

---

# The Future of the Cognitive Revolution

---

*Edited by*  
*David Martel Johnson*  
*& Christina E. Erneling*

The Mind Considered from a Historical Perspective:  
Human Cognitive Phylogenesis and the Possibility of Continuing  
Cognitive Evolution - *Merlin Donald* 355

New York   Oxford • Oxford University Press   1997

---

---

Merlin Donald

## *The Mind Considered from a Historical Perspective*

### Human Cognitive Phylogenesis and the Possibility of Continuing Cognitive Evolution

Thirty (some would say, forty) years ago, the proponents of the so-called Cognitive Revolution set out an agenda that grew out of a unique historical context. Their brainchild, cognitive science, is a product of the postindustrial present and, like many intellectual movements, it has used analytic tools and ruling metaphors that reflect its own immediate cultural environment. Thus, it is not surprising that our working models of cognition tend to typify literate Western (mostly English-speaking) adults, and tend also to resemble the computers that we have built into the fabric of our culture.

In principle, one could and should challenge the generality of any set of models with such a limited reach. The human mind has a long evolutionary history, and we have good reason to believe that it is still changing in significant ways. Certainly, the human mind has not always been the way it is in our society. The cognitive science mainstream could be accused of focusing excessively on the most recent cultural acquisitions of humans: paradigmatic thinking, precise denotation, causal formalisms, and so on. This emphasis on literacy-dependent logical and quasi-scientific thought reflects the roots of cognitive science in intellectual traditions deriving from logical positivism, and doesn't necessarily invalidate it as science. But none of the biases that characterize the field would encourage us to accept *a priori* that it adequately encompasses (or even acknowledges) the range of its subject-matter, namely, the whole of human cognition. Street language, the metaphorical (and very ancient) logic of mythic traditions, magic, custom, and ritual, and the whole range of non-verbal modalities of expression that still make up the greater part of human interpersonal communication are generally swept aside by cognitive scientists, while literacy-based skills are hugely overstressed in our theories. But in science, as in the courtroom, evidence of bias requires us to take a critical stance when we are evaluating the generality of our own theories.

The field of cognitive science has been split between those for whom the Cog-

nitive Revolution has apparently revolved around the inherent computability of mind, and those for whom it has revolved around a set of experimental paradigms aimed at modeling the various "modules" and "mechanisms" of the human mind. Both camps have traditionally shared a common fascination with mechanistic models, and the invisible (and, as Hebb observed, largely conceptual) brain-machines that support the putative mechanisms proposed by those models. Both camps tend also to strip away the richness of culture and context, in the belief that the "atoms" of mental processing and the "generators" of language can be revealed more precisely by paring away context, isolating general principles, and using a theoretical approach that is perhaps more typical of mathematics or classical mechanics than of biology (in this, AI, cognitive psychology, and even Chomskian linguistics have remained curiously similar to the behaviorism they were meant to supplant).

This predominantly mechanistic/positivistic approach has produced some very useful theoretical progress, and a great deal of interesting new data (the recent book by Posner & Raichle especially comes to mind); but a lot of AI research and much of cognitive psychology remain locked into a few paradigms that are too narrow to do justice to the enormous range of phenomena they are meant to explain. Maybe this is because they are overly concerned with rigorous reductive mechanisms, and not enough with old-fashioned scientific integration. A host of other scientific and scholarly disciplines have focused on the human mind and its representations, and it is worth considering (once again) the possibility that these other disciplines might contribute something fundamental to cognitive science. I am not suggesting that this should take the form of a reduction of one level to another, for instance the reduction of psychology to physiology or genetics; rather, I am suggesting a process of theory-construction that is essentially integrative, not reductive. Chomsky (1993) recently pointed out that strict reductionism often leads us down the garden path into a maze of contradictions, and in any case has rarely been successful, even in physics or chemistry. The more typical process of scientific understanding has been one of constant *integration* across disciplinary lines, rather than the "reduction" of one discipline to the terms of another. Such integration involves a process of successive approximation in which both parties to the integrative process must revise their theories, and importantly, as Chomsky observed, it has often been the more "fundamental" science that has been revised during this process of integration.

