Perspectives on Imitation: From Neuroscience to Social Science

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14 Imitation and Mimesis

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14.1 Introduction

The only output of any nervous system is muscle movement. Therefore, the only way a nervous system can publicly display and transmit its perceptions of the world to another nervous system is to translate its perceptions into patterns of muscle movements. A mimetic act is basically a motor performance that reflects the perceived event structure of the world, and its motoric aspect makes its content a public, that is, a potentially cultural, expression.

Archaeological reconstructions of archaic hominid life suggest that the genus *Homo* evolved basic mimetic capacities about two million years ago, with mimetic behaviors appearing in some degree at that time, followed by a very slow cultural accumulation of knowledge. These archaic ancestors of modern humans discovered the uses of fire in opportunistic, single applications, and after hundreds of thousands of years eventually mastered its continual use on a single site. They also became better at the preprocessing of food and the locating of campsites. They improved their hunting of big game, which for a small, naked mammal implies that they had developed significantly better methods of social communication and cooperation. They took tool manufacture to a completely new level.

All this happened very slowly. The extraordinarily slow initial rate of change in hominid cultures makes it extremely unlikely that they had either language or protolanguage. Nevertheless, their capacity for group living and social coordination, as well as the accumulation of knowledge and custom, was so dramatically different from any of their predecessors that there is no alternative to postulating a major change in their communicative abilities very early in human evolution.[1]

1. For a relevant discussion, see Harris and Want (vol. 2, ch. 6). ED.

The most parsimonious hypothesis to explain the cognitive aspects of their survival strategy is a group survival strategy based on mimesis, that is, on nonsymbolic, analog communication skills that permitted better social coordination. Whereas the predecessors of *Homo* had lived a variant of the primate style of social life, the archaic members of genus *Homo* adopted a very different lifestyle that depended heavily on social coordination, shared knowledge, and the transmission of skill. From the start, *Homo* was able to master and refine skills and transmit them, to coordinate group life to some degree around a home base, and to develop a cooperative hunting and foraging strategy. The rudiments of these may conceivably have been present in ancestral primates and australopithecines, but they were suddenly much more in evidence once *Homo* emerged.

Mimesis endures in human life. As anyone who has played charades knows, mimesis is a frustratingly imprecise mode of expression that is based on analogy, association, and resemblance. Mimetic acts consist of continuous flows of action, neither segmented nor digitized (labeled). They are typically organized into events and episodes that resemble the events and episodes they represent. Thus, children may mime their parents having an argument by "playing back" the episode in tones of voice and gesticulations. Effectively, these actions are edited reenactments of the events they represent. The audience recognizes the significance of the reenactment with reference to similar episodes, or by recourse to mimetic imagination (which might be regarded as the true "Cartesian theater" of the human mind), in which the components of episodes are reviewed and recombined into variants of the original episode. A child may never have been beaten, but having seen another child subjected to a beating, it has no difficulty imagining what the experience must be like, and acting out the imagined event. This is a typical product of human mimetic imagination.

The mimetic mode is essentially theatrical and cinematic. It contrasts with the linear, digital, nature of speech and narrative storytelling. In the latter, episodes are never directly reenacted (except perhaps as a supplement to the story). Linguistic representations are not restricted by the rules of perceptual resemblance and thus escape the limitations of episodic representations. At the same time, they lose some of their evocative power. Linguistic representations break episodes into labeled components and recombine them into sentences that allow the speaker a virtual infinity of options in representing the same episode.

The contrasts between mimetic and linguistic representation find a useful metaphor in the recording of sound. A magnetic tape recording of a song is called "analog" when it directly reflects the physical energy it

records, both in time and in space. This means it is a continuous, that is, nonsegmented, recording. While the singer performs, the analog recording tracks the physical energy in the room continuously, without breaking up the signal into labeled components. In contrast, a digital recording of the same song requires that the energy patterns of the song be sliced into discrete temporal chunks whose amplitude and frequency are quantified in numbers. In a digitized recording, every sound sequence is effectively translated into a series of numbers, with time on one axis, and another dimension, such as loudness or pitch, scaled on another axis. The digitizing process fragments the physical energy in the signal, converting a continuous stream of sound into a set of numbers, or symbols, that indicate relative values. Whereas an analog tape recording is completely nonsymbolic, a digitized recording is ultimately symbolic in nature because it uses a set of conventional symbols that encode the measured values of the performance.

