perceiver, external symbols are translated into physiological events in the brain. Thus, the external memory field becomes a fast channel from the cultural universe to

the control networks of the mind, a kind of cultural Trojan horse into the brain, a device that can play our cognitive instrument.

Through the external memory field, symbolic devices can display much of what was previously undisplayable – ideas, theories, plans, imaginary events – to be processed as we please or, as is the modern condition, as culture's cognitive engineers design. A proscenium arch, a large-screen monitor, a television network can coordinate experience on a scale previously impossible to contemplate. Indeed in an urban environment virtually every thought or action is framed by external symbolic devices, from the in-your-face such as advertising, traffic signs, clocks, and calendars, to the abstract and distant but nevertheless omnipresent such as taxation legislation. Many people live out their working lives as servants of the global storage system or as organizers or interpreters of the symbolic environment.

Human consciousness has evolved through three distinct layers of cultural representations – the mimetic, the linguistic, and the external. Each layer has magnified the effect of the previous one, and increased the number and variety of conscious modes. The human relationship with culture has given us a uniquely hybrid awareness, and additional channels for transmitting cultural influence.

This multilayered framework for modern consciousness can be conceived of as a set of concentric rings. At the center is the episodic core that we share with all the primates – binding, short-term memory, and intermediate-term governance. Outside that is the mimetic layer, the theatrical domain of human life – attitudes, gestures, postures, and unspoken nuances – where the basic rules governing communication and expression are set out. The linguistic layer is a precise and efficient system for encoding knowledge through countless stories, myths and traditions. The external layer is an even more precise collective system for formulating and displaying knowledge.

The nature and range of human conscious experience now depend on the unpredictable chemistry of brain and culture – and a mind isolated from culture is deprived of the outer layers of awareness. We depend heavily on culture for our development as conscious beings. Through this connection, we have acquired an awareness autonomous from the innately physical. On its own the human brain is an inarticulate, undifferentiated beast like any other. Joined to a community of its fellows, it has a remarkable capacity to create a community of mind, acquiring symbolizing powers and able to vastly expand the range of its own awareness. The triumph of consciousness lies in this conquering of the automaton, in the escape from the isolated mind.