In the spirit of integrating knowledge gathered from various disciplines relevant to the study of human cognition, I would suggest that one dimension above all stands out as a potential integrative device central to all of our subject-matter: time, that is, the historical dimension. Mental processes are not static; they change over time, in both the short and the long run. And like many other functions, the structures underlying mental processes would be more easily visualized and modeled if they were viewed in the time dimension. "Mind" is an aspect of evolving life, and evidence of mind (loosely defined) abounds in many organisms. Like all aspects of life, it has a phylogeny; and humanity's version of mind has, in addition, a cultural, as well as a personal history. The description of human phylogeny and cultural history should not leave out cognition; surely it is the most interesting and important part of the story. But ironically, most efforts to reconstruct human emergence have done exactly that: they have left out cognition.

The phenomena we call "mental" emerge only at the highest organismic level; that is, several levels of complexity above inert matter. And, as with many complex functions, there may be more than one evolutionary solution to the construction of "mentalities." Thus, just as there is no universal solution to the problem of thermoregulation, or sight, or navigation, there need not be a universal, once-and-for-all solution to functions such as language and communication. There might be many conceptual and actual solutions to the problem of memory storage, event-perception, or problem-solving; or even representation and communication. Thus, our understanding of cognitive evolution might be better served by moving away from abstract models of hypothetical and supposedly species-general cognitive mechanisms like learning, spatial cognition, and memory; and instead take aim at species-specific theories whose primary purpose is to understand specific cognitive adaptations tailored to particular environments. Human language is one such adaptation, very particular to humans, and there are other cognitive trademarks special to humanity that probably also depend on a unique biological solution to a specific cognitive challenge. Lineage is an important consideration in such a context, because evolution proceeds in a conservative manner, necessarily building on pre-existing adaptations. The lineage of a species has a determining influence on the types of cognitive structures that are available to be subjected to selection pressure, and this should provide a major clue to the nature of structures that emerge later in the evolutionary chronology. In the case of humanity, our lineage is primate, and therefore the cognitive characteristics of primates are the starting-point, the basic working material out of which our kind of mind evolved.

Recently, the subject of cognitive evolution has been rediscovered with a vengeance (e.g., Bickerton, 1990; Bradshaw & Rogers, 1993; Calvin, 1990; Corballis, 1991; Donald, 1991; Dennett, 1991; Greenfield, 1991; Lieberman, 1991; Pinker & Bloom, 1990; Pinker, 1994). Although there is certainly no consensus in these, and many other, efforts to reconstruct human cognitive origins, new efforts at tracking our mental origins are throwing light on cognitive science itself. It may be objected that the problem of human mental origins is unsolvable since it cannot be addressed by direct observation, but this objection also holds for most of the other really interesting problems facing scientists—the origins of the universe, the ultimate nature of matter, etc. We cannot pretend that our species has no documentable history, or that we know nothing about human origins. We know at least as much about the origins of humans as we do about those of any species, and perhaps more. The problem has been that when we have studied our origins in the past, we have not typically looked at them in the context of cognitive theory. Human cognitive evolution has hitherto been addressed obliquely, mostly from the theoretical viewpoint of ethology and sociobiology (Lumsden & Wilson, 1983; Barkow, Cosmides, & Tooby, 1992). But ethology and sociobiology have not approached the problem of cognition as their primary concern; their main focus is on selection and biological fitness, not cognitive structure or mechanism. They have traditionally left open the question of representational mind and its changing nature.

Any serious effort we make toward understanding the evolutionary origins of human cognition should profit everyone, and force us to develop an integrative view of human cognition. In the study of other species, we have already moved in this

direction. Animal behaviorists long ago realized the limitations of Skinner-box paradigms and moved toward naturalistic observation, systematic ethology, and a tighter fit between laboratory data and evolutionary theory. Some cognitive psychologists, ably represented by Bruner and Neisser in this book, have heralded a move away from black-box laboratory paradigms toward the complexities of the real world; and this constitutes an important albeit small step in the direction of improving the ecological validity of the field. But cognitive research also needs the broader perspective provided by the study of human prehistory and evolutionary biology, and the more comprehensive database offered by the direct study of human culture. This does not necessarily mean that cognitive science should change its basic approach to model-building. But it should be modeling a wider sample of human cognitive reality than it is, and should be using a natural, ecologically valid database to narrow down the enormous range of alternatives open to it. This approach is already found to a limited degree in some cross-disciplinary fields like neurolinguistics, cognitive anthropology, and neuropsychology.