In the same way, analog representations that are based on the brain's perception of animate motion (such as the event-enactments that determine the forms of a child's imaginative playacting) do not fragment the input. They "play back" perceived events in action, editing and compressing them without breaking down the sequence into a set of conventional labels. Event-reenactment is perhaps the clearest example of pure mimesis because it is a fairly literal reduplication of a perceived event in animate motion. Other reduplicative motor expressions, such as iconic or metaphoric gesture, or the rehearsal of skill, may be somewhat less literal and more abstract, but they are nevertheless analog in nature.

The most obvious arena of group mimetic cognitive activity is the refinement and ritualization of reciprocal emotional display, whereby one individual "mirrors" the emotional reactions of others. Humans are mimetic actors in this regard, or perhaps they are best seen as mirrors of one another's actions. Styles of group laughter, bullying, and rejection tend to have distinct characteristics in every human cultural group. Custom and ritual are thus basically mimetic and group specific. They rapidly relax into a standard pattern in any social group. Less obvious examples of mimetic cultural interaction are games of fantasy and play, which tend to acquire tribal significance in small groups. Craft and athletic prowess are also mimetic domains, with the creative process, as well as the dissemination of skills, both governed by mimetic capacity. The refinement of such skills is also achieved by mimetic means.

The mimetic behavior patterns that support human social interaction are just out of reach for most primates. Apes have some mimetic skill, but they

are very poor at it. In contrast, mimetic competence is found in human children at an early age, reflecting a uniquely human capacity. As a result of this capacity, the human social world can publicly "model" its perceived universe in patterns of action, creating a virtual world within which more and more cultural interaction takes place. The stream of social mimetic action thus "mimes" the stream of perceived events in the individual members of a given culture. A human child's remarkable ability to playact within the context of its tiny social world allows it to rapidly assimilate the norms, customs, and skills of its culture at a rapid pace. This ability is the driving force underlying much of human social life. The absence of this capacity during development, which is characteristic of autism, can often hinder language development. Moreover, it is always a fatal impediment to successful social development.

14.2 Defining Mimetic Performance

Mimesis is sometimes confused with imitation and mimicry, which are also reduplicative behaviors. Mimesis is an umbrella term that includes imitation and mimicry. The scale of mimetic performance might be clarified in the following way.

Mimicry is the deliberate reduplication in action of a perceived event without careful attention to, or knowledge of, its purpose. The actor's attention is directed to the surface of the action, with varying degrees of success. Some examples are a young bird duplicating the song pattern of its conspecifics, a parrot mimicking speech, or a human mimicking an accent in an unreflective manner.

Imitation is a more flexible, abstract reduplication of an event with closer attention to its purpose. This implies varying degrees of success. It is common to discriminate between accurate means-ends imitation and what Tomasello (1999) calls "emulation," which involves achieving the result or goal of the observed action but not copying the observed means to this result. Primates and young children often emulate, without successfully imitating, an action.

Mimesis is the reduplication of an event for communicative purposes. Mimesis requires that the audience be taken into account. It also demands taking a third-person perspective on the actor's own behavior. Some examples are children's fantasy play, the iconic gestures used in a social context, and the simulation of a "heroic" death during a theatrical performance.

There are no discrete boundaries separating these levels of mimetic action. Rather, they form a scale of successively more abstract or "intelligent" versions of reduplicative action. This is a sliding, rather than a discrete, scale that varies with the depth of cognitive processing required by the kind of action-modeling involved. In the first case, mimicry, the action need only be captured accurately in its superficial aspect. In the second, imitation, the model is more complex; a purpose or goal must be understood, and as a result the performance must be subjected to a more rigorous metacognitive self-evaluation. In the third, mimesis, not only must the purpose of the action be understood, but its various social ramifications and interpretations must also be understood in context.

However, even this set of distinctions does not fully capture the subtleties of the mimetic continuum. In the end, it is really the intention of the actor and the evocativeness of a given performance that define where on the continuum a mimetic action can be placed. The very same physical action might be classified on one occasion as a naïve and literal reduplication (parroting); on another, where the purpose is clearer, as a sophisticated performance in which the purpose of the original act is clearly understood (imitation). And yet, in a third instance, an actor might use exactly the same reduplicated actions in a sophisticated ironic "commentary" on the original action, as, for instance, in a comedy, where someone's eccentricities are exaggerated. The latter is mimesis, not because the action itself is more complex, but because of the high level of social understanding and metacognition that enables its appropriate use.

