Chapter 9
Human Group Identity: Language and a Social Mind

As presented in the last chapter, primates showed a significant shift in the mechanisms by which they attain group identity. Following the great HERV genome colonization, primates were no longer dependent on olfaction and MHC composition (as are all other mammals) for group recognition, but developed a strong dependence on visual information, especially facial and gesture recognition. This required significant brain developments to process visual information for social purposes. In humans, the HERV colonization has continued and possibly accelerated relative to other primates. Humans retain the primate's heavy dependence of vision (facial/emotional) for social purposes, and have further adapted the ancient link between the olfactory lobe to the amygdala, for visual-based emotional memory (especially fear) which is stored in the hippocampus. A vision-based system of group identity required adaptations in systems of emotional memories. It also required the development of additional social and emotional addiction states for extended social bonding. Using this vision-based system, primates initially extended the duration of the mother–infant bonds and also extended other social (troupe) bonds and structures. The human mother–offspring bond retains the strong ancestral primate visual sensory character, but further extends the stability and duration of the mother–infant bond. The use of song and voice assisted the extension of the maternal bond. The facial and gesture emotional recognition which was attained by the evolution of dedicated and specific brain structures had an inherently rapid, sparse and symbolic capacity. These brain structures (including mirror neurons) not only convey emotional content but also provide visual-based emotional group links between individuals. The maternal bond provided the basis for this development but conserved the prolactin, oxytocin, vasopressin and the opioid system to control and bind empathic/aggressive emotions. Humans, however, have a major distinction withal other primate social structures, in that humans evolved a paternal role in offspring bonding and a serial bonding between mates. Thus, human fathers became involved from infancy with their offspring and also form strong emotional bonds to their mates. The mechanisms of such bonding appears similar to the maternal–offspring bond (i.e., visual and prolactin), resulting in various forms of love (emotional addiction). Also in contrast to all other primates, humans have developed an

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evolutionary novel form of group (social) identity that involved recursive language as an audio-based social bond. Vocal learning also required a considerably expanded brain capacity, especially in the neocortex, as well as brain lateralization and a necessary link to emotional systems and memory. HERV colonization and involvement in this new system of group identity seems likely. This created the large social brain of humans, one that literally connects to other minds via emotions and uses both sight and sound (with mirror neurons). It is likely that the use of song in mother–infant bonding was the basal system of vocal emotional bonding and vocal control of infants. A more temporally variable sound pattern as in song and later the use of a recursive language, however, allowed human populations to rapidly evolve their own diverse versions of group identity based on learning and essentially liberated the evolution of human social structures from dependence on genetic colonization events. Learning of language, however, retains the essential features of a group identity system. The greater brain lateralization that was involved also allowed left/right specialization in major cognitive processing tasks associated with social membership (visual and sound based). However, language also provided a much more symbolic version of group identity and promoted the emergence of ideas and abstractions. This development marked a major shift in the evolution of social identity systems. No longer dependent on variable biological characteristics of individuals (i.e., MHC makeup), the symbolic meaning of language became a major system for defining group identity. Our large social brains (which promoted a social consciousness or social mind) essentially evolved to acquire (learn) language and became a host for 'language colonization' that also transformed brain architecture and further promoted abstract pattern recognition. Thus language, rather than genetic parasites, became the primary transmissible information system that colonized host (social brains) and provided the host with diverse and competing group identity. With this, the stability of language (its meaning) became of central importance to maintain group identity. 'Meaning stability' is the foundation of 'belief states', and this required specific neural substrates to retain belief memory. Thus the emergence of a language-based group identity inherently led to the emergence of 'belief states' as designators of social identity and corresponding evolution of the needed brain structures. Social identity remains mainly a language-mediated learned state. And beliefs have assumed a much expanded role in human social identity, as beliefs provide emotional bonds to populations. However, like all group identity systems, language and belief states still required emotionally powerful addiction modules to maintain identity. Since this identity is learned, it must also resist (sometimes violently) subsequent learning to prevent identity displacement. Thus 'learning resistance' or 'cognitive immunity' becomes a core feature of belief states. The emergence of belief as an identity system was much enhanced by the emergence of writing which greatly stabilized and extended religious belief and meaning. This also expanded the reach of social membership to allow broader populations (including nations) to link into large, connected social minds with common social bonds (via belief in cultural ideas,

political and religious leaders). However, the emergence of phonetic writing also greatly promoted brain restructuring, the expansion of vocabulary and the emergence of an internal voice of self-conscious reflection. From this quickly emerged the foundations for the individual-based, critical mind and a modern form of consciousness. Such a consciousness tends to acquire belief by distinct 'asocial' criteria, often based on evidence. Individual self-consciousness thus is a recent state to emerge, but depends on formal schooling (such as reading) to promote more abstract thinking. Such a process of belief acquisition has historically often generated conflict with social belief states and elicited anti-social reactions. However, since belief defined all prior social structures, scientific thinking has often been confused as another 'belief-based' identity system, although it is clearly not a social identity system. Science education should seek to clarify this distinction and educate people away from ancestral belief-based reasoning when it is used a force for unreason or the promotion of social conflicts.

The Shift to a Human Social Mind from a Chimpanzee Mind

A main evolutionary development in humans relative to chimpanzees is the much larger human brain which provided enhanced social capacity (hence social membership). Recent evaluations of the mental abilities of a pre-literate (2.5-year-old) human child relative to that of a chimpanzee or orangutan clearly establish that the humans are not superior in most mental activities (spatial, causal, quantitative), but were clearly better at social learning (by observing actions of others). The humans were also superior at 'theory of mind' tests. Thus humans seem to be 'ultra-social' in that their social intelligence, not general intelligence, seems to define the major difference between these species. Human social intelligence involves both learning from others as well as being able to infer what others believe or desire (theory of mind). This function develops after the first few years of life and involves characteristics such as seeing the eye gaze of others to know what they know. This is likely associated with the evolution of human-specific white eyes which aid in gaze identity, suggesting intense selective pressures. Such a gaze facility appears absent from cooperating chimps, although competing chimps may employ it. Curiously, domesticated dogs (but not wolves) seem better at following human gaze than do chimpanzees, suggesting that dogs were subjected to intense selection for such human social interaction. Human and chimp minds thus seem to differ in self-perception and envisioning mental abstraction of others (a clear social function). In keeping with this, chimps are unable to learn intentions via sign language, something human infants are inherently prone to do. Chimps learn words that are mainly sensory in character, but appear unable to learn metaphors. In this we see what appears to be another major distinction between chimpanzee and human minds. Chimpanzees can represent what they perceive,

but humans can represent what they imagine (from unreal sensory or cognitive source). As described below, metaphors also require abstraction and are major elements of all human languages. This crucial distinction thus appears fundamental to human social intelligence. What forces in evolution might have favored such a mind shift? Why would imagination, inferring others' thoughts and abstraction, be subjected to intense selection during the evolution of our large social brain? Imagination can be considered as a synthetic (non-sensory) or altered (misremembered) memory. Both humans and chimpanzees have excellent memory for faces, which also serves core social functions for both species. Imagination seems unrelated to this. Imagination can be used in group hunting, but, as described below, chimpanzees are good at this. Humans can inherently infer what others might be thinking and this will often have few visible cues, thus requiring imagination. But how could this be under intense selection for group identity? Humans also have excellent memory for voices and word sets of language. Such memory requires the capacity to store temporal streams of sensory input, so that it can be recalled later from non-sensory (internal visions of faces or voices) as sources for recognition. Single neuron recordings indicate face recognition and gestures are indeed encoded in highly specific brain structures. But these are found in both humans and primates. Therefore excellent visual memory provides an enhanced capacity for comparison and recognition of sensory visual input to internal sources but is present in most primates. The human mind also appears to have an inherent capacity for recalling synthetic voices and visions which can also be elicited by dreams, hypnosis or disease (schizophrenia). These can all be considered as imagined. However, what forces might select for a mind that could provide such altered or synthetic memories? One correlation is the emergence of human language which could be relevant. Humans are the only species that evolved vocal (auditory) communication which uses syntax (recursive language). In order for syntax to convey meaning, the word with in a word pattern (not just the word itself) determines meaning. Meaning itself becomes conditional on temporal sequence and the relative placement of a word. A recursive language therefore requires multiple meaning, or abstraction, hence imagination, for any specific sound (word) to have meaning. Imagination could thus be a byproduct of this development. Perhaps the proper question that needs to be considered is what selective pressure led to the emergence of recursive language in humans. As discussed below, the issues of meaning and group identity can be directly linked when verbal information is used for specifying group identification. The basal question might then be not about imagination but how the evolution of extended social structures can explain the evolution of an ultra-social brain and why abstract and recursive language was needed? What was the initial social purpose of syntax and why would any social structure need it? The answer I suggest is that early human social groups needed to differentiate themselves from each other, beyond the visual systems used by other primates. Direct human ancestors additionally used vocal-based differentiation (protolanguage/song) as an early human group adaptation (such as in maternal/paternal

bonding). Learning, however, often occurs via mimicry, and mimicry still appears to be an inherent process for initial learning of language (i.e., infants fists ma-ma, pa-pa). A vocal stream in which identity was not syntax dependent, however, is susceptible to copying by mimicry and social parasites or competitors. But mimicry could not reproduce proper syntax in which meaning depends on source. However, the use of syntax for meaning would make audio language-based identity or communication immune to copy or transmission by only mimicry. Thus syntax could provide an audio-based social identity that was differentiated from simpler systems based on position-invariant word meaning. A mind capable of abstraction would be needed for such syntax-based social identity.

The adaptation of recursive language for social membership is the thus major distinguishing development of human evolution that relates directly to our large social brain and our ability to infer what others think. Understanding the origin and consequences of this social adaptation is the main focus of this chapter. For language to mediate group membership requires that it also engages emotional systems and emotional memory to set social bonds. Language indeed has symbolic and strong emotional content (as does vision). Charged words, such as metaphors, elicit many emotions, even abstract ones. Posture also clearly has emotional content. The clarity of human gestures and expressions appears to be a cultural universal as seen in dance. When we observe others move, even abstract movements, the observers (a social set) experience common emotions. Thus our social brain uses both vision and recursive language to socially connect emotions of individuals. However, defects in the social brain can result in aberrant, sometimes enhanced, mental capacities. For example, some autistic people can demonstrate an incredible retention of factual detail, relative to most people (popularized in the movie Rainman). These people will often otherwise lack some of the most basic social skills and fail understand metaphors obvious to many children.

The ability to imagine, or originate alternate meaning and communicate abstractions has had many deep consequences for human cognition and culture. Although a capacity for recursive language may have been needed to initially promote abstract thinking, this has led to a positive feedback loop in that abstract thinking has very much expanded language, restructured brains and further enhanced abstract thinking. A much expanded capacity for abstraction and imagination thus developed which can now provide scenarios and concepts that cannot be observed or experienced by sensory systems, only by our mind. Let us now trace the specific steps in evolution that led to this.

Large Social Brains and the Great Viral Invasion

Morphologically modern humans are only about 150,000 years old. If we consider the types of genetic evolutionary events that might have happened during such a relatively short period of evolution, we are struck by the difficulty

to explain these dramatic changes based on gene makeup. There are relatively few genes that distinguish humans from the chimpanzees, for example. Indels (insertion/deletion) in non-coding regions clearly account for the majority of differences between these genomes. Comparisons between their sequenced DNA indicate that they have relatively few ORF differences but have about 400,000 indel differences, the bulk of which correspond to LTR element differences that average about 300 bp in length. As suggested in the prior chapters, such genetic perturbations could easily affect gene regulation of many genes, in possibly coordinated ways (including transcription and post-transcription via RNAi). Thus dramatic changes in human function could be the result of wide-scale regulatory adaptations mediated by these and other genetic parasites. At a cytogenetic level, we previously noted the distinct C-bands found on chimpanzee but not human chromosomes. We know these regions are composed of highly repeated sequence elements, including HERV W and HERV-FRD (needed for placental function). We also know that some HERVs found in the human genome are much more recent than the time since chimpanzee divergence, and date to about 150,000 ybp. Thus HERV colonizations match the recent changes during human evolution. Since such elements are also highly represented in the Y chromosomes, and Y chromosomes between human and chimpanzee are distinct, these may also serve as marker of the most recent genetic changes and evolution specific to humans. Y chromosomes are indeed especially colonized by ERVs. Human evolution is now accepted to have been out of Africa, into Asia, then possibly returning to Africa to initiate modern humans. This view can be suggested based on the Y chromosome phylogenetics, which roots to Africa. It is interesting that India has highest diversity of Y chromosome haplotypes (12 of 18 total), relative to Africa (2–4). Although it would be highly informative to know the Y chromosome composition in other hominid lineages, only data from *Homo sapiens* is known. Neanderthals are dated to have become extinct about 40,000 ybp. Neanderthals thus appear to have overlapped with *Homo sapiens* for about 28,000 years. mtDNA evolution can be followed by using a distinct 344 bp D-loop method. Using such analysis, it does not seem that human and Neanderthal genomes were sexually mixed. Thus the two lineages seem to represent distinct species. Although we know little about how ERV DNAs might differ between *Homo sapiens* and Neanderthals, some things can be expected. In all mammals, ERV makeup provides clear (diagnostic) differences between related species. So in Neanderthals we would also expect distinct and recent ERV composition. Neanderthals also had large brains (slightly bigger brain than humans), suggesting a large social brain involvement is their group interactions. As noted below, *Homo sapiens* children undergo much brain growth and development after birth, and some of this development is crucial for our more advanced social features (such as language development, self-awareness and theory of mind). At about age 4, humans develop theory of mind and start to reason about the causes of other peoples behavior. In this social brain development, it appears that Neanderthals were more like chimpanzees in that the majority of infant brain development was

completed by age 4. The inference is that the brain-based social functions that develop later in *Homo sapiens* children (e.g., theory of mind) did not occur in Neanderthals (or chimpanzees). Although we do not currently know the genetic mechanisms that expanded the human brain (especially the neocortex), we can guess that indel-mediated regulatory changes, not gene acquisitions, would be more likely to account for the numerous alterations. The human neocortex expresses more complex RNA sequences than any other organ, so clearly it underwent large-scale regulatory changes. Neanderthal brain would likely be similar (with hypertrophic cortex invasive of basal brain structures) and their increased brain size also suggests they had a large social brain. Various HERVs are known to be expressed in human cortex, but not in brains of other primates, including HERV-E, HERV-F ERV-9 and various HERV K members, although there seems to be some individual-based variation in these expression patterns. In the last chapter, I emphasized the significant shifts that occurred in primate genomes regarding HERV Ks as well as significant shifts in relationships to exogenous retroviruses (SIV and foamy virus). Since HERV K can also conserve dUTPase genes (see Fig. 8.6) and since dUTPase can be considered as an antiviral activity, its conservation in the human genome is most interesting. As viruses can potentially provide rapid and wide-scale shifts in molecular genetic regulation, it is reasonable to hypothesize that ERV and associated hyperparasites (LINEs, alus) could promote the wide-scale regulatory changes needed for rapid human brain evolution. It is thus intriguing that the most recently acquired of these HERVs (HERV K10 (HML2)) has also been shown to be significantly overexpressed (including env sequence) in prefrontal cortex in both bipolar disorder and schizophrenia relative to samples from healthy brains. Similar ERV overexpression in this mental disease was not seen with HERV W, HERV-FRD envs. Interestingly, some antipsychotic medications (haloperidol and clozapine) inhibit retroviruses in vitro. Schizophrenia is a complex and poorly understood neuropsychiatric disorder (discussed below), but one is closely associated with evolution of human language acquisition and human social intelligence. Thus viral footprints associated with this disease are intriguing.