### The Roots of Language in Action

Having said this, is there any single theme that is central to human cognitive evolution, or a property of mind that can be held up as the quintessential human innovation, the one that allowed humans to create the technologies and cultural structures that surround us today? The most obvious candidate for such special status is language; and indeed the origin of language is often the only issue discussed in evolutionary theories coming out of language-oriented disciplines like linguistics and philosophical psychology. However, I would ask my colleagues in these fields to try to see the problem of language from a different perspective.

Human language must have come into existence during some specifiable period of time, in a particular chronology. It could not exist in isolation from its nonlinguistic predecessors, and cannot have evolved in some sort of Creationist vacuum. The strong form of a discontinuity position is simply untenable in an evolutionary framework. But the simplest form of a continuity position also runs into trouble. It can no longer be argued that human language lacks uniqueness—for instance, that it is no more than a variation on some universal quasi-computational “language of thought” found in many species. The evolutionary theorist cannot avoid either horn of this dilemma. In effect, language is unique, and apparently discontinuous with what preceded it, and yet logically it must be continuous with the primate mentality from which it has sprung.

One possible solution is that language did not spring fully armed from the minds of primates in a single step. Rather, there were earlier cognitive adaptations that set the stage for it, on both a cognitive and a social level. Human language undoubtedly has special features, but these features came into existence in the context of a unique pongid cognitive environment; and the human brain is, for all intents and purposes, a variant of the primate brain. Since chimpanzees are genetically much closer to us than they are to most other primates, we must share a great deal, in the cognitive realm, with chimpanzees. There is no credible alternative to the conclusion that the human evolutionary journey started with a primate mind, living something like a

chimpanzee life style. And this simple insight has implications for the kinds of language origin theories we can accept as feasible.

For one thing, it implies that the vast majority of the structures and systems supporting human cognition preceded language in the evolutionary chronology, and that modern human language emerged as the end-product of a series of changes to the basic primate mind that we must still possess under the surface. Put bluntly, language was an evolutionary latecomer, an add-on, albeit an add-on with a revolutionary impact. It follows that if our cognitive models of the human mind are to be accurate, they should build carefully from primate to human, and *give precedence to the primate part of the equation*, which is precisely the part left out of most cognitive science. An adequate model of human representation has to start with a primate (read: nonlinguistic) infrastructure that should logically account for most of the built-in features of human cognition. Primates have highly complex and subtle event-perceptions that enable them to understand a great deal more of human culture than any other species, and they achieve this without language.

Assuming this kind of starting point, there is the question of mechanism. How did the earliest humans dig themselves out, figuratively speaking? What new mechanisms would a basically primate brain have needed in order to support the spontaneous appearance of language in the wild? There is no possibility of giving this complex topic a fair hearing in this short chapter, and there are many possible answers, as can be seen from the variety of hypotheses in the current literature. There are, however, a few basic points that need to be kept in mind when thinking about language origins. First, any significant change to the primate mind would have immediate social and cultural consequences; no cognitive adaptation can be convincingly argued without working out this aspect of its emergence. Second, language emerged in a social environment, and is inherently social even in modern humans. Humans cannot learn to speak in communicative isolation, the way, for instance, they can learn to walk or see or use their hands; language requires a public forum for its development. Third, the only public forum for communication is action; and specifically, the actions, or motor activity, of a species must show a great deal of *morphological variability* to support language as it is manifest in humans. Fourth, other primates, despite their capacity for understanding, are very limited and stereotyped in action, relative to humans. It follows that before any public forum for the invention of language could have emerged, primates had to generate much more morphological variability in their action-patterns.

This variability could not be random, however. To support a skill like language, the variable morphology of action must be (1) rehearsable and subject to practice and purposive refinement; (2) rapidly communicable to other members of the species by some means; (3) replicable by other members of the species; and finally (4) driven by some sort of representational agenda. The fourth item doesn't have to be immediately engaged, however; it is entirely conceivable that this kind of morphological variability did not initially emerge in a communicative framework. It is also worth keeping in mind that the well-documented morphological skills of humans extend well beyond speech and language. It is true that infants babble and human languages seem virtually infinite in their variability; but this is generally true of human action. Humans generate this same apparently infinite morphological variety in their play,

their athletic skills, their crafts and customs, and in their nonverbal communications and representations. The variability of action is every bit as unique to humans as human language, and logically prior, since it is the precondition of any voluntary communication system.