Mimetic action constitutes a style of representation with different rules from language. It also forms the basis for evolving a basic level of cultural convention. There are four major manifestations of mimetic representation in human culture, each of which has a distinct operational definition: (1) reenactive *mime*, as in the flexible role-playing of children and adults; (2) precise means-end *imitation*, as in learning how to fry an egg or make a stone tool; (3) the systematic rehearsal and refinement of *skill*, where each rehearsal amounts to a reenactment of a previous performance, as in learning to throw a ball, drive a car, or develop a facial expression that elicits sympathy from others; (4) nonlinguistic *gesture*, as in learning how to dance or act in a theatrical production.

In each of these, the actions resemble the events they reenact by the principle of perceptual similarity. In this, mimetic representation can be said to follow an "analog" as opposed to a "symbolic" logic. Mimetic action involves a continuous playback of imagined events, in selective,

edited actions that do not engage any of the characteristic elements of language, such as words or grammars. There are important methodological differences in how mime, imitation, skilled rehearsal, and gesture are measured. Each reflects the specific academic tradition in which it was first studied in detail. However, the underlying cognitive and neural mechanisms of mimetic action seem to overlap. At the top of the mimetic hierarchy there is reason to argue for a common underlying neural adaptation that started evolving in primates and culminated its evolution in human beings.

14.3 Some Properties of the Mimetic System

The ultimate source of mimetic representations is a mental model that is being expressed in action. The model is really a remembered event perception, or episode. The central questions for cognitive neuroscience are first, How are complex event perceptions resolved by the nervous system? and second, How are they mapped onto the motor regions of the brain so as to create an action-model of the episode?

Mimetic action can engage the actor's whole body. It is thus inherently amodal, although it can also play out in single modalities. But most often, mimesis involves the ability to integrate and match actions to perceptions in several sensorimotor channels at the same time. This involves a hypothetical entity that might be called the mimetic controller. This is a brain network that generates implementable motor maps of event perceptions.

In the human brain, mimetic capability has another important feature. It is metacognitive; that is, it is reflective and potentially self-supervisory in its uses. Mimesis is also recombinatory; that is, it is able to generate novel arrangements of a given mimetic action sequence. Thus, mimesis is also potentially creative, capable of generating novel action patterns. Finally, mimesis is imaginative; that is, it involves the active rearrangement of kinematic imagery.

Another key feature of mimesis is the mimetic controller's ability to offload its products to the automatic mode. Although mimetic learning initially requires conscious capacity, highly rehearsed actions can become so automatic that they make minimal demands on conscious capacity. This allows the actor, through repetitive skilled rehearsal, to weld together hierarchies of skills into very complex systems, such as those involved in playing a musical instrument or reading. Such skills are built essentially by imitating one's previous performances, reviewing them in mimetic imagination, and refining the motor model by matching it to a template of ide-

alized action. Elaborate action systems involve installing in the nervous system a new functional architecture that governs each new skill hierarchy; thus, mimetic capacity redeploys the nervous system for novel ends by functional restructuring.

Presumably the so-called "mirror" neuron circuits are involved in mimesis, but the process itself is still not well understood. Mirror neuron circuits are found in large numbers in species, such as monkeys, that are very poor at imitation and gesture. It follows that the mere presence of a mirror neuron system in the brain is not sufficient for the emergence of mimetic skills or even of imitation. Mirror neuron systems, taken alone, lack some of the key cognitive components required for high-level mimetic action. The discovery of these neurons is nevertheless important because they provide investigators with a crucial clue as to where to look next. However, it is important to note that there are several important features of mimetic action that are missing from the paradigms used in our present definition of mirror neurons. First, these paradigms do not seem to provide the wide amodal framework that would be needed to explain the crossmodal flexibility and integrative power of mimesis; this point will be expanded later in this chapter.