The evolution of a large social human brain presents many dilemmas for evolutionary biology if looked at from a perspective of organ efficiency. For one, our big social brains are metabolically very costly. The human brain is 2% of total body weight, but uses 20% of total body energy; 60–80% of this energy is consumed for communication between neurons that do not appear to be doing much to support physical activity (as they are active during sleep). Human infants, with their disproportionately larger heads and brains, are even costlier metabolically speaking, plus their large heads radiate much heat, making young brains especially costly organs to feed and maintain. This high metabolism is continuous regardless of mental activity, thus big brains make humans prone to starvation. Why is the large social brain so active and costly? The human brain also has relatively disproportionately high level of connections in the visual cortex. Thus our brain is never at rest, even during sleep, and

activity does not depend much on perception. In addition to being metabolically costly, an infant human has a functionally undeveloped brain and is the most helpless of all mammals. Aside from defecating, human infants have no preset knowledge or physical capacity. They cannot walk, crawl or even lift their head. And relative to a chimpanzee, they are significantly more incapacitated in that human infants cannot grip their mother and travel with her in trees. Human infants are truly helpless and must learn all their basic movements, and even must learn sensory functions. It seems that expanded human neocortex needs to develop before it can provide humans with all these needed functions. The growth of the infant brain is charted in Fig. 9.1, relative to the acquisition of language. Also, although such early incapacity seems associated with continued brain development, the large social brain does not complete its development until young adulthood (over 20 years). A schematic of the human brain, with some relevant regions labeled, is shown in Fig. 9.2. Thus the cost and developmental duration of a large social brain seem highly inefficient. Such a large social brain is also associated with longer life span. This long and extended brain development appears to provide various opportunities for much social learning to occur (theory of mind language, beliefs, etc.). Clearly, social learning must be crucial for human survival given these costs and biological problems. But in what way can the benefits of social learning offset such major and extended inefficiencies of our large social brain. Large social brains are not common to other mammals (including most primates) so it would not seem to represent a general issue for selection and fitness. What was special about human evolution and their social characteristics that favored or required this costly brain?

Let us consider what a 'brain-mediated' enhanced social capacity might provide humans to offset the major evolutionary cost outlined above. What

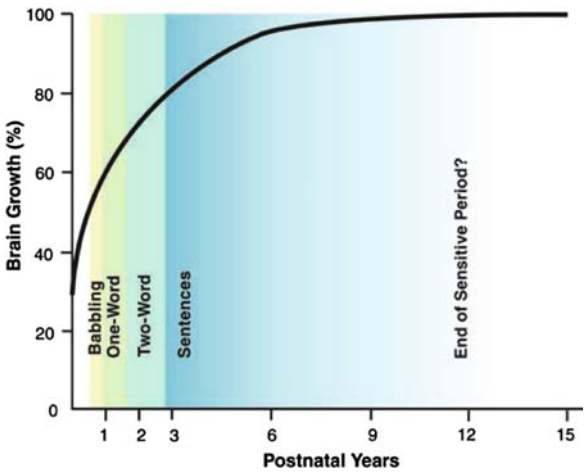

Fig. 9.1 Overall human brain growth and acquisition of language (reprinted with permission from: Sakai (2005), Science, vol. 310)

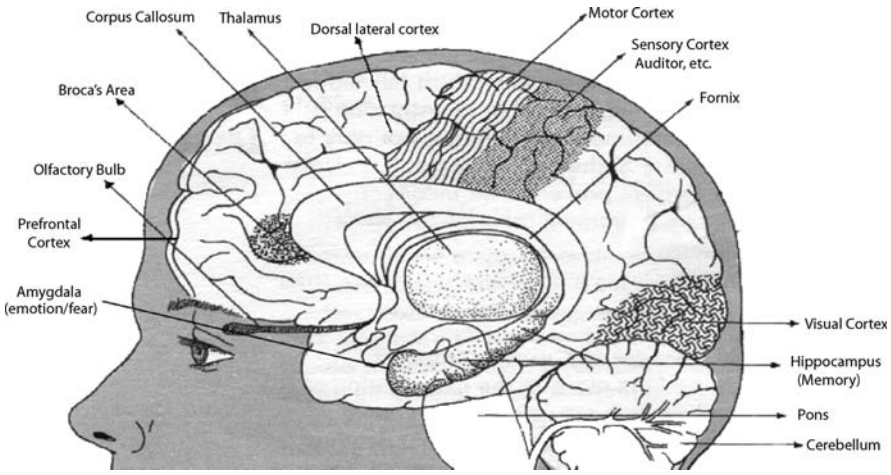

Fig. 9.2 Human brain schematic

about the extended maternal bond? In primate ancestors to humans, a visual-based group recognition system was mainly used for maternal bonding (see prior chapter). Many such species show extended maternal bonding, although not for the duration seen in the great apes. It seems likely that the initial selection for extended human social bonding would also use visual mechanisms, but the extended duration and strength of the human maternal–offspring bond is well beyond that of even the great apes (see below). This extended care promoted or allowed the development of an even more delayed social brain. Maternal obsession and compulsion are examples of emotions that would contribute to extend maternal bond. These could clearly be implemented as emotional addiction modules, but do not seem to require a bigger brain. We do not yet know how the human maternal bond was extended. However, besides an extended maternal bonding, and in contrast to all other apes (but seen is some New World primates), visually mediated parental social bonding appears to have been acquired by human fathers. Although not well evaluated, human fathers do show prolactin-associated changes in response to crying of their infants (discussed below). Clearly, emotions such as sympathy, love, anxiety must somehow be involved in such bonding. Thus in humans, both mothers and fathers were more socially bonded to offspring. Might this dual parental infant bonding account for some of our larger social brain? This seems unlikely. Given that much smaller-brained New World monkeys can also show visually mediated biparental bonding, a big brain would not seem needed. However, unlike the other great apes, both female and male human mates are also socially (romantically) bonded to each other. As discussed below, it is likely that the

mechanisms bonding females to male mates and visa versa are similar, but not identical to each other. Clearly, humans do show extended social bonding, but similar bonds are seen in other vertebrates with much smaller brains. The distinction, however, may be that human bonding uses few biochemical signals, but is mostly cognitive, placing more demands on brains. There is, however, one human-specific social feature that places large demands on only the human the brain: language. As mentioned above, recursive language, if it is used for the purposes of group identity, might require a larger brain. But here, we can see the potentially large dividends in terms of group survival and adaptation and general intelligence. Language, besides possibly providing group identity, also transmits survival experiences and promotes social cooperation. Indeed, the human brain does appear to have specific structural adaptations associated with language acquisition, such as Broca's area as shown in Fig. 9.3. Thus the acquisition of language could offset the large and inefficient human social brain if such dividends are major. Furthermore, if language created the large social brain, the social mind that emerged from it becomes available as the substrate that can now be selected for an even more extended social membership. Accordingly, this emerged social mind required sensory, brain and emotional mechanisms that would compel greater social bonding and identity, placing even greater selection on a large social brain. These mechanisms involved would

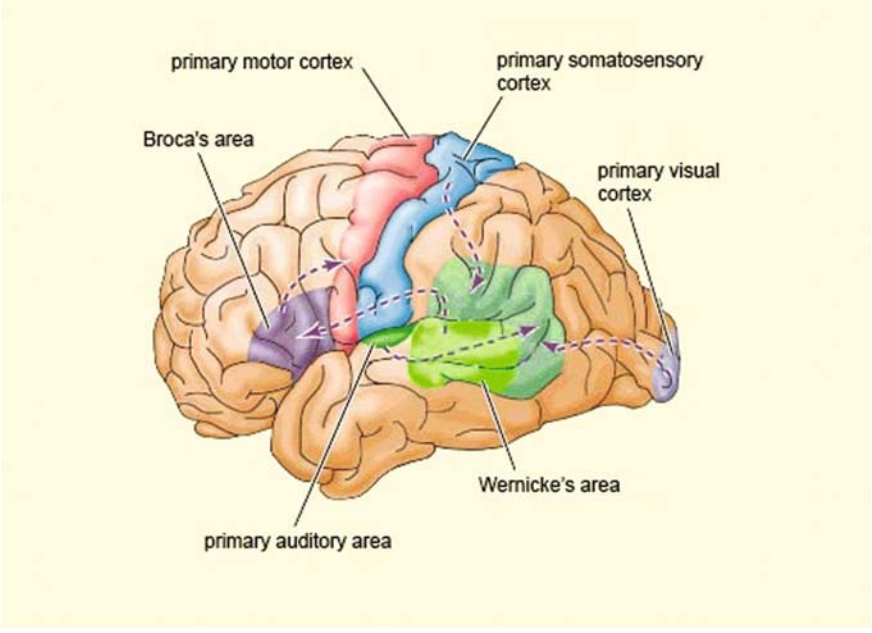

Fig. 9.3 Broca's area identified onto human brain (*See* Color Insert)

likely include social cognitive functions and social–emotional addiction modules. This would require the emergence of more complex social emotions that develop with socialization. Perhaps the human social emotions of pride, embarrassment, guilt that develop between 5 and 14 years of age are examples of such systems.

Human Social Brain: Addiction and Social Bonding

Humans, like primates, no longer depend much on olfaction, MHC or other biochemical identity markers as their social brains provide almost all of their group identity. By extending the basic mechanism of maternal and paternal social bonding, this social brain allowed the development of nuclear families, extended families, tribes, nations to large pan-national cultures, the most extensive group identity being that of religion that can cross all national, language, ethnic, racial and cultural barriers. However, all these group identities appear to have retained the basic group characteristics of addiction strategies and the mechanisms to define, stabilize and defend group identity. They are generally harmful to non-members and protective of members and are mostly acquired by learned information that colonizes a social mind. It is worth stressing again the fundamental importance of the concept of an addiction module. Although the application of this idea to stable phage colonization in bacteria was presented early in Chapter 1, it should be noted that the initial concept of an addiction module stems from the study of the human brain and drug addiction. Ten years prior to its application to phage and bacteria, R. Solomon (1980) proposed that human drug addiction could be understood by thinking of this state as having two components, one involved a rapid pleasurable process succeeded by slower but long-lasting toxic process (withdrawal) (see Koob and Le Moal). In terms of its application to social membership, strong emotions can provide both the pleasurable and toxic components (the T/A of a module). The internal brain structures associated with these emotions (such as maternal and romantic love presented below) are indeed similar to those involved in drug addiction. But human social group identity does not directly stem from the external action of opioids or endorphins. Our identity is learned during our development and the principle thing we learn is language. However, with the development of language as a transmissible group identifier, a transforming event happened in the human mind. Language led to the development of a cognitive, conscious and self-aware mind. This mind state, however, has not escaped the selective forces of group membership. Our mind has also been adapted for and used to evolve even more extensive group identity; a group identity based on cognitive content or belief of our mind will be emphasized below. This greatest of human identities thus has an ancient biological legacy.

Language, Speciation of a Group Identity System

As asserted, with the evolution of language, humans have been largely freed from many of the 'biological' constraints that drive the evolution of most other species, although we are still susceptible to large effects from viruses, for example. Our mind and culture (products of language) provide us with a very rapid behavioral adaptability to deal even with such threatening agents (like avian flu and SARS), well beyond the usual genetic adaptability of other species. For example in the 2005 outbreak of avian flu in China, 250 million domestic birds died whereas only about 250 humans died. This contrasts with an estimated 60 million human deaths from influenza during the 1918 pandemic. Social responses matter to our survival. Indeed, it appears that human evolution (genetic diversification) has accelerated in the last several thousand years and I would argue the chief reason is that we control infectious diseases and have learned to grow and protect our food, via social learning. No other species has even freed itself from similar biological constraints. Although language may have initially evolved as a group identity system, it now provides the basis of all our adaptability and social identity systems, such as culture and religion. Yet language still adheres to many of the basic principles of identity systems as we have considered in this book. Language is a transmissible information system that will superimpose an identity onto its host, much like a genetic parasite. Only the host of language is the large social human brain which is physically altered by the language that colonizes it and is also biologically adapted to be colonized by language. As presented below, languages retain many virus-like features: transmissive, colonizing, stable, preclusive, highly adaptive. But these features are no longer very dependent on our genetic content. Language thus promoted a major evolutionary transition in humans, well beyond even what chimpanzees are capable of. Yet languages, like persisting genetic parasites, still behave like species-specific entities. Language seems to be the DNA of culture and social identity. And like DNA, language can show some interesting patterns of speciation. In the DNA world, when we see situations where there are lots of related species in one particular habitat, we consider what external forces might be driving such high speciation. For example, in the relatively young Hawaiian Islands, there are 500 species of Drosophila found, yet in the combined total for the rest of the world, only 2000 Drosophila species are found worldwide. In such a circumstance, I have argued that we should look for the role of persisting genetic colonizers in speciation as they impose group identity onto their host. A language-based equivalent to this might be what existed in pre-Columbian California. When early Spanish explorers came to California, they were surprised to see the diversity of languages that existed there. An estimated 400 distinct languages, most of which were not understood by the other tribes are estimated to have been present. By contrast, it is estimated only about a dozen languages were present in India, a much older and larger human habitat. In both cases, it appears diversity is associated with more recent habitat

introduction, and competition for persistence leads to reduced species. I suggest this is also a competition for group identity in the context of language.