This suggests that a good starting point for any evolutionary theory of language origins would be in the realm of action. In what part of the system would the morphological skills of humans have originated? My suggestion in this regard, is that, first and foremost, the primate brain needed some changes to its *memory* representation mechanisms. In particular, it needed some means for achieving *voluntary access* to memory. In order to refine and extend action, actions must be rehearsable and autocuable. This is a form of recall; one might argue that the capacity for purposive rehearsal is the most basic form of voluntary recall. It is self-triggered, or autocued recall. But in this primordial case, the self-trigger cannot be a lexical address; rather, it is an image that is tied into an action-schema. The autocued recall of action-schemas is a skill that is probably unique to humans, although there might be a case for a limited degree of this capacity in pygmy chimpanzees. Such recall does not depend on language; it is present in very young human children, who spend much of their time repeating and refining action-patterns. Humans seem to experiment with, and reflect on their own action from an early age, and alter it accordingly. A child might spend an afternoon practicing standing on one foot, for no apparent reason; or throwing stones, or turning somersaults. Or, in a more social vein, spend a lot of time re-enacting episodes. The capacity to rehearse action, and to generate novel actions through iterative refinement, may not appear representational. But the repeated act is in effect representing itself. And the point is, once a capacity for self-initiated rehearsal has been established, it sets the groundwork for similar public representations.

The representational use of autocuable action would not necessarily lead directly to language. It would lead to a general increase in socially diffused skills—toolmaking, for example—and in the range and variability of social communication systems and gestures. The complex of actions that would be triggered by this capacity may be called “mimetic” and finds its cultural expression in what I have labeled as “mimetic culture.” Mimetic skill involves much more than imitation; but it must have started as an extension of primate imitative ability. It probably began as an extension of primate imitative skill into the realm of intentional expression, and remains the basis of many modern-forms of human expression that are principally based on body-metaphor: dance, expressive games, ritual, much social custom, acting, athletic skills, and toolmaking. Although this capacity was a necessary cognitive bridge to the later evolution of language, it lacks certain key linguistic properties. Mimesis remains an *analog* representational strategy; driven largely by imagery, which refers by means of perceptual resemblance. Mimesis does not use denotation or grammars, or construct lexicons; however, it might generate iconic and metaphoric gesture.

Mimetic representations are evident in human children before they acquire language competence. Their representations include re-enactments, explicit imitations, pantomime, rehearsal and intentional repetition, and reciprocal mimetic exchanges

such as those that control joint attention, mutual emotional reactions, and mimetic games. They continue to be important in adults, taking the form of highly variable social customs, athletic skills, and group expressive patterns (such as mass demonstrations of aggression or rejection). Mimesis is the predominant skill underlying dance, simple forms of song, acting, and the transmission of nonverbal arts and crafts. It can be present in the absence of language in certain neurological cases, and in certain of the congenitally deaf (Donald, 1991). An interesting dissociation of mimetic skill, language, and social understanding can be seen in certain well-documented autistic savants, whose artistic skills developed before they had any measurable language skills (Sacks, 1995).

Despite their nonlinguistic nature, mimetic representations constitute a sort of "proto-symbolic" representational system that combines the intentional use of repetition and imitation, gesture, facial expression, gaze, body language, mutual attention-getting, and group reactions and displays. Nonverbal self-reminding is another important spinoff of mimetic capacity. Mimetic capacity is the underlying support system of language; it made hominid society more complex, increasing the need for a more powerful expressive device. At the same time, it allowed hominids to generate the morphological variation in action that, given the right cognitive incentive, would lead to lexical invention. But, without an underlying capacity to generate a wide range of retrievable morphological variation, there would have been no production system in existence to respond to whatever selection pressures favored the appearance of large lexicons and more complex communication systems.