Second, it is not clear how the nervous system generates the neural maps that combine and recombine perceptual and motor models on various levels of abstraction in a complex event-perceptual context. Nor is it clear how the brain can implement such mappings in specific motor command channels (for instance, in writing the letter "A" with the foot). Mirror neurons might indicate no more than the presence of powerful correspondence detectors in the motor control system (see Heyes, vol. 1, ch. 6), or they might indicate a more abstract process; only time, and many more experiments, will resolve this issue.

A capacity for mimetic action probably resides in higher-level integrative neural circuits that receive outputs from mirror neuron systems and feed them into a wider cognitive map of the social environment, and vice versa. The location and nature of these mimetic networks are still unknown, but they are almost certainly widely distributed. In many ways, this mimetic process, which binds event-percepts to action-patterns, represents the ultimate achievement of the mammalian nervous system. It can be regarded as a very advanced form of binding in which long, multiframe social events are perceived and remembered as unitary episodes. From the standpoint of information reduction, such percepts are incredibly complex achievements. Events unfold as patterns of physical energy presented in a series of frames, each of which is highly complex in the spatial configuration of the sensory

energies that convey the event to the nervous system. This point will be expanded later.

14.4 The Evolutionary Road to Mimesis

Any evolutionary scenario is based on speculation, but there are not as many degrees of freedom in this regard as some may believe. Hypotheses about human origins must be based on sound axioms and assumptions, and these must take into account our best knowledge about both the nervous system and the mind. The major points of my evolutionary proposal for mimesis (Donald, 1991) are roughly as follows.

14.4.1 The Nonsymbolic Nature of Nervous Systems

Based on present evidence, we must assume that the mammalian nervous system (including the human central nervous system) is basically a nonsymbolic system, that is, similar in principle but much more complex and powerful than artificial neural nets. The latter are analog (as opposed to digital) in their internal modes of computation (this holds even when they are simulated on digital computers). Simulated neural nets function on the principle of impression-formation, without explicit symbolic programming. Living nervous systems seem to function along similar lines, and although they are much more powerful, there is no evidence for their having innate quasi-symbolic programming, and they do not seem to be born with explicit "operating systems" programmed into them. The human nervous system undoubtedly has complex innate architectures, especially in the sensory and motor regions, and innate capacities, but its modes of operation do not seem to be even quasi-symbolic. Rather, the brain is filled with many parallel analog impression-forming networks, each of which has a high degree of redundancy in design.

14.4.2 Emergence of Symbols

Language and all forms of symbol-mediated thought came very late in human evolution, and were preceded by earlier cognitive changes that set the stage for the evolution of symbolic processing. There is no reason to abandon the analog principle in constructing theories of language evolution. Symbols emerged from interacting groups of analog brains. They did not originate in the brain, but rather in distributed networks of brains wired for analog communication. Symbols thus have their origin in social interaction, even in modern humans. As Saussure observed long ago, languages emerge in the spaces between brains. Language, even in its most rudimentary

forms, has never developed in an isolated human brain, and fully developed languages are always the product of group communicative interactions.

Languages and symbols can thus be regarded as the cultural products of interconnected cognitive systems. They exist at the level of the ecosystem, or "cognitive ecology," within which human beings exist, and the ecology always encompasses a population of brains rather than a single brain. We do not have to assume that single brains must have evolved all the necessary equipment to generate languages. They had only to evolve capacities that enabled the network to achieve this. Cognitive-cultural networks generated languages, and the first question to address is, What features of the brain allowed such networks to emerge in the first place? When juxtaposed with the first, this assumption imposes a strict discipline on any theory of the roots of language because the starting point must be a primate brain whose sole operating mode is something like the analog logic of neural net computation.

14.4.3 Need for Plasticity

The human brain evolved capacities that prepare it for the unpredictable nature of human culture. Our cultural environment is extremely variable, to a degree that has no parallel in any other species. Therefore the genome cannot "assume" very much about the specifics of its cultural adaptation. The hominid strategy was to build a more flexible brain. Cultures and languages must be assimilated easily by infants during development. Therefore the child's brain must be extremely plastic to optimize its adaptation to the unpredictable cultural environment. Given the importance of plasticity for adaptation to complex cultures, neurocognitive plasticity itself would have come under selection pressure during human evolution.