The Human Mother–Offspring Bond: the Basal Social Link

Bonding with Infants: Nursing, Prolactin, Oxytocin and Vasopressin – the Face

As asserted above, the basal mechanism for extended primate and human maternal bonding is via visual cues, and primate brains are specifically adapted for facial recognition. Primates, including humans, have a very fast recognition of faces (200 ms) which occurs in the inferior temporal cortex. Even when presented at various viewing angles, faces are rapidly recognized, a task that is difficult for artificial intelligence systems. From this it seems that face recognition has an inherently abstract or sparse character to it. This may relate to why even primates are able to recognize clock faces as representing real faces. Interestingly, an even faster system of face recognition has been measured regarding the non-conscious recognition of the emotional content of a face (such as fear or disgust), as measured by facial responses. Thus both conscious (170–200 ms) and non-conscious (30 ms) face recognition exists that is able to read emotional content. The culturally universal ability to quickly recognize the ubiquitous smiley face may be due to similar built in pattern recognition capacity. The rapidity of this recognition appears to involve very few spikes per neuron, thus suggesting the existence of a sparse but dedicated neuronal system specific for faces. That this sparse system can also recognize the emotional valence of a face suggests the biological importance of social communication. By 3 months, human infants show clear preference (via eye tracking) to natural face recognition and will prefer attractive to unattractive faces. They also become able to better recognize, respond to and prefer faces of the same racial type, although exposure to faces of other races can reduce this preferential effect. It seems clear that the function of the fusiform area is involved in this face selectivity. Self-face recognition also seems to involve specific neurological domains involving frontoparietal structures that are part of the 'mirror neuron system'. This function would seen relevant for social cognition.

Faces, Fear and Racial Recognition

In humans, rapid facial detection is also linked to a rapid unconscious emotional response in the viewer, which likely involves mirror neurons. Within a second of viewing a facial expression, most people will match the emotional expression of the face. Thus emotions can be rapidly transmitted. It is also suspected that these emotional reactions most likely involve dopamine

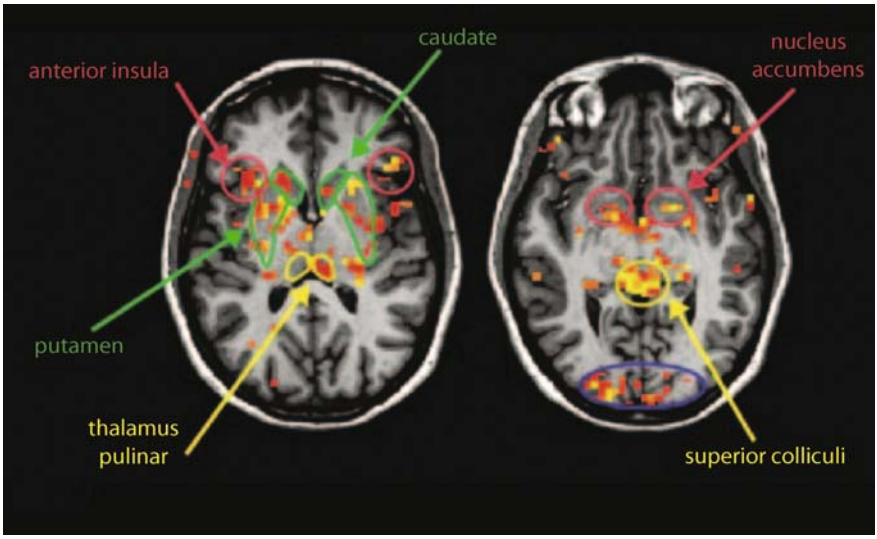

Fig. 9.4 fMRI study of brain response to fearful body positions (*See* Color Insert, reprinted with permission from: Gelder, Sgnder et al (2004), PNAS, Vol. 101, No. 47)

neurotransmitter. Such social contagion via facial recognition is also rapid. For example, facially expressed fear can be propagated as quickly as 150 ms and can be used for fear conditioning (association and learning). An fMRI study of face and body fear recognition is shown in Fig. 9.4. It now appears that there is an inherent tendency in human infants to associate other (non-mother) racial face types with fear and that the resulting fear association is persistent. Thus negative (aversive) attitude will be quickly expressed in response to facial-type recognition, which suggests that an implicit racial prejudice is inherent in the human face-recognition system. Such a reaction would be expected, if humans initially evolved to use facial appearance as a system of group recognition. Consistent with this idea, fear reactions (associations) like these can be measured even in human individuals that do not consciously endorse prejudice. However, it also appears that learning can counter such inherent association tendencies. Human infants repeatedly exposed to other racial face types in a non-fearful situation will lose their negative bias. It seems humans must learn not to respond negatively to other facial types as such a tendency is biologically favored.

Thus it seems clear that at least some of our big social human brain is associated with facial recognition, but this does not really explain the large increase in size relative to other primates. Although vision clearly serves a basal function with regards to group recognition, it too must be learned and developed after birth. Thus the cortical development of human visual capacity takes on special social interest to human evolution and why infants' brain development is so important. For example, if an infant's eyes are non-functional when they are young, subsequent cortical development is permanently affected. Any

such individual will struggle with their pattern recognition capacity, especially the recognition of 2D and 3D patterns, if their vision is restored later in life. This indicates the existence of a developmental window during which their visual cortex has developed crucial pattern recognition capacity. Color vision is also interesting with respect to cortical development. For example, some types of cortical damage (extrastriate) can produce severe loss of color vision, but preserve non-color vision. Often this involves lingual and caudal fusiform gyri. This suggests that the basic function of vision was present prior to the primate's adaptations for color. Thus we have numerous reasons to think that higher primates in particular are highly visual creatures. For example, Chimpanzees, unlike humans, when they become separated from each other, do not vocally call out as do people. Instead, they search silently until they see one another then rush together. Vocalization, when it occurs, seems essentially reflexive in chimpanzees and is mostly associated with females greeting males. We might therefore expect that if chimpanzees had developed a language, it would have had to be visual (facial) basis. However, hand gestures could also provide the basis of a vision-based language but no chimpanzee (or other great apes) has developed any communication that resembles a gesture-based language (see Fig. 9.5). I suggest hand gestures would need to become important for ape group identity and be associated with their own dedicated brain regions to allow them to evolve into a language form.

Fig. 9.5 Chimpanzee gestures and expressions (Source: Photo researchers)

Even in visual primates, including human, it is likely that an even earlier more ancient system of mammalian maternal bonding involved the action of suckling and vasopressin and prolactin (described previously). It is known that longer breast feeding in humans leads to stronger maternal attachment, which is thought to be mediated by oxytocin. It is also known that vasopressin regulates prolactin and is associated with suckling-induced prolactin. We can recall that in mice-pup generated ultrasound stimulated the mother's prolactin production. Human babies do not generate ultrasound, but they do cry. Endo-opiates appear to be involved in mother's prolactin response. We might guess that in primates some significant adaptations might have occurred in the prolactin system. Indeed it is known that primates differ markedly from non-primates in their prolactin genes and that this difference occurs before New/Old World split. The human and chimp versions are very similar to each other (only 2 aa difference in the coding region), although human regulatory region has 64 bp satellite insert which is absent in chimp (but present in bonobos).

However, in the case of humans, facial vision does appear to contribute to the maternal bond. In terms of brain adaptations, forebrain neural circuits have been implicated in this maternal behavior, bypassing, perhaps, the older circuit from the olfactory bulb to the amygdala and the hippocampus (associated with long-term memories). fMRI examinations by Bartels and Zeki (2004) of brain response in mothers shown pictures of their infants is shown in Fig. 9.6. Here states of maternal love and romantic love are compared. We can see both states elicit partially overlapping activation of reward (and addiction) centers and regions expressing oxytocin and vasopressin receptors. With maternal love, the face-selective fusiform gyrus was activated whereas in romantic love this region was not activated. The deactivation response was fully overlapping between maternal and romantic love and involved brain regions associated with strong negative emotions (i.e., amygdala; fear and aggression). The implication is that these two states of strong social bonding (maternal and mate bonding) are related, can be visually elicited but are not identical. In other prior studies, infant vocal responses also elicit brain responses. Women, but not men, showed neural deactivation in anterior cortex in response to infant crying. However, the amygdala showed stronger activation from crying, independent of sex, but this is dependent on parental experience. Clearly these brain responses to infant vocalizations are able to affect emotions of both men and women, although there do seem to be differences between the sexes. There appears to have been additional brain-specific adaptations. For example, both oxytocin and vasopressin are strongly implicated to be generally involved in social memory and learning. In addition, humans seem to have a special version of neuropsin (associated with learning and memory) that is of recent origin in the hominoid species. I have already mentioned that oxytocin has also been associated with the social emotion of trust, apparently involved in social bonding. Trust allows one to develop the feeling they know someone else, such as their

mother. The link between oxytocin and trust is not limited to maternal bonding and seems to be applied to other social interactions into adulthood. For example, in studies involving games of risk and trust, nasally administered oxytocin significantly increased tendency to trust the involved individual. Interestingly, this reaction was specific to a person (face) and was not applicable to a computer game partner. Thus oxytocin affected the human emotional response and learning to a facial interaction.

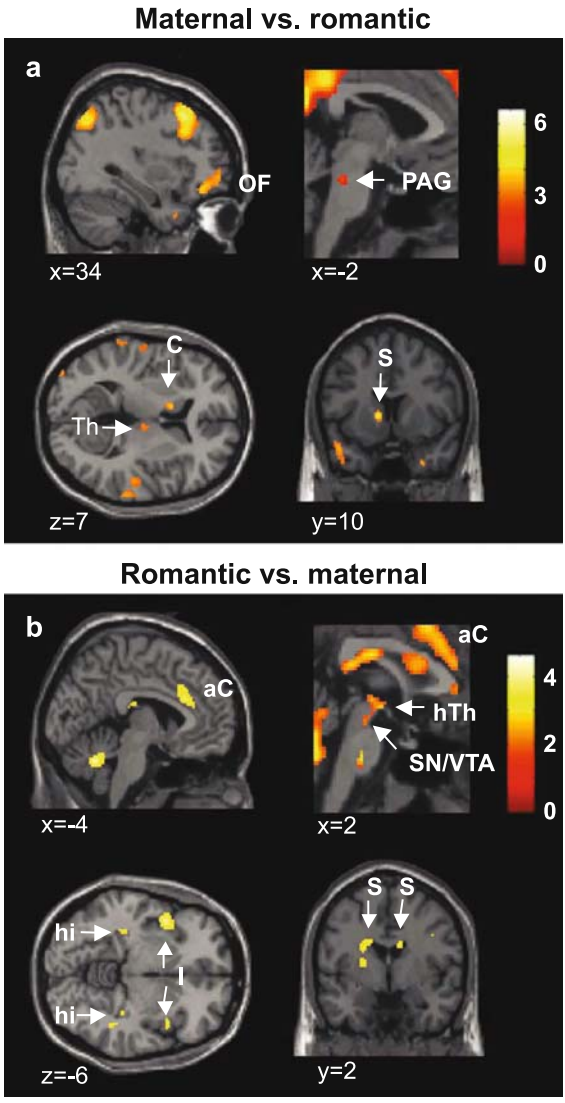

Fig. 9.6 fMRI brain study of maternal and romantic love (*See* Color Insert, reprinted with permission from: Bartel Andreas and Zeki Semir (2004), NeuroImage, Vol. 21, No. 3)

Brain Biology of Facial Emotions: Brain Damage

The emotional aspect of facial recognition appears to involve specific neural substrates, as implicated by brain damage. Bilateral damage to amygdala, for example, can impair the recognition of negative facial emotions (fear, anger), but leave the recognition of positive emotions (happiness) intact. This emotional reaction is also distinct from that of face recognition. For example, some stroke patients have difficulty recognizing a specific face, but can still recognize its emotional expression. Brain damage can thus result in poor facial recognition yet leave intact recognition of emotional expression. Thus there appear to be specific brain structure for personal face recognition and for facial emotional content. Since positive and negative emotions can be considered as distinct parts of an emotional T/A addiction module, such physical separation is not unexpected. In addition, there may be some sexual dimorphism with this facial emotional recognition. Female and male expressers can elicit different eyeblink startle responses, potentiated by happy faces but inhibited by angry faces. Normally the amygdala will activate before 170 ms when exposed to fearful faces. It seems right brain hemisphere is predominantly involved in control of these evoked emotional reactions. As presented below, schizophrenia is also associated with impaired facial recognition. Fear recognition and the amygdala is of particular interest here. As mentioned above, fear and emotional contagion is seen in infants, as young as 3 months of age. At around that age, infants become able to perceive facial emotional expressions from the mother. Indeed most studies of emotional communication have focused on experiments using facial expression, and such studies dominate the current literature. Since very specific neurons are involved with facial expression, clearly an intense biological selection for face recognition and emotional reaction occurred in primates. The amygdala is involved in communicating and assisting the remembering emotional events. In humans, it is massively connected to cerebellum and frontal lobe. Since the frontal lobe is the center for most advanced human cognition and more developed in humans than in other apes, its connection to this circuit is most interesting from the context of a large social brain. It seems that the most recent and advanced part of the human brain connects to the most primitive and uses emotional memory via amygdala. The clear implication is that our large social brain needs to link its most advanced cognitive functions to basal emotional reactions, which I suggest promotes social bonds and group identity.