In the field of human memory research, voluntary recall is sometimes known as "explicit" memory (Graf & Schacter, 1985), although the term is usually reserved for linguistically driven explicit recall. But a capacity for explicitly recalling action-schemas through imagery is surely a more fundamental form of explicit recall (explicit procedural memory?) without which the underlying morphology of language would be unacquirable and inaccessible. The rehearsal and refinement of action must have preceded spontaneous lexical invention in the wild, since lexical entries are built from elementary action-patterns, or articulatory gestures that must be imitated, rehearsed, and refined. The acquisition of basic morphophonology is still an essentially mimetic phase in language acquisition, which usually occurs before linguistic reference is acquired. And this skill must be supra-modal, since the morphological components of language are not restricted to vocalization (Poizner, Klima & Bellugi, 1987).

This is evident when we consider the nature of the most elementary component of any language, the lexical entry. Lexical entries are built around addresses, which usually take the form of phonetic production systems, which may be used to "point" to semantic content, and vice versa. This system of counterposing address and semantic content creates a tension that gives the language user great power over the (formerly unaddressable) contents of semantic memory systems, in the sense of clustering and cross-referencing material under a form of self-referential control. But the *sine qua non* of the lexical entry system remains, at the ground floor, an autocuable, rehearsable, refinable bit of morphophonology, and a public system of nonverbal communication, both of which reside at the mimetic level.



### The Question of Continuing, Culturally Driven Cognitive Evolution

The evolutionary wedge, the bridge from primate dependency on environmental cuing to the relative autonomy of human memory access, probably originated in a revolution on the level of action and its expressive product, action-metaphor. Needless to say, the limited power of explicit recall found in mimesis was greatly extended when the second level of explicit access—oral language—evolved. I will not try to discuss that issue here, but I am sure I do not have to convince linguists and philosophers that the transition from mimetic to linguistic representation required another very major evolutionary step, one in which a capacity for constructing narrative descriptions encompassed (without superceding) a pre-existing capacity for mimetic invention and retrieval. The net result was a second level of retrievable representations, and an extension of the reach of explicit memory.

Is cognitive evolution continuing in any significant sense? The continuing story of human cognitive evolution looks very much like an extension of the earlier theme: a continuous expansion in the degree of endogenous control over the contents of memory. Of course it involves a great deal more than this; memory storage media and retrieval strategies are only aspects of the human capacities for representation; but they are essential aspects. And once the human capacities for mimetic and linguistic representation were established, the main scenario of cognitive evolution shifted into the realm of new external memory media. The externalization of memory was initially very gradual, with the invention of the first permanent external symbols. But then it accelerated, and the numbers of external representational devices now available has altered how humans use their biologically given cognitive resources, what they can know, where that knowledge is stored, and what kinds of codes are needed to decipher what is stored. Both mimetic and linguistic internal representations can now be externally driven, formatted, recombined, and retrieved by means of a tremendous number of new external memory media. In fact, the whole hierarchy of biological retrieval mechanisms and subsystems acquired over the past two million years has gradually been wired into a fast-moving external memory environment, with results that are difficult to predict. One very good reason for re-examining the longer time frame of cognitive change is to achieve a clearer view of one of the most dramatic outcomes of human evolution, namely the modern, fully literate, electronically plugged-in mind.

This can be regarded as a hybrid system that has acquired various "layers" of representational skill over a long evolutionary period (Donald, 1991). It is not easy to develop a clear picture of the modular structure of such a complex cognitive system because of the interconnectedness and interpenetrability of its highest representational levels. When we study literate English-speaking adults living in a technologically advanced society, we are looking at a subtype that is not any more typical of the whole human species, than, say, the members of a hunter-gatherer group. What would our science look like if it had been based on a very different type of culture? The truth is, we don't know, but it would profit us greatly to find out, because the human cognitive system, *down to the level of its internal modular organization*, is affected not only by its genetic inheritance, but also by its own peculiar cultural

history. The idea of culturally imposed cognitive modularity (or quasi-modularity—we don't have to be too rigidly Fodorian here) is not a vague or obscure concept; the existence of one form of this can be seen clearly in the case of reading and dyslexia. Reading can break down in a variety of ways after brain injury, and this suggests that several semi-autonomous brain systems may be involved in reading. Moreover, these systems can break down without the loss of other visual or linguistic functions, suggesting that, to some extent, they are dedicated systems. This implies the existence of specialized subsystems in the brain dedicated largely to reading, and the literature on dyslexia is filled with speculations about the underlying modular structure of these purported subsystems (Morton, 1980; Coltheart, 1985). Usually their putative modular structure is rooted in brain anatomy, whether in a highly localized manner (McCarthy & Warrington, 1990) or in a more distributed, somewhat less localized system (Hinton & Shallice, 1991). These approaches are quite credible on empirical grounds, because there appear to be some neurological regularities in the way literacy skills are represented in the brain.