14.4.4 Zone of Proximal Evolution

Archaic hominid culture was shaped by its primate roots and had to fall within the primate "zone of proximal evolution" (Donald, 2001). This archaic adaptation determined a great deal about how language and symbolic thought emerged in the human species. The assumed generative sequence by which language evolved from mimetic skill was as follows. First, a form of protolanguage (perhaps one- and two-word utterances without complex grammars or inflectional rules) emerged in a simple cultural network, primarily to disambiguate mimetic gesticulations, which are inherently imprecise. This was achieved by negotiation, and the founding group agreed on a conventional mapping system that fixed the relationship between meaning and gesture.

The advantages of the vocal channel as a communication device have been discussed many times (see Donald, 1991, 2001) and will not be covered here. In the case of speech, a set of standard articulatory gestures emerged, not necessarily in an entirely vocal context. This rudimentary vocal-gestural system was disseminated selectively to those equipped to learn it, and these individuals had a fitness gain, putting selection pressure on the attentional, learning, and memory capacities needed to adapt to the changing linguistic demands of late hominid cultures. Since the properties of any specific human culture are indeterminate and highly unpredictable, this generated even more selection pressure in favor of increased plasticity.

14.4.5 Culture First

Most theories of cultural evolution have assumed that language must have been the catalyst for human culture. These are known as "language-first" theories, and they tend to place research emphasis on finding the specialized "language devices" of the brain. But this misses the point. Where could language have come from in the first place, if no symbolic system already existed? I have suggested a reversal of this conventional order (Donald, 1991, 1993), in a "culture-first" theory that places language second, not first, in cognitive evolution, and that scaffolds language on a series of mimetic cultural adaptations. A shared communicative culture, with sharing of mental representations to some degree, must have come first, before language, creating a social environment in which language would have been useful and adaptive. There is good reason to believe that such a culture was mimetic in its mode of representation. It would have provided the rudimentary gestural skills that allowed archaic hominids to share knowledge and memory in a limited way, and a physiological basis for evolving a rudimentary morphophonology. The adaptive value of improved mimetic skill is obvious. Hominids so equipped would have become better able to master skills, to develop a powerful system of social cognition, to perform coordinated work, and to express themselves in a nonverbal manner, long before the complex phenomenon we know as language came along, with its lexicons, grammars, and high-speed communicative capacity.

14.4.6 Mimetic Preadaptation

The suite of adaptations that made possible the development of a mimetic communicative culture was expressive in nature and primarily produced by changes in the motor systems of the brain, especially the more abstract aspects of motor control. Only motor outputs can create public displays

of knowledge; that is, only action can move ideas out of the brain, into a public communicative space. Thus the first leap toward a distinctive hominid culture had to be a motoric one. Cultural expression took the form of whole-body action, incorporating facial expression, voice, attitude, posture, and movement. This led to a rudimentary expressive repertoire, enshrined in body language, custom, habit, group gesticulation, and ritual. This was and still is the basis of human "mimetic" culture, the first form of culture in which mental representations were truly shared, albeit in a vague and imprecise manner. This explains why human language remains amodal in its organization and can be expressed in a variety of modalities, unlike birdsong, which is restricted to the vocal channel.

14.4.7 Mimesis as a Social Adaptation

The evolution of imitation was embedded in a larger pattern of social and communicative evolution, rather than evolving along its own path. Under archaic hominid cultural conditions, imitation in various domains would have become a crucial survival skill in social life. The existing primate capacity for crude imitation, or emulation, was undoubtedly one of the starting points for this evolutionary change. But, judging from the uses of mimesis in modern human social life, it was not the only component that led to the evolution of mimetic skills. Mimesis is highly social. Its adaptive significance depends upon such phenomena as empathy, sympathy, social identification, role-playing, imagination (especially kinematic imagination), gesture, and mind reading, or the ability to track other minds and share attention with them. All these capacities are either present in primates in a limited degree or are well within the primate zone of proximal evolution. They would have evolved together, as a suite.