Song, Human Emotions and T/A Sets

In contrast to all primates, which are indifferent to or avoid music in their habitat, in humans music communicates emotional content and provides a source of pleasure. Music can also communicate danger. Music seems to

amplify the emotional content of visual stimuli and it is for this reason that music is so effective in setting the emotional valence of scenes in the movie industry. Besides music, fear contagion in the voice tone also exist between mother and infant (discussed below). But this contagion is also unconsciously modulated by facial expression. This face–voice emotional pairing also seems to be mediated by amygdala. Body position and gestures (lacking faces) can also transmit emotional and fear states. It seems clear that such emotional content of music is also the basis for use and appreciation of music and dance in all human cultures. There also appear to be other emotional links to sensory input. For example, there is a curious connection between emotion communication, movement and timing (tempo) in humans. Tempo (as used in music) can clearly add emotional content to visual stimuli, and this is also much exploited in movie soundtracks. In humans, the cerebellum (considered an older or primitive brain) is involved in maintaining tempo, but is also involved in sensing the emotion of music. It has been proposed that cerebellum is involved in modulation of emotional arousal. Monkeys with lesions in some regions of their cerebellum can show dramatic changes in arousal and can sometimes induce rage, perhaps the most potent of negative emotion. It is known that stimulation of a central region called vermis also leads to aggression in humans. Interestingly, lesions in other parts of cerebellum induce calmness (contentment) and have been used clinically to sooth schizophrenics. Yet other regions of the cerebellum can be stimulated to reduce anxiety and depression. Thus, various intense emotions (such as those induced by music) are associated with ventral striatum, the amygdala and the midbrain and are involved in reward, motivation and arousal. Ventral striatum includes the nucleus accumbus (NAc), the center of brains reward system and important for drug addiction and pleasure and also directly involved in transmission of opioids in the brain. This last region may be the end point of sensory stimulation of emotion when it must affect group identity. Why then is it so important for humans to communicate emotion? All of these emotional reactions can be considered as emotionally toxic and antitoxic sets and it thus seems likely that they constitute T/A pairs (addiction modules) that could define group identity if learned. Many of these same emotions are elicited during grief following death of close offspring (see below). As I have asserted, positive and negative emotions together would be needed to create extended social bonds, a core function of and crucial selection for the social human brain.

Biparental Social Bonding as a Base for Extended Social Bonds

It seems well established that evolution tends to build onto prior solutions and systems tend to develop more complexity. The mammalian maternal–offspring bond is in part mediated by the actions of prolactin. Also only in mammals, the placenta is a major site of prolactin expression and the placenta also has many placental-specific versions of prolactin. In humans, the placenta has three

distinct types of placental trophoblasts and each of these cell types expresses its own version of prolactin. Thus it appears that the placenta itself was involved in the evolution of maternal–infant social bonding. This would clearly present a situation that applies only to the mother, not the father. In humans, however, it is clear that the brain is also affected by and involved in prolactin-mediated bonding. Evidence suggests that this also applies to human fathers. As presented above, visual input became prominent for social bonding in primates which allowed the extension of the maternal bond beyond the duration that could have been mediated by placental prolactin. The extended bond between mother and infant is maintained by visual and other stimuli and produces an emotional state we call motherly love. However, the involvement of the brain and vision (or voice) in maternal bonding would entail the use of a mechanism that could also be adapted by evolution to apply to fathers, who would otherwise lack bonding mediated by the placenta. All group identity systems need T/A sets. Thus any human paternal (and maternal) bond to infant must include negative or harmful reactions to non-members or those that threaten the bond. Thus toxic emotions, such as aggression and rage, are essential for social bonding. The positive emotions are the strong contentment and joy that is felt in the presence of the offspring. Negative emotions are strong fear, anxiety in the absence of offspring or aggression to threats. The sight of an infant is known to provide comfort to both mother and father. It seems likely that dopamine is involved in the pleasure part of this emotional bond. Both maternal and paternal bonds should increase aggression toward threats to offspring. For fathers to form such stable social bonds, visual (or sound) mediated sensory input needs to communicate and engage positive and negative emotional memory in a stable way. Thus the emergence of paternal bonding in humans was likely adapted from the visual and vocal emotional mechanisms that primates had already adapted for the maternal bond. However, the mechanisms employed for this paternal human bond promoted the evolution of even more extended social bonds. Since paternal and maternal bonding now involves all members of the species (male and female) in common social links, it becomes available for evolution to promote additional and extended group identity and social structures. As these bonds were mediated by learning and various social-CNS adaptations, social learning (especially language mediated) can now provide extended human group identity.

Grief as an Exemplar of Basal Social Bonding

If, as I have asserted, most human social bonds are derived from the maternal bond and maintained by sets of positive and negative emotions, then it is also expected the maternal bond will identify many basic features of general human social bonds. For example, breaking the maternal bond will disrupt emotional T/A sets in ways that are likely to be similar to other social bonds and we should expect that intense emotional discomfort and pain should result. The strongest

bond in primates is the mother–offspring bond and it is clear that the great apes will experience intense grief with the death of their offspring. That humans also experience grief at the loss of a loved (bonded) one is a well established and one of the most intense emotional states they can experience that can incapacitate an individual. Bereavement and grief, however, is not usually a conscious choice. I suggest it results from the disruption of a cognitive-based (psychological/emotional) addiction module. Human grief indeed seems generalized in that it can also be induced by separation from other loved ones and is not restricted to the death of offspring. A romantic break up is a good example of this. Thus grief can provide the exemplar for how hominids form strong social bonds mediated by emotions and inform us about the inherent characteristics of such bonding. Humans experiencing romantic break ups will display changes in brain activity that can be seen by fMRI studies. Five stages of grief are currently recognized. The initial stage is disbelief. The affected person refuses to accept what can be compelling evidence. This basal reaction suggests that a belief mechanism is an early inherent part of the social bonding process. As developed below, belief will be presented as core component of extended social bonding. Next phase of grief is a yearning for the individual, the wanting of something positive that is now absent (reminiscent of yearnings for drugs). This is a less stable or transient phase. This phase is then followed by a period of anger. Anger would appear to represent the expression of the stable and toxic emotion of a T/A set. The anger phase is typically followed by a depression phase which can also result in a stable and toxic emotion that can last for an extended period and incapacitate an affected individual. It is interesting that depression seems to involve the same brain region as affected by romantic love. The final phase is that of acceptance in which the strong emotional reactions are over. This process normally takes about 6 months to complete for most people. This long duration is interesting and suggests some structural changes in the brain may be involved. It also seems possible that this long duration is associated with the time it takes to reset belief states. A grief response is considered pathological if it lasts longer than this period. When pathology occurs, it is associated with social withdrawal (group dissociations), thus it represents a clear disturbance to our social brain function and social activity. Extended pathology can result in post-traumatic stress syndrome (persistent negative thoughts), if the death of the loved one was witnessed. Also, children's reaction to parental separation will follow similar patterns. Related sets of grief responses can occur with the death of a leader (political, religious), thus this emotional dynamic clearly applies to larger and more extended social bonds.

Abstraction of Visual Group Recognition

Because our brains have inherent capacity to recognize faces via sparse and relatively abstract characteristics, we tend to rapidly and inherently recognize abstract or generalized facial difference (and other abstractions). Thus racial

recognition, representing generalized variations in facial appearance, are easily recognized as representing other groups. However, aggression to non-group members also appears to be an inherent tendency. Yet, even when there is no facial or racial variation between similar groups (for example very similar but Paleolithic human island populations), there will still exist a tendency to create or adapt visual abstractions that will provide identity markers. Thus we know that face painting in Paleolithic cultures was common. Other abstract visual markers are also known, such as the tattoos found on the 'Iceman' that had been frozen into a glacier in the Alps. In New Guinea, distinct visual designs painted onto shields of otherwise identical warring tribes were common. Although such symbols have no meaning, they simply convey abstract patterns associated with the tribal identity. Thus, it seems that Paleolithic human cultures tend to use abstract pattern with no specific meaning that indicates group identity. Such a tendency can still be seen in national emblems and even in the hand signs of modern urban gangs.

Song: Early Vocal Amplification of Emotional Bonds

The human capacity for song and speech involved many evolutionary changes to brain and vocal architecture. These changes involve the human tongue, epiglottis, larynx and trachea, changes that for the most part make humans prone to chocking relative to apes, so their selection needs an explanation. These changes are estimated to have started about 2 million years ago and distinguish humans from the other great apes. What was the initial selective pressure for these vocal changes? As mentioned, humans clearly differ from the other primates in their preference regarding music. Monkeys and chimpanzees prefer silence to music. Tamarins and marmosets, for example, will spend the majority of their time in cages free of music including lullabies that are soothing to humans. In contrast, humans prefer a constant music environment (such elevator music, car radios or the ubiquitous iPods). As originally proposed by Darwin, music may have evolved prior to speech and was likely involved in maternal–offspring bonding. In chimpanzees, chorusing is most often done by females in response to males. Thus we expect human ancestors would likely have some vocal traditions in their females. In humans, this must have been adapted to extend maternal bonding. Maternal singing associated with bonding to babies is found in all cultures. Mothers sing to infants in all cultures. Typically, the mother's singing is relaxing to the baby and lullabies are used to help babies sleep (human babies have extended sleep, along with extended infant helplessness). Singing thus induce sleep via a process that likely involves endorphins. Other effects have also been documented, such as lower saliva cortisol levels and babies have a documented preference for song over spoken language. Thus, it is clear that singing provides an emotional link between mother and baby that could extend the duration of the bond. In addition, the

recognition of the emotion valence in song is universally common; recognition of anger, sadness, threatening, happiness or joy of music is not culture specific. Why should music communicate such robust emotional content for all human cultures? If, as initially proposed by Darwin, music was part of a maternal–baby bonding system that promoted emotional links, then it would not be expected to have resulted from mate selection as proposed for bird songs. Indeed, mate selection has often been used to explain most social and sex behaviors in humans. As discussed previously in primates, mate selection cannot explain the social structures involving genetically unlinked females in infant care. A role for music in human mate choice is thus most unconvincing.

In terms of neurobiology, singing activates distinct brain regions from that of speech, although there is some overlap. In one fMRI study of music's effect on the brain, chord sequences were seen to activate regions that included Broca (left frontal cortex) and Wernicke's areas (left temporal lobe) (see Fig. 9.7). These regions had been previously thought to be domains specific for human language. Music is clearly emotional but it can be both pleasant or unpleasant;

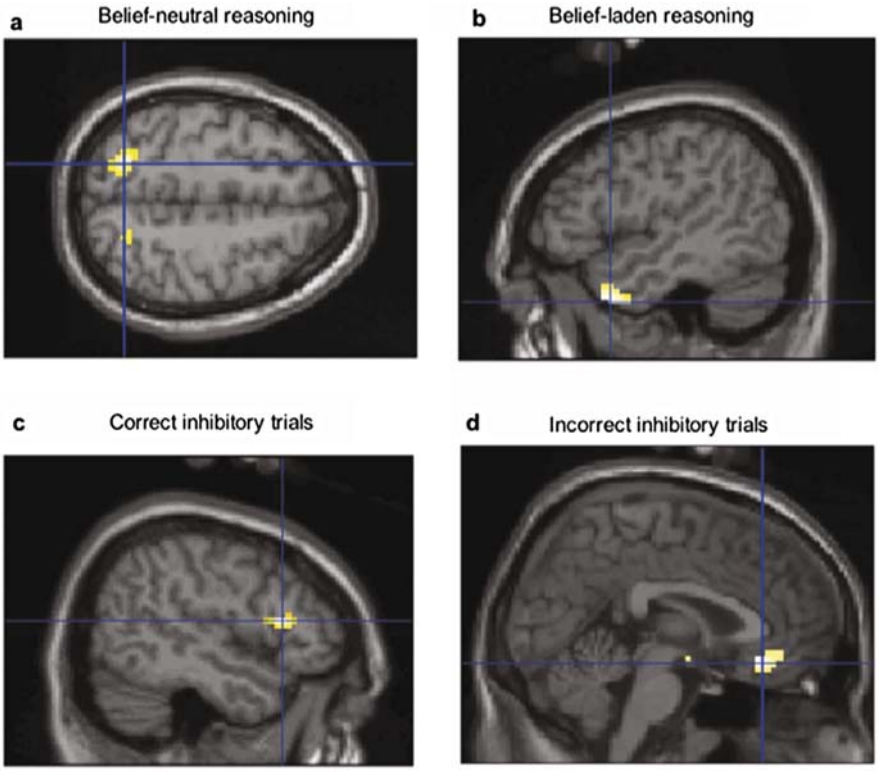

Fig. 9.7 fMRI brain study of belief-based reasoning (reprinted with permission from: Vinod, Raymond (2003), Cognition, Vol. 87, No. 1)

dissonance is unpleasant whereas consonance is pleasant. The cry of a baby for example, is unpleasant and emotionally links the distress of a baby to its mother and other adults. Baby crying also has a contagion character (like facial fear) and will induce other babies to cry as well. Thus this form of emotional audio communication exhibits 'mirror-like' affects on nearby individuals, clearly a feature of a social brain function. As mentioned above, music evokes emotions especially when applied to visual images and will activate various brain structures associated with emotion (amygdala). The amygdala also plays a role in recognition of negative, dangerous emotional social states produces when the amygdala is damage it can selectively impair recognition of scary and sad music, as well as facial fear and facial anger recognition. Congenital amusia is also known for some people; the existence of such non-musical humans clearly identifies the presence of a biological substrate for music perception. Some individuals with specific types of brain damage can also become indifferent to dissonance, yet can still differentiate the emotional valance of music (similar to face recognition). It is interesting that Broca's area and Wernicke's area are next to and linked with facial recognition and mirror motor system (found in two regions) which was not present in chimpanzee brain. These regions also overlap with regions involved in imitation, learning and theory of mind system of humans (all important human social functions). In homologous (but distinct) regions of macaque brain, these regions are activated by species-specific vocal calls. Thus singing is not the same as talking and likely represents an older, second mode of audio emotional communication, in which lateralization is different and uses distinct, although complementary (asymmetry), neural substrates. Along these lines, trained musicians will activate both left and right midfrontal brain regions when hearing music, an expanded pattern relative to non-musicians. Thus it appears that the human brain can be trained or developed into a more expansive and involved neurological substrate capable of identifying and producing more complex or sophisticated audio patterns. This capacity is the product of extensive sensory training and experience and is not simply inherent or genetically endowed. If such complex pattern recognition capacity can be used for group identity and membership, selection for it in a social brain would seem likely. However, since complex pattern recognition is also a basic feature of general intelligence (that includes sophisticated abstractions), this suggests that experience expands the social and general capacity of the brain. This concept will be of great significance when we consider the development of reading and the modern human social mind below.