But no one has seriously proposed that humans could have evolved a specialized reading module in the brain; literacy is far too recent for that to have happened, and besides, members of human groups that have never developed an indigenous writing system can acquire literacy skills in a single generation. This suggests that the brain's reading systems must be "kludges" or culturally jury-rigged arrangements that employ existing neuronal capacities to create the neural complexes that support such an esoteric skill. Above all, neuronal plasticity must be the key to humanity's flexibility in acquiring such radically new cognitive adaptations. Recent work on brain plasticity shows that extensive skill-training can have a major impact on the way the brain allocates its available resources (Merzenich, 1987). Such plasticity would be a prerequisite for cognitive survival in a culture that changes as fast as our own society does. Thus, the way such a recently acquired skill as reading sets itself up in the brain is probably a by-product of neocortical plasticity, amplified by and interacting with the rapidly changing human representational environment (Donald, 1991, chaps. 8, 9).

The plasticity principle applies to a wide range of cognitive subsystems that support not only alphabetic reading, but symbolic literacy in the broader sense. These subsystems are all evident in selective cases of brain injury; together literacy-related functional subsystems of the brain must support several types of lexicons, phoneme-to-grapheme mapping rules, specialized grammars, scanning conventions, novel nonverbal and symbol-based thinking skills, and new classes of semantic content (Donald, 1991; Shallice, 1988; McCarthy & Warrington, 1990). These skills, and the social institutions that support them, form the infrastructure of symbolically literate cultures.

There is also an external infrastructure of symbol-based cultures that takes the form of a variety of external memory devices—writing and counting systems, large artifacts such as books and reports, indexing and classification systems, electronic retrieval and a variety of other symbolic storage devices. Individual minds carry the burden of serving as a link between the external infrastructure of representation, and the real world knowledge that only brains seem (so far) capable of acquiring. But the changing external structure continually imposes new patterning on developing brains

as cultures change. In principle, at least for cognitive changes as massive as the shift to literacy, the modular structure of both mind and brain must have been influenced by culture.

Once granted, this general principle, that culture might directly influence and "install" cognitive architecture (both inside and outside the biologically defined individual), should change the way cognitive scientists do business. We have always assumed that culture affects cognition only in ways that we would consider irrelevant or unimportant—for instance, in determining the particular language or version of history we learn, or in specifying the specific customs, experiences, stereotypes, and attitudes we might acquire. Such cultural variations were regarded as trivial because they have no implications for the basic researcher, who is presumably more interested in cognitive universals. However, the idea that certain major cultural shifts can "invade" the brain and impose major structural change down to the level of fundamental representational architecture, suggests that cognitive fundamentals are not always universals in the biological sense. Some cognitive fundamentals may be largely cultural products, and thus culture cannot be safely ignored by basic researchers in cognitive science. Note that the word "culture" also encompasses our current technological changes in electronic communications media, which are undoubtedly having a major impact on individual cognition—another issue that needs further systematic study by cognitive scientists.

Thus, the externalization of memory, which came quite recently, brought with it new mechanisms of storage that had radically different properties from those of internal biological memory (Donald, 1991). Perhaps even more important, however, were the novel representational and retrieval paths that have been created by various new electronic media. We might gain some control over what is happening if we study the external memory environment and its effect on us. We should do this optimistically, just as we did when we decided to focus on the physical environment; with the hope that things might turn out a little better as a result of our efforts. This should be a priority for the near future. If cognitive scientists do not look into the cognitive implications of current technological change, I cannot imagine who will.