14.4.8 Persistence of Mimesis

The human mind and its cultures are still basically mimetic in their mode of organization. The earliest human cultures, and the sophisticated symbolic skills that came much later with language, retained a deep connection with primate cognition and culture. Despite the immense historical overlay of human enculturation that was imposed on an increasingly plastic brain, our minds are still basically primate on the deepest level of their operation. This has a social corollary. If mimesis was the adaptation that generated a distinctly human culture, it follows that the deepest communicative framework of human culture must still be mimetic. This follows from the scaffolding principle that applies in human cognitive development. New capacities are always scaffolded on existing ones. On this principle,

language was scaffolded on mimesis. Thus, mimetic rules of representation, based on perceptual resemblances and metaphors, continue to operate below the cognitive surface, obscured perhaps by the more spectacular human abilities that have succeeded them, but nevertheless indispensable. They continue to affect the way we use languages and symbols. Moreover, if we are to maintain continuity in our evolutionary accounts, this also implies that all distinctly hominid cognitive traits, including our highest symbolic processes, such as analytical thought and the semantics of language, are ultimately scaffolded on mimesis.

14.4.9 Language as a Network-Level Phenomenon

Human brains have evolved and are designed specifically to live in communities of minds. Mimetic skill was the cognitive foundation skill for our most distinctive human trait, the tendency to hook up, create, and live in, communities of minds. These communities are still dependent on a strong mimetic foundation for their stability. This idea has a major advantage for the continuity theorist. It establishes a platform on which the evolution of full-fledged language becomes feasible in a truly Darwinian sense (Donald, 1999). Language is a network-level phenomenon, and evolved more like an ecosystem than a single organism, as the negotiated product of interactions taking place in an established cognitive community.

The implications of this idea for brain research are profound. Cognitive neuroscientists are unlikely to find an innate language acquisition device, and should redirect their investigations toward the powerful analog processing systems out of which language can emerge in group interactions. Instead of looking for specific language genes, or dedicated grammar regions, we should be turning our attention to basic presymbolic capacities that create and stabilize the social networks within which languages and symbol systems are negotiated and disseminated. We should also be studying the executive brain systems that govern social learning and enable the brain to import language effortlessly from the social environment. These include such things as a much wider working memory system, multichannel attention, and the capacity to keep several cognitive and behavioral systems active at the same time.

14.5 The Cognitive Starting Point for Mimetic Representation: Event Perception

Before the vertebrate brain could be expected to create pantomimes and reenactments of perceived events, it had to have the ability to perceive

those events in the first place. This was no small evolutionary achievement. Event perception emerged in evolution very long ago, probably in reptiles, and possibly in some insects. Some existing species of reptiles, and most mammals and birds, are quite good at perceiving social events that are important to them. This includes such complex events as mating rituals, aggression displays, and hunting patterns. These patterns are highly variable and complex in social mammals, whereas they tend to be fairly fixed and simpler in nonmammalian species.

In social mammals, life is remembered and experienced as a series of events. This is evident in the ethological literature, where events may be regarded as the basic units of experience. Thus a dog tends to remember the specific details of such things as fights, rivalries, displays of aggression, attempts at mating, and patterns of socialization. In the memory system, this plays out as a time-marked series of events bound into discrete episodes. To the participants, the visual memory of a fight is arbitrarily broken up into a series of discrete frames, each of which has an internal event structure, whereas in real time, the action is continuous. The visual image is also interpreted in terms of other crucial information conveyed by other channels, such as sound, taste, smell, pain, balance, muscles, joints, tendons, and the sense of gravity. When all of these are taken into account, the event can be seen as a very complex pattern-recognition problem that requires large-scale amodal integration over time.

Amodal integration of complex social events is a fairly common capacity in mammals, and it is never a question of simply perceiving them, but also of selectively remembering them. Even though they are not cleanly separated from the events that precede and follow them, complex social events are parsed within the animal's stream of experience and remembered as discrete entities organized in terms of their social significance. In the case of a dogfight, the event is remembered by each protagonist as an encounter with a specific dog, in a specific place and time, with a specific outcome that affects all future interactions between them, and possibly with third-party observers as well.

The immense theoretical challenge such complex perceptions present becomes clearer when one considers the current precarious state of neural binding theory. We have enough difficulty explaining how the nervous system might bind color to form in shaping the static image of an object, or how the pattern of optical flow might relate to the control of locomotion. However, the perception of social events involves multiframe integration, that is, integration across time as well as modality. Such perceptions also involve instantaneous integration of inputs from several sensory

modalities. Understanding an event as complex as a dogfight, from the viewpoint of either competitor, requires the integration of concurrent asynchronous inputs from vision, audition, olfaction, taste, and pain receptors, not to mention a number of internal channels conveying body sensations. The asynchrony in particular is difficult to explain, and large-scale neural integration on this scale is well beyond the explanatory power of any current version of binding theory. Yet it is commonplace among all higher vertebrates.