Children will dance and sway to music well before they learn to talk, clearly indicating that they have inherently developed a sense of rhythmic sound–body connection prior to speech, However, we do not understand the neural substrates of rhythm. Yet it seems clear that music is not essential for emotional bonding as demonstrated by the deaf or people with amusia. Rather it appears that music and sound will greatly amplify the social emotional impact of visual information and can also affect larger groups. Music alters constitutively expressed opiate (mu-receptor) on mononuclear cells in listeners and has

shown a robust ability to induce a sense of group calmness. This transmission and amplification of emotional response is the basis of its use in sound tracks of movies. The origins of using song this way date to the very earliest recorded human stories, such as songs used in story telling. Music not only remains a transmissible (social) amplifier of emotions, moving from one individual (mother) to another (baby) and exerting emotional content, but is also able to transmit and sooth emotions of adults in groups. As music is able to transmit pure enjoyment, it would seem to have no selective or adaptive value by traditional Darwinian reasoning. Its role in social bonding, however, explains a selective value in group identity. Musical instruments date back 35,000 years so music seems to have been present since the time of Neanderthals. The transmissive and often stable character of music is well established and music can also have a viral-like persisting character as anyone that has ever been colonized by a sound worm can attest (an internally reproduced song that cannot readily be forgotten). In addition to its likely role in maternal bonding, all cultures also use music for various social purposes, but mainly to set the emotional group ambience. When performed together, many voices singing in synchrony will acquire the same emotional valence, thus its use in choirs and chants to synchronize emotions. Endorphins appear to be released during such coordinated group singing, likely providing the soothing character to social music. Music can also diffuse social tension for example as used in social gatherings, parties and dancing. But it can also be used to stimulate or arouse emotions such as used for tribal music, fight songs, ritual bonding and religion. Clearly music provides a socially transmissible system for emotional communication and its role in group identity seems clear. Although it can be used to transmit cultural information, unlike language, it has remained active principally with emotional content, not information content and abstract meaning.

Paternal Bonding and Empathy

Why did humans need to amplify emotional communication by vocal means? In what way did this promote the evolution of much enlarged human social brain? Clearly, amplification of emotional communication could be used to extend social bonding and group identity. As previously noted, humans show two universal social features that are absent from the great apes: mate bonding and paternal role in upbringing of young offspring (both associated with nuclear families). Both of these social characteristics also appear to involve prolactin. In terms of mate pair bonding, we presented evidence that supports a role of prolactin and oxytocin in both romantic love and maternal bonding in which visual (facial) input was the primary stimulus. As outlined above, for human fathers to acquire this, their visual centers must engage emotional addiction systems that compel the father to bond with the young. One emotion that could provide this is empathy. The father must feel empathy for the helpless

young. It has also been suggested that empathy is the main underlying emotion that mothers feel toward their young and thus is a main emotion for maternal bonding. We might now suggest a process by which this bonding might have also been developed in males via sex chromosome involvement, specific to human evolution. Empathy appears to be the central characteristic that underlies most positive human social and ethical behaviors. Its absence is strongly associated with social pathology (see below). Therefore, introduction of empathy as a social bonding system into males would represent a major development in human social evolution. It is therefore most interesting that recent fMRI studies suggest that humans performing selfless acts are actually tuned into the needs and emotions of others in ways that activate specific visual brain regions. The posterior superior temporal cortex (pSTC, near back of brain, involved in visual perception) becomes highly activated during altruistic acts. This is not part of the reward system, whose involvement had been hypothesized at the start of this study. Rather it appears to identify a more primitive system that may not simply define the emotion of empathy, but identifies a visually linked process that socially connects minds and emotions. The development of this system might also be related to the theory of mind as discussed below. In terms of inherent capacity for empathy, there is clearly some human variation. At a population level, females are generally stronger empathizers than males which clearly implies some role for the X/Y chromosome in this. Empathic ability also appears to be of relevance for autism, which affects males more often than females. Here, social sensitivity seems clearly affected and autistic individuals show clear impairment in empathizing (indicated by psychological profiles). Autistics also show an extreme bias in systemizing, a strong interest in narrow areas, insistence on sameness, repetitive behavior and obsessions with lawful systems (such as train timetables), including a strong interest in rule-based predictions. Autistics tend to show a form of a mind-blindness, or a delay in developing theory of mind during childhood. It is interesting that these same characteristics have also been proposed to be considered as an extreme version of the male brain, which is also more systemizing, more rule governed and less empathic as a population. As discussed below in the context of social minds, the conservative stance also appears to have many similarities to an extreme 'male' brain, but unlike autistics, a conservative or social mind shows characteristics of strong group identity.

Serial Mating Pairs, Bonding and Love

Although it can be argued that human pair bonding between mates is not fully monogamous and life long, relative to some pair-bonded voles (or birds), it is nonetheless clear that humans display much more pair bonding than do the other great apes. Accordingly, romantic love between mates is a universal characteristic of all human cultures. This bonding can be characterized as mostly being a form of serial monogamy. Examination of divorce rates in

numerous and various cultures shows similar patterns. All these divorce rates peak around the fourth year of marriage, followed by a long-tailed decline afterward. Most of these divorces are followed by subsequent pair bondings. Thus, although absolute divorce rates vary with cultural setting, shape of their divorce rate curves is essentially the same. Thus it seems clear that human pair bonding has this inherent profile. Clearly, an early and strong emotion associated with initial pair bonding is that of romantic love. In romantic relationships, it is clear that visual input (facial pictures) can provoke a love reaction, and several fMRI studies of subjects deeply in love who were shown pictures of their partners suggest these subjects showed focused activity in medial insula and the anterior cingulated cortex plus other areas, all bilaterally. Deactivation was also seen in amygdala and was right lateralized. This pattern was distinct relative to fMRI studies of other visual (facial) stimulation. It has also been reported that happiness correlate with deactivation of right prefrontal and bilateral parietal and temporal cortices. We might consider this to be the A element of an emotional addiction module. In contrast, sadness and depression correlates with activation of some cortical regions (deactivated in this study). The deactivation of amygdaloid was also noted above in maternal bonding. Since it is associated with fear, sadness and aggression, it can represent the T element of an emotional addiction module. The activated foci seen here also overlap to a large degree with those activated by cocaine and mu-opioid agonist-induced euphoria. These two euphoric states (romantic love, opioid induction) overlap in brain structures and it has been proposed that romantic love resembles an addiction state.

A More Split Brain: Language and Belief

Brain lateralization especially with regard to language utilization appears to be a human-specific adaptation. However, some lesser lateralization is seen in primates. For example, most ape populations, such as chimpanzees, are right handed as are humans. The humans left brain controls right body. The left brain is also called the verbal half and is thought to be most involved in language. Language use is the most lateralized of human brain functions and as argued below represents the most recently evolved group identity system. Seizures in left brain account for large majority of language deficits. There seems to be some sexual dimorphism in language capacity as female populations generally perform better than do males. In addition to language, the left brain is also thought to be more involved in details, facts, order, patterns, names and math. For example, some left brain stroke patients can name objects, but not explain its use. The left brain is also considered to be more involved in rational thought. In savant individuals, the left brain is the usual site of damage or dysfunction, and it appears the right brain then takes over more functions.

In contrast, the right brain is considered ‘non-verbal’ half involved in explaining meaning and beliefs. The right brain is thought to process symbols

and thus also appears to play some role in processing written language. Music and tonal stimuli are usually considered as right brain functions as are their emotional reactions. Thus symbols, emotions, imagination, religion, risk taking and beliefs are all more associated with the right brain. As will be presented below, belief states have a central role to play in the use of language as a system of group identity, so we might consider an overall lateralization has occurred in these two linked and interacting functions. The right brain which assumes a greater role in savants also seems to be more active in special perceptions of some autistic individuals (such as the fact-based detailed memory of the 'Rainman'). Thus the right brain is considered more important for emotional processing and appears involved in providing the 'big picture' for many individuals.

Sex and Brains

As alluded to above regarding overall language capacity, brain lateralization is associated with some sexual dimorphism (asymmetries, such as in the larger male amygdala). Sex and chromosome effect on lateralization have been reported. In this, it appears that the Y chromosome must have some activity since XX and XY chromosomes have distinct X dosage which affects various aspects of brain lateralization. XO individuals (Turner's syndrome) have non-dominant hemisphere deficits whereas individuals with an extra X (XXY, Klinefelter's and XXX syndromes) have dominant hemisphere, i.e., verbal deficits (mostly delays). Thus it appears that an extra X chromosome results in language deficits in individuals that are normal with regard to IQ and other aspects of mental performance. Since males (XY) do not show a single X effect (like Turner's), this indicates that the Y chromosome must provide some off-setting function preventing language deficit. It is thus very interesting that a recent genetic alteration in human evolution involves significant exchanges in the Y chromosome (involving recombination with sequences in the short arm of the X). This alteration in the Y makeup occurred after the separation of the chimpanzee and human lineage, and is also directly related to SRY (sex-determining factor on Y). We can recall from previous chapters that the Y chromosome has a distinct composition, composed of relatively few ORF but many ERVs, including recently acquired, human-specific HERVs, and other repeat and satellite elements. In the evolution of other vertebrates, similar Y-ERVs have been associated with group and sexual identity (see platyfish).

Applying the Split: Language, Acquisition and Bonding with Infants

First Words

In most mammals, early years of infant care and development are all almost exclusively female directed. This pattern was maintained in the great apes, such

as chimpanzees in which females are responsible for the first 10 years of upbringing. With human infants, a mother's role continues to dominate, but a paternal role is now apparent. Both the maternal and paternal human social bonds are associated with the development of language. In essentially all cultures, the most basic words first learned by infants are usually a name for the mother, then their father (see Fig. 9.1). Thus these first words provide a social foundation absent in the great apes. These first words are typically produced by a reduplicated process, resulting in terms like ma-ma, da-da and pa-pa. The vocal reiteration appears to be important to allow setting or imprinting of the memory and association must provide meaning to the words. Visual facial learning occurs in association with audio learning. The words for parents clearly associate with emotional and facial states and are spoken at times of stress (a feature that can be maintained into young adulthood). Clearly, the presence of the parents (especially mother) provides comfort for the infant. Thus a basal maternal social bond has been mediated or enhanced by these first words. The basal importance of the maternal bond has long been recognized in all cultures, and was noted by Aristotle who viewed childbearing and sex as the basal social links for all human interactions.

First Grammar, First Insight

Language is thus used as an additional system to mediate the basal maternal bond. However, the character of language becomes rapidly and increasingly complex with infant development. Young humans are spectacularly good at language acquisition. It is an effortless, unstructured learning process that results in linguistic competence. But along with the acquisition of language, young humans also become inherently good at understanding what is going on in other peoples minds (theory of mind, presented below), thus its competence is directly associated with development of other social capacity. It appears that language acquisition may also be needed for these additional cognitive abilities to develop. Although simple language provides emotional links between parents and offspring, the human brains have clearly been adapted to learn complex language. As this language is recursive, its meaning depends on context, thus grammar or syntax becomes crucial for the specification of meaning (a skill that develops about 3 years). However, the nature of grammars that humans can learn appears to have biological constraints. Thus, it has been proposed that only certain universal grammars (UGs) exist and appear innate. The brain seems to have a grammar center (such as subregions of the left frontal cortex), much like it had a face recognition center as presented above. Consistent with this idea, not all grammar structures can be learned by children during primary language acquisition. In some cases, grammars can show competitive exclusion. In this, it appears that less-specific UGs can resist invasion by more specific UG, if learning is accurate. Accurate learning appears to stabilize UGs. It is

interesting that some of the universal grammars also show evidence of competition and exclusion, although it is clear that other UG combinations can co-exist. Some neurological studies have suggested that language centers are linked with and adjacent to brain regions involved in gesture recognition, as present in primates. This has led some to propose that language may have evolved from sign language-like form of communication. However, there is little evidence that human vocal communication evolved from sign language. Still, there remains a curious link between gesture action and language. In one case study of viral-mediated brain damage, the patient lost all sense of touch below the neck, but continued to gesture automatically when speaking. Thus it seems that human hands are somehow linked to speech articulation. I suggest this link is due to the need for abstract (symbolic) pattern recognition in recursive language. When children are learning new words, they are guided by mouth gestures. This results in the McGurk effect, in that if one sees the mouth say 'ga' but it was recorded as saying 'ba', one will hear the sound 'ga'. It seems that language acquisition has somehow superimposed the system (Brocas) associated with visualization, manual motor control and mirror neurons. This could make sense if we consider both these to be core social systems involved in social communication with similar needs to link sensory input and access emotional memory. The ability to hear or perceive subtle verbal patterns, or nuances, is affected by the language learned as infants, who map language into the brain before they speak. It is interesting with English, the mapping of letters, words and sounds is more distributed than other languages. English has many inconsistencies due to the heterogeneous origins of its various elements. In this sense, English may not represent a fully natural grammar when compared to Latin language for example. PET-visualized activation patterns in English and Latin language speakers support this view. These characteristics of language are consistent with the idea that it may provide a vocal version of a group identity system.