### References

- Barkow, J.H., Cosmides, L. and Tooby, J. 1992. *The Adapted Mind*. New York: Oxford University Press.
- Bickerton, D. 1990. *Language and Species*. Chicago: University of Chicago Press.
- Bradshaw, J. & Rogers, L. 1993. *The Evolution of Lateral Asymmetries, Language, Tool Use and Intellect*. New York: Academic Press.
- Calvin, W. 1990. *The Ascent of Mind*. New York: Bantam.
- Chomsky, N. 1993. *Language and Thought*. Moyer Bell.
- Coltheart, M. 1985. "Right Hemisphere Reading Revisited." *Behavioral and Brain Sciences*, 8, pp. 363–365.
- Corballis, M.C. 1991. *The Lopsided Ape: Evolution of the Generative Mind*. Oxford: Oxford University Press.
- Dennett, D.C. 1991. *Consciousness Explained*. Boston: Little, Brown.
- Donald, M. 1991. *Origins of the Modern Mind*. Cambridge: Harvard University Press.

- Donald, M. 1993a. "What We Were, What We Are Becoming: Cognitive Evolution." *Social Research* 60, pp. 143–170.
- Donald, M. 1993b. "Précis of Origins of the Modern Mind." *Behavioral and Brain Sciences*, 16, pp. 737–748.
- Donald, M. 1993c. "On the Evolution of Representational Capacities." *Behavioral and Brain Sciences*, 16, pp. 775–791.
- Graf, P. and Schacter, D. 1985. "Implicit and Explicit Memory for New Associations in Normal and Amnesic Subjects." *Journal of Experimental Psychology: Learning, Memory and Cognition*, 11, pp. 501–518.
- Greenfield, P. M. 1991. "Language, Tools and the Brain: The Ontogeny and Phylogeny of Hierarchically-Organized Sequential Behavior." *Behavioral and Brain Sciences*, 14, pp. 531–95.
- Hinton, J. and Shallice, T. 1991. "Lesioning an Attractor Network: Investigations of Acquired Dyslexia." *Psychological Review*, 98, pp. 74–95.
- Karmiloff-Smith, A. 1992. *Beyond Modularity*. Cambridge: MIT Press.
- Levelt, W. 1989. *Speaking*. Cambridge: MIT Press.
- Lieberman, P. 1991. *Uniquely Human: The Evolution of Speech, Thought and Selfless Behavior*. Cambridge: Harvard University Press.
- Lumsden, C. and Wilson, E.O. 1983. *Promethean Fire*. Cambridge: Harvard University Press.
- McCarthy, R. and Warrington, E. 1990. *Cognitive Neuropsychology*. New York: Academic Press.
- Merzenich, M.M. 1987. "Dynamic Neocortical Processes and the Origins of Higher Brain Functions," in J.-P. Changeux and M. Konishi (eds.), *The Neural and Molecular Basis of Learning*. New York: Wiley.
- Morton, J. 1980. "The Logogen Model and Orthographic Structure," in U. Frith (ed.), *Cognitive Approaches to Spelling*. New York: Academic Press.
- Nelson, K. 1990. "Event Knowledge and the Development of Language Functions," in J. Miller (ed.), *Research on Child Language Disorders*, pp. 125–41. Boston: Little, Brown.
- Olton, D.S. 1984. "Comparative Analysis of Episodic Memory." *Behavioral and Brain Sciences*, 7, pp. 250–251.
- Pinker, S. and Bloom, P. 1990. "Natural Language and Natural Selection." *Behavioral and Brain Sciences*, 13, pp. 707–784.
- Pinker, S. 1994. *The Language Instinct: How the Mind Creates Language*. New York: Morrow.
- Poizner, H. Klima, E.S., and Bellugi, U. 1987. *What the Hands Reveal about the Brain*. Cambridge: MIT Press.
- Posner, M. and Raichle, M. 1994. *Images of Mind*. New York: Scientific American Library.
- Sacks, O. 1995. *An Anthropologist on Mars*. New York: A. Knopf.
- Savage-Rumbaugh, E.S., Murphy, J. Sevcik, R.A., Braake, K.E., Williams, S. L., and Rumbaugh, D. 1993. *Language Comprehension in Ape and Child. Monographs of the Society for Research in Child Development*.
- Shallice, T. 1988. *From Neuropsychology to Mental Structure*. Cambridge: Cambridge University Press.
- Tomasello, M., Kruger, A.C., and Ratner, H.H. 1993. "Cultural Learning." *Behavioral and Brain Sciences*, 16, pp. 495–552.