Incoming sensory channels are never perfectly synchronized in such events. What a dog sees may or may not coincide with what it hears or feels, and this is not a trivial problem. For such a complex event to be encoded by the brain as a unified episode, the brain must have computational powers that we cannot yet model with any degree of accuracy. We are only beginning to understand the computational challenges underlying the resolution of animate motion, and social events such as competitive mating or resolving conflict involve many simultaneous sources of animate motion acting in complex scenarios. Yet all mammalian species, and many species of birds and reptiles, seem able to perceive social events as a matter of routine.

Moreover, these event perceptions are almost never remembered as isolated events. They are batched into "episodes." One of the major problems in batching events is locating the boundaries of each event. The temporal boundaries of such episodes are rarely fixed or predictable, and their internal temporal and spatial structure is rarely constant across episodes. However, the boundaries of the event are crucial to its accurate storage in memory, and the brain must establish its beginning and termination time, as well as its relevance to the larger social scenarios that are under way. For instance, a dogfight might have long-term implications for the dominance hierarchy in a canine society, as well as a dog's relationships with every other dog in the pack. This must be realized immediately or there will be fatal consequences. Remarkably, these tremendous interpretative challenges are met routinely. The boundaries of the events are perceived instantly and clearly, and incidents preceding or following an event are rarely confused with the event itself.

Largely depending on its emotional valence and outcome, an event may or may not be stored in memory as an episode. The episode is the "atom" of experience for most social mammals. A social life is lived, and remembered, in terms of episodes. And despite the complex structure of episodes, many species with small brains can perform this kind of experiential sorting of the remembered past. They batch past events into small packets of

experience, noticing and recording specific features of social events for future use.

This capacity plays out in social organization, generating hierarchies of social relationships that some ethologists compare to human culture. "Episodic" cultures based on a set of episode-by-episode reactions and interactions are often quite complex. The cultures of many social mammalian species, including especially canines and primates, reflect their ability to resolve social events (such as grooming episodes and changing alliances) accurately in memory. These remembered episodes form the basis of social life and are predictive of future social behavior.

Such animal societies are episodic in nature because despite the high resolving power of their social event perceptions, they live largely in the concrete present and are usually very poor at communicating with one another except through species-universal, stereotyped signals. This leaves most knowledge locked into the individual brain. Individual animals cannot convert their social perceptions into expressions that can capture and transfer specific information. They also lack voluntary recall from memory. Thus, they depend on the immediate environment to trigger memories of past episodes. While such species are often very good perceivers of social events in the moment, and can understand shifting alliances and changing hierarchies of dominance, they are poor at representing events.

This seems to be primarily due to a failure of action, not of perception. They know, but cannot express. This prevents the creation of transmissible social knowledge networks, even simple networks of very low fidelity. Judging from the archaeological record, such powers emerged only with archaic hominids, who were the first species to leave behind archaeological evidence of a cooperative, group-oriented cognitive strategy in which skills and knowledge could be accumulated and transmitted over many generations. Mimesis was the vehicle for this, the product of a change in the structure of motor control by which the primate apparatus of event perception was merged with the most abstract regions of the motor brain.

14.6 Conclusion

Imitation is a large subject, and yet from an evolutionary standpoint, perhaps it is not large enough to explain its own evolution. Broadly speaking, imitation is the deliberate copying, or reduplication, of behavior, especially the behavior of others, with an understanding of their intent. However, accurate reduplication is not necessarily a useful or adaptive trait. Evolution is driven by the conditions of life in specific ecologies, and function is

an all-important consideration in the emergence of any new capacity in a species. Why would a species have evolved a capacity for the accurate reduplication of another's behavior? What vital function would it serve for the species, and how would it enhance the reproductive fitness of individuals with such traits?