Requirements for Language (and Emotion) to Provide Group Identity

An exemplar I introduced with mice was how colonization and persistence by extragenetic parasites (like mice with MHV) could differentiate otherwise identical mouse populations. Language can also have this viral-like feature to differentiate host (human) populations. If language initially evolved as a group identity system, language will also differentiate otherwise identical populations. Consider two neighboring tribes that speak distinct languages but are otherwise identical. Each has acquired their own social (group) identity systems via their respective language. Such a process of group identity should also generate diversity. For example, as mentioned, in pre-Columbian California, it is estimated that a high diversity (about 400) of distinct tribe-specific languages existed. In a sense, a population (tribe) that has been colonized by a

specific language precludes the colonization by a second, adjacent tribal language. However, languages, unlike viruses, are not a genetic-based information system and do not evolve by the same principles. Yet it is an adaptive and dynamic information system that does have a transmissible character that stably colonized human brains (it host) and populations during crucial periods (childhood) of identity transfer. In so doing, it provides a common system of group identity and also provides a system that resists other identities. Because meanings are only fully maintained within one language group, the benefits of a common language are restricted to that language group. However, because language is not a genetic-based system, it is much more adaptable and can readily and rapidly be extended to very large social groups that have no genetic linkage. This could be accomplished within the duration of one generation in which offspring are now raised in the presence of the new language and their brains become colonized by that language. Thus, unlike facial (or racial) visual imprinting, language has a greatly enhanced social adaptability and promotes group communication and cooperation on larger and more dynamic scales. For this, language required a much more complex social brain to process and understand the large increase in audio complexity and abstract pattern recognition needed for a recursive language. It would also be expected that a language-based identity system must engage in some forms of addiction module involving emotions. Clearly language can convey a strong emotional content. And language can exert a potent transmissive control over the actions of others, clearly a social function. The command or urgent voice of a mother to her infant can exert considerable control over the independent actions of the infant. Fear and anger, for example, can readily be transmitted by such mother's commands. In terms of the basal maternal or pair bonds, it is clear that language can have a powerful role. Even mis-information transmitted by language can induce emotionally potent bereavement reactions, for example. In fact it can be argued that the majority of words in most languages are emotionally charged and in some instances they are highly charged. In English, for example (a language with various linguistic roots), most words are metaphors and expressions are rich with rhetorically charged emotional expressions, often associated with favorable or despised group identity.

Descriptive and Objective Language

It is also clear that language has a very functional and potentially objective or descriptive character to it. Language provides a media that can transmit information important for survival (concerning food or defense, or danger for example). Clearly, the benefit of language goes beyond any strictly social role in group identity, and in this feature language may have partially escaped from a strictly emotional basis for social or group bonding. By providing clear but functional information regarding survival, language is a crucial and emergent phenotype of our large social brain.

A Developmental Window

During language acquisition, many biologically based associations are seen. The most apparent is the neurobiological developmental window during which language acquisition is effortless. Numerous observations suggest that if language is not acquired by age 7, the person will never entirely catch up with training during childhood and will struggle with the higher syntax of language. In the case of feral children rescued as young adults, their speech level will typically attain that of only a 5 year old. Such feral children that have learned language late will also be unable to develop deep cognitive or thinking skills. Their brains appear to remain undeveloped and unable to develop more abstract or complex forms of pattern recognition. Thus a brain that has developed without a language colonization is a less capable brain. This clearly resembles a state of symbiosis between the brain and the language. The rate of normal language acquisition is impressive. During childhood development, children acquire about 8–10 words per day, a phase that has been called a vocabulary explosion phenomena. In order for such a high rate to be achieved, it appears that words must be acquired in a parallel, or distributed, process. The usual level of attainment for individuals after education at college level will be a vocabulary of about 60,000 words. This will have taken an estimated 75,000 hours during which much brain connection and remodeling has occurred. Thus during this developmental period, a new language identity has been acquired that has altered patterns of brain development, and transformed the cognitive capacity for abstract thought and learning.

As mentioned, a recursive language not only greatly expands the possible meanings of language but also required a large expansion in the ability of the brain to recognize very complex (perhaps infinite) vocal patterns. Such syntax-dependent meaning leads to the need for alternate meaning or alternate emotional reactions for the same specific word sound. From this, we can see how general intelligence was also greatly enhanced. The ability to think abstractly, including the ability to imagine alternate meaning and what has not or cannot be seen or heard as well as to imagine emotional reactions, was the product of recursive language. It is therefore likely that the much extended human brain development in human infants is associated with the demands of a recursive language on our social brain in order to promote effortless language acquisition. Thus not only does the development of recursive language place stringent requirements on the pattern recognition capacity of the brain, the acquisition of language itself transforms the cognitive and thinking capacity of the colonized brain by promoting more complex brain connections. It also provides a vocabulary that becomes used for internal dialog as used in conscious thinking (see below). In providing these features, language not only transforms human group identity, but also transforms human social intelligence and potential for general intelligence.

Social Learning, General Learning and the Social Brain

Our large social brains were thus especially enhanced as an evolutionary product of recursive language-based group identity. As a consequence of such enhanced social and abstract capacity, humans were indeed transformed in how they learn relative to the other great apes. In most mammals, mothers are most responsible in training offspring. One basal lesson they provide is in training what other species to fear. As a side note, mice inherently fear cats, but ablation of the mouse VNO olfaction yields mice that do not inherently fear cats, but can learn to do so. It is clear that in most mammal species, training can override fear of natural predators. Such fear is normally acquired observing the mother's emotional reaction. However, mothers can also contribute to non-fear-based training or learning. With chimpanzees, for example, mothers will teach offspring how to crack nuts which seems to be one of the more difficult skills young chimps are taught (around age 10). However, there are clear social differences in chimp mother–offspring training from that of humans. Although imitation seems crucial for both species, with chimps, young observe their mothers intently, but the mothers seldom observe their offspring when teaching. Chimp mothers seem unconcerned with the mental process that is occurring in their young, showing no eye contact with their pupils and not reacting to facial emotional states or reiterating parts of the lesson. Chimp young simply observe and attempt to copy their mother with no feedback from her. It has been proposed that chimps lack theory of mind and thus do not concern themselves very much with the mental states or processes of others. Thus when learning to crack nuts, (their most complex technology), infant learning is inefficient, taking years to acquire. This absence of the mental awareness of others may also relate to the different relative states of consciousness between chimpanzees and humans, which also requires self-awareness, as discussed below. Another major development in chimpanzee learning concerns young males that learn to hunt in groups. This occurs at the time of sexual maturation. But besides learning to hunt prey, they also form strong male in-group bonds and learn to hunt strange (non-group members) male chimpanzees, suggesting this learning might be also the development of a male-specific group identity process. The resulting competence of the trained young male is that not only do they participate in group hunting, but also participate in group attacks on lone males they do not recognize.

In contrast, humans are very much aware of the mental states of other humans that are learning. For example, in a human classroom where we can evaluate the gaze patterns of children, we see many children watching other children as well as watching their teacher: that is, child A watches B watches C watches the teacher. This is an inherently recursive behavior absent from chimps, in that children must be thinking about what others are thinking. The gaze pattern with chimps is one where animal A watches its mother as do animals B and C. In chimps, these non-recursive interactions are consistent

with the absence of theory of mind. This learning pattern is social and identifies a crucial aspect of human social structures and group identity that differentiates human social structures from those of the great apes. Yet, chimpanzees are clearly better learners (by observing others) than are other apes. For example, in contrast to chimpanzees, baboons will not learn from watching the actions of others (like chimps) regarding learning to use sticks for termites. They simply wait until chimps have finished to go in and gather any remaining termites.

General human learning thus seems to be a byproduct of visual and vocal-based social learning that was much enhanced by acquisition recursive language and the resulting large social brain. In the field of human learning, general learning has often been thought of as a special creation, essentially from an a-biological perspective. The field of psychology has also identified many human behavioral tendencies and created many clinical evaluations that seem to provide some reproducibility of behavioral phenotypes. But such approaches have also essentially lacked attention to the underlying biological mechanisms, let alone how social learning behaviors were selected as evolutionary adaptations. With the concepts associated with group identity, we can now provide direct links between group behavioral characteristics and underlying biological mechanisms as well as associated evolutionary pressures.

Learning and Resisting Learning: a Stable Social Identity

Let us now summarize characteristics that support the assertion that language is a group identity system that has all the needed features for such a role. As mentioned, language differentiates otherwise identical human populations. It has an adaptive and transmissive character that is transmitted from old to young during a crucial period of development in young, where it is readily learned in a stable way. After brain colonization, language resists displacement by other language (identity) systems. As a result of colonization (stable learning), it marks population as distinct, adds both identity and capacity, inhibiting communication between populations that use other languages. It provides benefits to host (common communication, language-based general thinking, survival information). But it also identifies non-members as foreign. It is important to consider in greater detail the consequences of acquiring language by learning, since, as we will see, this will also identify an counter intuitive need to resist learning. Learning can be considered as the acquisition and acceptance of new information. If as asserted, language originated as an information system of group identity, the colonizing language must readily attain stability (be learned) during development, but once colonized must also resist displacement by subsequent languages (identities). Thus, the continued learning of subsequent languages becomes disfavored and the learning of more languages difficult. One direct implication of this assertion is that the resistance to learning (beyond a crucial developmental window) is fundamental to the use of language

as a learned set for social identity. Both learning and resistance to learning are required. Indeed, resistance to learning is essential if learning is to serve a role in group identity. In the terms of the use of language, the resistance to learning a subsequent language appears to have an inherent biological basis associated with brain development in children. Learning becomes either closed or difficult afterward for most individuals after this window. However, the resistance to learning is not absolute, since language competence can continue to develop in older children. In addition, learning resistance need not theoretically be limited to developmental neurological windows. Such learning resistance can also be attained cognitively in a more developed brain (such as a mind). As presented below, such stable cognitive states for information are called 'belief states' which resist new information or learning (via closed minds). Thus the concept of 'belief' and its role in learning or resisting the learning of new information can serve a crucial role in group identity. We will now consider some of the biological observations that relate to this role of learning and belief.

Neural Substrates of Belief Indicated by Brain Damage

I have just asserted that belief, defined as the resistance of new information or new learning, is a needed feature of the use of learning in social identity. Previously, we have noted that a major region of the brain (the right hemisphere) is involved in belief attributions. We can now start to consider what role belief has in human social structures and if this has required special neurological adaptations. The development of the large human social brain also requires the development of an enhanced capacity for social learning. Any social information that is to be used for group identity will also need to be stable or attain belief states. Are there then any neurological substrates for such belief stability? The usual way we identify function- or domain-specific brain regions has been as the consequences of damage to specific brain structures. Accordingly, damage to right hemisphere can show specific belief deficits. In one example, an 85 year old woman developed a flaccid left limb paralysis following a stroke. Although her memory was normal, she lacked awareness (belief) of her deficit and denied its existence when questioned about it. She did not believe she had a problem and this belief state resisted learning and was not affected by demonstration of her paralysis or instruction about it. She was resistant to new reliable information. Instead of accepting the validity of such demonstrations, she would rationalize a confabulated explanation. A conclusion that was reached from such a clinical presentation was that the belief system of this patient had been damaged. Other similar cases are known. People with left temporal parietal junction brain also show it is needed for normal reasoning about beliefs. In some patients, it is clear that visual self-body part pointing can be affected by brain damaged. One such disease, autopagnosia, involves representation and pointing to body parts. Following brain damage, some patients are

able to point to another persons body parts but not their own. Somehow, their self-representation has been damaged. The converse deficits are also seen. In other studies, the ventral medial prefrontal cortex was reported to be involved to override logical reasoning. An fMRI study of people undergoing reasoning that is either consistent with or inconsistent with beliefs shows that left temporal lobe is engaged during belief neutral reasoning. This parietal system is known to be involved in representing and processing special information, associated with mathematical reasoning, and numeric approximations. In contrast, ventral medial prefrontal cortex (VMPFC) is engaged when reasoning must overcome belief bias suggesting an influence of emotion on reason. VMPFC highlights its role in non-logical, belief-based responses. In general, it appears that the left temporal lobe is engaged during belief-based reasoning. Deductive reasoning and drawing valid conclusions should logically be a closed system. But clearly beliefs can compel people to logically invalid conclusions. During such reasoning, participants will rationalize or explain their beliefs (even falsely provided beliefs). These results taken together lead us to a very interesting idea. Normally, we consider the process of rationalizing some explanation as a simple attempt to explain what was true. However, one implication is that rationalization is often a confabulated mental activity intended to support or defend beliefs. Thus, we inherently tend to generate explanations that support our beliefs. Since our brain appears to have domain-specific reasoning functions regarding belief states, it seems that specific domains of the brain are involved in the contents of beliefs (belief attribution). There are also some developmental observations that suggest that a belief function appears to develop after perceptions and emotions functions are established. The existence of such brain structures in a large social brain also suggests they are also involved in social identity.

Clearly, belief, emotion and memory must be linked, but how they are linked is far from direct. Belief must involve stable memories in some way, but these may be distinct from short-term memories. One telling example of this idea was seen with amnesic Clive Wearing, a BBC music expert, that developed herpes encephalitis (March 1985). HSV-1 is a neuron-specific virus that persistently infects most humans. Clive Wearing developed an unusual encephalitis that involved his hippocampus (associated with long-term memory). In addition, there was some temporal (amygdala) and frontal lobe involvement. As a result of this infection, regions involved in transfers of memory were damaged, but in a particular way. Every day he appears to restart his consciousness when he awakes and he claims to have just woken up from a coma of many years, and disbelieves any evidence to the contrary. Yet, long-term memories and beliefs are intact. Thus he fails to accept any evidence that contradicts his false belief. For example, he remembers being in the active Navy (as a young man), although he was then over 60 years old; his early memory was more compelling (accepted as a belief) than the current logic he was presented with (i.e., he was too old to be in the Navy). This is like many patients with damaged belief reasoning that will confabulate denials of physical evidence (sometimes

preposterous), including as proposing dead people coming back to life, in order to explain their memories or false beliefs. This tendency implies a biological basis for rationalizing, which need not involve causal reasoning. In the case of Clive Wearing, it was also clear that he still retained strong and recent emotional bonds (memory). He clearly still loved his second wife, Deborah, although they had been married only a year before his illness, which was clearly within the range of his other short-term memory that was lost. This retention of this recent emotional bonding clearly suggests emotional memory and bonds use distinct memory mechanisms. Also, he still remembered how to play the piano but would react with strong emotion upon stopping play as he seemed no longer able to control emotional memories elicited by the music. It thus appears his brain has distinct domains concerned with the emotional memory (romantic love and music) that were mostly undamaged. It is surprising that such mental specificity was brought on by a virus. A virus is usually thought of as a simple destroyer of tissue. Clearly its affect on Clive Wearing's consciousness was highly selective and reminds us of a computer virus that compels its host computer to continually reboot. This case also raises the question of what then is nature consciousness if no recent memories are needed? What constitutes self? Does this only require awake states plus stable memories including emotions? These questions are explored further below. Another relevant issue concerns this illogical belief that fully resists verifiable information. Similar resistance to logic, such as people believing in alien abductions, are also discussed below. Both these situations appear to identify specific alterations in consciousness associated with belief that resists logic.

We start to see a biologically based role for beliefs, or other stable forms of cognitive or emotional memory (including language), in the function of our social brain. Resistance to change in memory is essential for the stability of memory-based group identity. I have asserted stability is generally attained by the action of addiction modules. How then do beliefs and memory operate with regards to possible addiction modules? What, for example, might be toxic or antitoxic with regards to a stable memory? What emotional modules are engaged when stable belief is set that will resist evidence to the contrary? Language is the foundation from which higher cognitive capacity developed. We should now consider how language may have led to the developments of belief in group identity.

A Short History of Early Language

The topic of the origin of language should be approached with some caution. Extant humans are immersed in the complex fabric of intellectual life that has been made possible by modern language. The very consciousness of the modern mind is mediated, in part, by the internal voice provided by our language, thus language is hard to separate from our minds. As we now come to examine the

basis for its development from the perspective of group identity, it needs to be acknowledged that the study of language evolution has a long, unproductive and checkered history. At one time, discussions on it were banned from some scientific societies due to their contentious and non-productive nature. Indeed, following the publication of Darwin's 'Origin of Species', after 1859, it was the topic of language evolution that was the source of strong anti-Darwin attacks. Chief amongst these attackers was Max Müller, who felt that Darwin's theories could not possibly account for something so complex as the evolution of language and thus used derogatory names (i.e., bow-wow theory) to attack Darwin's ideas. This compelled Darwin to consider this issue in his second book as he examined song as used in birds as a likely predecessor to language. Language dominates as an agent of human education and culture. How did we get to the point where the average college-educated person knows 60,000 words that represent essentially infinite set of ideas and took about 75,000 hours (about 9 continuous years) of learning to acquire. Recall that chimp's use of sign or symbolic words are sensory only. Chimpanzees are able to represent what they see or observe via their very limited vocabulary. But humans can represent what they imagine, or what cannot even be seen as mediated by language. Most of the words in human language are metaphors, not sensory or descriptive. Above, I argued that our large social brains were selected to evolve by the neurological demands of a recursive language used for social identity. However, the Neanderthals had brain sizes equal to or slightly larger than that of *Homo sapiens*. Does this suggest that they also used a recursive language? It seems likely that the large Neanderthal brain was also social. Neanderthals were in Eurasia for 200,000 years and were stable occupants of Europe for 50,000 years, until about 30,000 ybp when they became extinct. But Neanderthal child development was different from that of *Homo sapiens*. Although big brained, they developed their brains more like a chimpanzee in that adult sizes were reached by 4 years of age. Such rapid brain development would appear unable to provide the extended brain development that could be molded by the neurological demands of a highly recursive language. From this, it would seem their language capacity would need to be quickly attained and hence less developed or more biologically determined (such as universal grammar). We do not know if Neanderthals also underwent the late adolescent development in which the frontal cortex completes its development. However, it does seem likely though that the Neanderthals had developed language to the point where it was a group identifier. There is also good evidence Neanderthals held beliefs, since they buried their dead. Thus their language must have been able to communicate some degree of belief or acceptance and in this they resembled *Homo sapiens*. But they did not represent abstract symbols or paint symbolic faces so it would not appear that they had a strong tendency to associate abstractions with group membership (an indirect sign of recursive language capacity). It also seems clear that they were less imaginative than *Homo sapiens* since they showed little innovation in their rock tools for extended periods.

Homo sapiens are estimated to have emerged about 200,000 ybp. This aligns closely with estimates of the development of their physiology capacity for modern speech, which is also estimated to have developed about 300,000 ybp. Curiously, the FoxP2 gene, which is thought to be important for language is estimated to date from ~100,000 ybp. Full recursive human language appears to have been in use by *Homo sapiens* since about 50,000 ypb. Congruent with language development, we see that the emergence of humans of art (symbolic representation) and burying of their dead (belief attributes) becomes prominent. Thus, with the emergence of modern humans, we also see a sudden proliferation of various symbolic items, personal ornaments, abstract figurines and cave drawings. As mentioned above both musical instruments and art can be dated from 30,000 ybp and since both music and art convey and amplify abstract emotion content, such cultural forms can also apply to the formation and stability of social identity. This is consistent with the evolution of symbolism as an element of group identity. In terms of early forms of human language, it is interesting that 'click-speaking' as used in South Africa (Damin language) is thought to be ancestral to most other languages. In its current state, this language is used mainly during manhood initiation ceremonies. In this regard, it clearly appears to be used for tribal identity development.

A History of Early Group Conflict

Thus it is proposed that abstract and symbolic elements became used for social membership purposes. Symbolic stories also were adapted for use in group identity. About 30–40 kybp, there was a tremendous expansion in symbolic behavior of humans. In addition to the artifacts mentioned above, body painting became prominent, which can be considered as a visual symbolic group identifier. It is also at this time that not only bone flutes, but also spear throwers were introduced. The use of spears and throwers is generally associated with the development of more efficient hunting. However, I suggest that this technology would more likely initially have been invented for the purposes of human–human conflict between groups. In this regard, humans would be similar to chimpanzees that use group hunting for both prey and to attack other chimpanzees that are not group members. I suggest humans undertook a similar dual use for the development of spear technology, but that inter-group violence or group conflict was the initial selection for this technology. Chimpanzees did not develop weapons for group conflict purposes. But more imaginative humans did. Evidence that weapons technology was generally used for group conflict can be seen with the 'Iceman' who was found preserved after 5,000 years in a melting glacier in the Alps. It is now clear that his death was due to the action of other humans. The Iceman had a bow and arrow technology, generally considered as primary hunting weapons. But he died by bleeding to death from an arrow in the back. In addition, he had knife wounds on his hand indicating

defensive wounds from attack by another human. It therefore seems clear that he was the victim of group conflict, much like a lone male chimpanzee might be a victim of troupe aggression. It also seems the Iceman had tattoos. Tattoos are symbolic emblems that could have also been used for group membership purposes, much as they are often used today in urban gangs. In humans, language, symbolic identity and beliefs, not just troupe association, became important for group identity. With the expansion of human social identity systems, we would also expect an expansion of conflict between otherwise similar human populations as we expect non-identity to likely be met with group hostility. Group identity remains a fundamental force in human social structures that drives innovation. Just like modern humans invented first fire arms then later the atom bomb for the purposes of group hostility in wars, I suggest that our ancient ancestors similarly invented spear throwers.

The Role of a Paleolithic Mind in Social Identity

A Social Mind Originating After Language

Humans of all cultures, including hunter gatherers, are story tellers in which cultural traditions and meaning are maintained by language. Clearly, social cohesion was promoted by language, allowing the transmission of not only information, but of oral traditions that are socially binding. And it is through such oral traditions that larger social identity can also be promoted. With language, the brain and the mind are the substrates for colonization (learned) by information-based identity. Thus with the emergence of the human mind we see the emergence of another entity available for social bonding; the mind. As our large social brain now supports an internal dynamic state we call the mind, this can also be selected for social membership. A mind can be considered to be the collective state of consciousness, memory and sensory input and that involves a sense of self. Evidence was presented above that mental states can also be socially linked between individuals (mirror neurons, emotional contagion, empathy systems). Thus our minds appear to have a considerable social interacting capacity as an inherent character. Given the strong biological basis of this, it is most likely that all these characteristics were also present in the minds of Paleolithic humans and contributed to their social structures. Early human cultures had memories, dreams and imagination that were available for social purposes. They held beliefs which must also serve social functions and like modern humans were also likely prone to hallucinations and religious experiences. As demonstrated above with Clive Wearing, a conscious mind needs sources of stable memory. But memory is the product of and can also be altered by learning. Thus, for use in social identity as described above, a mind would need to have both open and closed learning states in order to set its group identity but resist subsequent identities. Both language and belief acquisition

have this open and closed character. A social mind would also necessarily require some form of social control over an individual (via addiction modules). If we consider the developing mind of an infant, it seems clear that the mother can initially exert considerable control over the will of the early infant. The urgent command, fearful voice and emotional facial expression of a mother can in some cases override the volition (conscious will) of her infant. Thus, a mother can to some degree command the mind of an infant as an extension of the mother's mind. However, with more development, the infant will become a toddler, able to (possibly needing to) resist the will of the mother as a sense of self develops. The mind can become closed to external agency. However, we can also see other circumstances in which human minds will remain accessible to external agency. The susceptibility of a mind to external (or alternate internal) directive or command appears to be an inherent feature in the developing mind. As presented below, the ability of most minds to undergo hypnosis appears related to the ability of vocal commands to engage in regulatory mechanisms that have been proposed to be integrated into the attachment or imprinting systems in individual behavior. Thus the volition control of individual behavior appears to have some inherent capacity to be overridden, most likely for social control of an individual mind (see also schizophrenia). In this case, sense of self (consciousness) is not always controlling behavior. How does the conscious mind participate in such unconscious social control? What is the relationship between sense of self (individual consciousness) and a social (possibly subconscious) mind?

Active Frontal Cortex Is Needed for a Conscious Mind and Sense of Self

The frontal cortex represents a newly expanded brain structure of the large social human brain. It is thought to be essential for the state we call consciousness. This state can be clearly recognized by its absence by neuroscientist, and involves being able to respond to sensory stimuli. Thus it appears consciousness requires a sensory stream or similar (memory) communication to be engaged or maintained. The cerebral cortex also contributes to consciousness, whereas cerebellum does not. Consciousness is the primary aspect of our lives. John Locke proposed that for the concept of a person to operate, one requires a mind with the capacity for conscious experience and its permanent loss is equivalent to the death of a person. The representation of self can be considered as a conscious construction of the brain. Although we are born with inherent tendency for maternal social links, it does not appear we are born with a sense of self. It develops along with greater consciousness during childhood. During such development, it might recapitulate the evolution of the mind and its association with recursive language. It is well established that the 'understanding other minds' also develops during childhood. At the age of 3–4 years

children start to use whole sentences and represent mental states, thoughts and beliefs of others (theory of mind). Consciousness, memory and sleep are all linked. During slow wave sleep, for example, consciousness is much reduced but neural activity is as high as or higher than waking state. Thus consciousness seems to be a dynamic state that integrates a stream of information which is normally a non-static, temporal sensory stream (such as visual). Recent results with coma patients in minimally conscious states have added to our understanding of this state. Eye opening and visual sensation can be used to monitor consciousness. The thalamus (involved in motor control and sensory relay) sits between brain stem and the cerebral hemispheres and is considered a gateway needed to activate cortical networks. This gateway also allows verbalization. In one clinical study, deep electrical stimulation of the thalamus restored consciousness to a patient that had been minimally conscious for years. Thus it appears that consciousness requires dynamic consultation of information normally through the senses and memory. In the case of Clive Wearing mentioned above, it was clear that essentially no short-term memories were needed. However, alternative states of consciousness, such as during hypnosis (described below), appear to also exist, although such states may alter volition and relate to social control. Other studies also support the view that our thoughts (mind) are literally linked to our vision. Small eye movements known as 'microsaccades' can give away mental attention (thoughts) even when gaze is consciously directed differently. Such a linkage would provide a conduit needed for a social mind, and a skilled observer could literally see what others might be thinking. The ability to inhibit such a natural tendency (socially broadcast thoughts by eye and facial movements) may well underlie the skill needed for maintaining a poker face. Conversely, major politicians appear to be especially skilled at reading the gaze and facial expression of social groups. Indeed, it seems humans do have social minds. Yet a mind is an abstract dynamic state, not a thing that can be physically and statically defined. Understanding a mind required the abstract capacity of recursive language.

Another very recent study further informs us that consciousness is a dynamic construction of the brain that may have no firm biological residence. Sensory input seems generally important for the state of consciousness. However, such input can be manipulated to alter conscious perception. Recently, scientists in England and Switzerland used goggles that project video images and also used physical contact to communicate touch, creating sensory illusions in the subjects. The subjects were viewing the backs of their real body, while receiving unseen physical touch. This sensory illusion induced an 'out-of-body' experience in that subjects reported that their consciousness had drifted from their real bodies into the virtual ones provided by the video goggles. This suggest that this state of displaced consciousness was promoted by viewing of self (possibly activating the mirror sensory neurons) that promoted a mental association linking the virtual and real bodies. In this case, the 'other' vision was self and the self-perspective was a virtual self. This study supports the view that consciousness is a transient, dynamic construct of the brain created by multiple

sensory sources and memory. I suggest such apparent transfers of conscious states were also made possible by the biologically based social human brain. Accordingly, it had been previously known that damage to specific brain regions could also induce such out-of-body conscious states. What then constitutes a conscious self if we can move it to virtual bodies? Our modern understanding of consciousness involves a sense of self which also involves a sense of agency. We strongly believe in human intentionality, as a culture. But the sense of agency, like self, also seems to be dynamic mental states that can be externally manipulated.