Accurate imitation is so highly developed in humans that it stands out as one of the defining characteristics of the human mind. Mimesis is a coherent social adaptation, and it makes sense in terms of an all-encompassing survival strategy for archaic hominids in the ecology in which they evolved. It also makes sense in terms of its vestiges in modern human life. According to the principle of conservation of gains, evolved traits tend to endure, provided that they still serve well in their niche. Mimesis endures in human life; language did not negate its value. Language came later and made mimetic communication far more exact. However, the evolution of mimetic cognition and culture before language is probably the best explanation for the underlying metaphoric "style" that governs both language and thought (Lakoff & Johnson, 1980; Fauconnier & Turner, 2002).

Mimesis is a more inclusive notion than imitation and speaks to the creative or generative aspect of human culture. It encompasses many forms of analog communication, skill, and social coordination, as well as accurate means-ends imitation. This does not necessarily imply that imitation, gesture, mime, and skill are all direct products of a novel hominid "mimetic module," or that all these capacities should emanate from the same brain regions. On the contrary, mimesis is complex and interconnected with many brain systems. Radical evolutionary adaptations, especially those that lead to new species, tend to occur simultaneously on many fronts and usually involve an entire "suite" of traits, including many aspects of anatomy and function. This was surely true of archaic hominids. They evolved on many fronts, including gross anatomy, cranial morphology, facial expression, posture and locomotion, body hair, heat dissipation, diet, energy distribution, and so on. The evolution of the brain also reflected this pattern. As hominids evolved, the primate brain changed in both size and connectivity on many concurrently changing fronts.

The cognitive aspects of hominid evolution were not independent of these physical changes, nor could they have occurred in a vacuum. Imitation and mimesis were products of complex evolutionary changes in both the brain and society, and it would be unrealistic to expect that these traits are highly developed in humans because of a straightforward change in brain anatomy or cognitive organization. These capacities emerged gradually out of a basically primate brain design, in an evolving cultural-

cognitive network, and they occurred very high in the system. The most credible way to model such systems is to understand that any changes on this level took place within a larger functional context and were mostly focused on nonmodular, supramodal, and domain-general capacities of maximum flexibility.

It is doubtful whether our exceptional capacity for means-ends imitation is dissociable from mimesis in human evolution. Given the interconnectedness of communication and skill, the unique human capacity for accurate imitation must have evolved as an aspect of a wider adaptation for mimetic communication. The strongest evidence for this is that in primates the uses of emulation and imitation seem to be tied to emotionality and socialization, not just to toolmaking and problem solving. Where imitative capacity occurs in mammals, even in rudimentary form, it usually does so in the most social species. It shares some properties with social-cognitive phenomena such as emotional contagion, empathy, shared attention, and the rapid communication of group emotional reactions, such as panic or alarm. The common group dynamic is the spread of behavioral patterns through the group.

Mean-ends imitation is an effective mechanism for the transmission of simple skills. It can also account for the replication of local traditions and customs, to a degree. However, in its conventional definition it cannot account for the creativity or genesis of human culture, especially in its representational aspects. Yet there is reason to link the evolution of imitation with the emergence of gesture, mime, and skill. Human beings have a creative capacity that manifests itself in group cognition and that generates shared representational cultures. This includes body language, reciprocal emotional displays, and specific skill sets, such as athletic skills. These are all highly variable across cultures. The word "mimesis" captures this wider urge to generate culture, whereas the word "imitation" connotes the replication and transmission of existing patterns, not the creation of new ones, and leaves out the social dimension captured by gesture and role-playing. Mimesis places more emphasis on the expressive and social aspects of action and less on the accurate reproduction of means and ends, but it includes the latter.

Art and ritual are two of the continuing manifestations of mimesis in human society. Even in its daily uses, the human process of mimetic representation can come very close to art. In fact, this use of the term "mimesis" comes close to Eric Auerbach's use of the same term in the context of literary representation; this is no coincidence, since language has deep mimetic roots. All human beings represent reality through mimetic means,

and language is scaffolded on mimesis in a child's development (Nelson, 1996). We are mimetic creatures. We identify mimetically with our tribal group and have an irresistible tendency to conform to its norms. Conformity, on all levels of overt behavior, is one of our signature traits, conferred by a universal mimetic tendency. We conform not only to the immediate patterns of our social group but also to the internalized ideals and archetypes of that group. And those archetypes shape the roles we tend to play during life, as actors in our own dramatic productions.[2]

2. See comments on this chapter by Christiansen (vol. 2, ch. 19.8, p. 391) and by Blackmore (vol. 2, ch. 19.9, p. 396). ED.