Hypnosis and Alternative States of a Social Mind

Hypnosis is a state (trance) in which one's mind becomes subjected to external agency. This is an altered mental state (consciousness) during which one becomes susceptible to the vocal suggestions of others. Since consciousness itself requires a dynamic sensory stream, it is most interesting that hypnosis can induce visual, audio and other sensory perceptions that are not actually happening (hallucinations). Hypnosis can also block or inhibit actual sensory streams, such as thermal pain or vision. Such hypnotic analgesia appears to be mediated by mechanisms involving release of opioid peptides in CNS, as it can be reversed by naloxone. These analgesic states involve activation of specific brain structures and deactivation of others. Thus it appears hypnosis may prevent nociceptive inputs from reaching higher cortical regions that perceive pain. One can also hypnotically induce pain, not just block it. The existence of hypnosis thus also identifies the existence of alternative, internally derived (dream-like) mental sensory streams, presumably derived from memory or imagination. The state of hypnosis is thus the product of external language instruction that leads to an altered state of consciousness involving a temporal flow of virtual internal senses. It appears that the external oral suggestions have displaced the inner voice of consciousness which also indicates the capacity of language (a social medium) to influence consciousness and control agency. Inducing a state of hypnosis is associated with mental relaxation and mental adsorption. It appears that hypnosis provides obstructive hallucinations that allow a hypnotic focus inward (e.g., a back flow sensory stream) as opposed to external sensory stimuli. During hypnosis, sensory cortical sources show decreased arousal. Much of the population is susceptible to various degrees of hypnosis. In men, 80% of subjects appear to be able to enter the first stage of hypnosis, and about 25% can enter second and third stages. Much of this susceptibility is heritable. Curiously, it appears individuals with strong belief-based reasoning are less susceptible to hypnosis. In contrast, individuals that do not hold such strong belief-based reasoning seem more susceptible, so some link to belief status seems present.

During hypnosis, a state of mental adsorption is reached, in which one shows a diminished tendency to judge or exert an independent will. One's own

response seems to become automatic with a loss of agency. Thus internal volition becomes subjugated to external vocal stream. This sense of will may have a specific brain substrate. For example, some patients with lesions in anterior cingulate report developing an 'empty mind' state with no will to reply verbally. Seemingly, the normal internal voice has lost initiation control. Such patients show EEG patterns (theta activity in the cingulate cortex) that resemble people under hypnosis. Both hypnotic subjects and these patients lack desire to initiate activity, although in both the level of awareness is good.

Hypnosis and Sleep

A loss of volition and control also occurs during sleep. In addition, dreams involve internally generated sensory streams from memory thus resembling hypnosis in this as well. However, brain states during REM sleep and hypnosis clearly differ. The EEC patterns of hypnosis resemble those of an awake state, not REM. Therefore hypnosis does not seem to use a dream-based visual stream, and unlike dreams, it retains a open sensory stream. However, it is interesting that during REM sleep, this frontal cortex goes 'offline' allowing a dream stream to communicate. Clearly, dreams, hypnosis, memory and external and internal (memory) generated sensory streams, and memory (visual) shows some similarities. Hypnotically induced visions can also resemble other forms of hallucinations. Both types of visions require an unconscious synthesis. Thus hypnotic suggestion can override conscious will, and block external sensory streams and allow internal mechanisms for streaming sensory information. Although similar to dreaming or sleep walking, this in not a REM state.

Why should a capacity to be hypnotized by language exist in our large social brain? Was this the product of some evolutionary pressure regarding needs for social behavior or group membership? Did such control initially evolve for the purpose of maternal attachment and/or control of infant behavior? It has been proposed that indeed hypnosis is related to maternal attachment mechanisms in that hypnotic suggestions engage self-regulatory mechanisms that were integrated into attachment and imprinting instincts. In order for a mother's voice or her language to bond to or control her infant, volition control by the infant must be able to be interrupted by the mother's voice. Hypnosis suspends a self-regulatory mechanism (most likely involving the amygdala). This appears to be a direct product of evolution of attachment via voice, requiring control, and resembles visual attachment in birds. However, unlike avian visual imprinting, hypnosis requires learning the emotional content of the mother's voice for the infant to accept directives. For the mother's voice to communicate action, it must compel the emotions of the infant, thus her voice must have emotional (readily learned) meaning. Thus, it seems unlikely that such social attachment could be attained by a language that lacks emotional content. Clearly, explicit commands cannot be orally communicated to an infant, before meaning is

learned. Only emotional tone might be communicated early in infant development. Human infants (especially their first year) do instinctively respond to parental communications (which requires a self-regulatory reaction). During this period, infants do not show emotional hostility or negativism, needed for social identity. Recursive language acquisition and theory of mind seem needed for this to develop.

Social Mind and Sense of Agency

Above, it was asserted that consciousness itself (the mind) can participate in human social identity structures. A social mind participation requires that social information (visual, facial inputs, spoken language) must also be able to exert some emotional control over actions. If so, social emotions must bind the individual minds, similar to the affect of a mother's voice on her infants. Thus the sense of self and agency (consciousness) must be open to some degree of social control. Accordingly, I would also expect such social bonding would need to use addiction strategies as do all other group identities. Clearly there exist both normal and diseased mental states in which the sense of self and agency are disrupted. The sense of self, or conscious self-awareness, develops later in infant mental development, but clearly needs stable memories. And hypnosis informs us that there clearly exists a capacity for alternative internal (virtual/vocal) sensory streams (an altered consciousness) that can control both sense of self and sense of agency. These observations together suggest that the mind has the characteristics needed for participation in social group identity. However, as a culture we hold strong belief in full human intentionality, which dismisses any significant effect of group or social consciousness. Human actions are considered as the results of individual consciousness, not under social control. It now seems clear that things are not so straightforward as we might wish to believe. Overall, human behavior must have a strong social component and instead resembles an assemblage of individual consciousness and social–emotional directives via suggestions, habits and urges from others we are bonded to in various degrees. Our actions only partially depend on volition, although education can alter this independence to some degree. The social circumstances during the mental developmental of a child can affect how 'social' their minds become, but so can genetic variables (see vole bonding genetic variation). A social mind thus resembles an imprinting-like situation that develops early. However, a social mind is not necessarily fully maintained during education. The continued development of 'self' and the resistance of self to social beliefs appears able to override strong social bonds.

Hypnosis is not the only process that can induce visual and audio (voice) sensory hallucinations. Psychoactive drugs, brain damage, mental disease and religious experiences can all induce various forms of sensory hallucinations. Interesting that many of these situations are also associated with a loss of a

sense of agency or conscious control. Somehow, there seems to be a common relationship between a social mind, hallucinations and a sense of internal or external agency. Perhaps all these are epiphenomena of a recursive language-based social mind that must be open to external (social) agency. There are other circumstances in which self-generated actions can be attributed to external agents. Delusions of alien (external) control is one example that is also associated with schizophrenia (described below). Such states are associated with parietal cortex activation. Also common in schizophrenia are vocal hallucinations attributed to commands from God (perhaps the most potent and abstract of external social agents). Schizophrenia can clearly involve a loss of sense of agency, and induce alternative internally generated sensory streams (private internal voices) that can command free will. It is thus interesting that some schizophrenic patients make excellent hypnotic subjects and are able to hypnotically induce various psychiatric symptoms. It thus seems likely that schizophrenia may represent dysfunctional aspects of social mind.

Schizophrenia, Command Voice and Social Mind

The most diagnostic symptom of schizophrenia is hearing internal voices, that are often command voices (i.e., from God). It seems clear that language, meaning and memory must somehow be essential to this state and that language as a media of external social control has become a media for alternative internal control in schizophrenia. There are other links between schizophrenia and language. For example, some researchers have proposed a reversed language dominance in schizophrenia (with left hemisphere dysfunction). fMRI studies of normal people indicate a right-lateralized temporal lobe activation upon hearing human voices, but this seems impaired in schizophrenics. In addition, schizophrenics show verbal memory dysfunction as a most consistent cognitive problem. Thus the capacity to hear internal (command) voices appears to be a biological legacy from the development of a social brain (mind). Interesting, as proposed in 1976 by Julian Janes, early leaders of human social groups often heard voices that were then used to command social followers. Such capacity to hear internal command voices is still relevant to religious and other tribal social experience. That such internal dialogue may provide a source of new knowledge for many ancient cultures also seems common (discussed below). Clearly, the evolution of a brain able to understand the complex patterns of a recursive language is relevant to this disease.

Voice Memory in Schizophrenics

Humans are very good at recognizing voices, songs and emotional content with the minimal sets of sounds. Therefore our brains have potent audio pattern

recognition that can work from sparse information. This suggests that an equally potent and sparse (i.e., abstract) memory systems must exist to recognize similarity. Memory and recognition must fundamentally involve a reversal of sensory stream to the cortex. As the main symptom is hearing voices (usually the same voice), schizophrenia clearly involves voice and language memory systems. Since these voices can be commanding, it also has emotional potential for social control. These verbal hallucinatory aspects of schizophrenia can often involve the reproduction (memory) of the same verbal content. In this memory, it seems auditory cortex (Herschl's gyrus) shows aberrant activity, which is mostly associated with emotional stress. However, hearing the same words expressed with similar emotional valence does not activate this region in schizophrenic patients in that such external sensory input did activate the orbitofrontal and medial prefrontal cortex, associated with cognitive control of emotional processing. Thus an external stimulus of similar content is not equivalent to the hallucinations from internal origin.

Aberrant Schizophrenic Social Biology

A schizophrenic state may thus be an aberrant version of normal social mind mediated by language. Since related mental states can be biologically manipulated and induced in normal subjects, this suggests that these voice and commands represent some inherent capacity of our social brain. For example, PCP (phencyclidine) and ketamine can induce both the positive and negative symptoms of schizophrenia in most normal people at adequate doses. During such induction, hyperactivity in cortex is observed. Interestingly, naloxone will inhibit unusual thought content of schizophrenics, but will not improve mood or other symptoms. Another reason to suspect some linkage to normal brain social biology is the curious linkage this disease has to the development of young adults and adolescents. Adolescent onset is a characteristic of schizophrenia. In addition, adolescent males are more affected in most populations. Since this is a period of considerable mental plasticity that is also associated with the last phase of cognitive development and the acquisition of male-like group (social) behaviors, and identity, including voice deepening, a derailing in the development of a social mind seems possible at this period. The deepening of voice is interesting from an evolutionary perspective. Recent estimations from vocal bone structures of Neanderthals suggest that Neanderthals had high-pitched, child-like voice. However, we are unable to answer the question regarding the occurrence of schizophrenia in Neanderthals, but with evidence of their reduced imagination, music and abstract art, it suggests schizophrenia may not have been a problem for Neanderthals.

Schizophrenia has often been proposed to be the byproduct of the evolution of a social brain and language in humans. About 80% of schizophrenia is estimated to be heritable (via twin studies). However, schizophrenia is not

fully determined by genetics and also shows some epigenetic component. For example, dizygotic twin studies have shown that in some cases, one twin will develop schizophrenia, but not the other. Such a situation has been used to try to isolate the underlying biological differences between them. Schizophrenia involves frontotemporal and frontoparietal circuits. In one study, RNA expressed in the affected areas was subjected to an analysis which is used to isolate over-represented transcripts in affected brain regions (aka RDA). Interestingly, this resulted in the isolation of transcripts from an endogenous retrovirus, the SZRV-1 sequence. This ERV was similar to MSRV and ERV-9 described in the last chapter. Interestingly, related transcripts are also found in the placenta. As this is an endogenous virus, the mechanistic implications of this observation regarding schizophrenia remain obscure. However, this suggests some ancient but unknown process that was initially associated with maternal bonding (via ERVs) and has been adapted to language-based social bonding. Since ERVs are also under epigenetic control, they might also be relevant to the development of schizophrenia.

It is thus interesting that schizophrenic families tend to generally have intense interest in religion. Since religion and belief appear to be inherent characteristics of Paleolithic social structures, belief seems to represent a major and apparently new component of such early human social bonding. Acquisition of religious belief often involves transcendent states of rapture or euphoria. In this, belief can have an addictive (but cognitive) component of a T/A module needed for a social mind. If so, the related ability of psychoactive drugs to also induce states of rapture may be identifying the biological substrates involved. Language has a high emotional content. It is estimated that current languages are mostly composed of metaphors, words that are emotionally laden. Interesting that schizophrenics will sometimes speak only in metaphors, whereas autistic people (a different disease of a social mind) often fail to understand metaphors. Schizophrenics seem to have a disturbance in the emotional valency of their language usage. Conversely, some autistic savants, such as the Rain Man, although processing amazingly detailed memories, could not use or understand metaphors. In this case the emotional valency of language is diminished or lost entirely. Both these states seem related to brain lateralization in which right hemisphere damage is associated with singing (emotional) deficits and left hemisphere damage is associated with speech deficits. In savants, the left hemisphere is dysfunctional and right hemisphere takes over, thus seems to then provide largely accurate perception with little emotion. As discussed below, it is also interesting that religion, in particular, especially depends on metaphors for rationalization.

Beliefs and Their Learning as Basal to the Social Mind

One implication of the above discussion on schizophrenia and aberrant vocal hallucinations (including voices from God and beliefs) is that the process that

sets language-based beliefs is part of the normal system that defines identity in a social mind. A mind can be defined mainly by its cognitive features: thoughts, emotions and memory expressed during periods of consciousness. We have already seen above that primate brains have neurological structures (mirror neurons) that allow vision to link the neurological and emotional reactions of individuals into social networks. Humans have an even more social mind and in humans, language allows the content of a mind to be transmitted between individuals. A 'social mind' needs to link the cognitive content of individual minds, thus thoughts, emotions and memories provide the basis of mind-based social identity. For these elements to be used for group identity, the cognitive content must link to stable toxic emotional components and work together with an unstable protective or beneficial emotional component. The combined T/A set would create a cognitive-based addiction or identity module that maintains the same or compatible cognitive content. A stable thought or memory also defines a belief state. Belief is the acceptance of cognitive information as stable or invariant (we call true), which is resistant to displacement. Its maintenance would be emotionally comforting and its loss would be emotionally painful. This state stems from the maternal–infant bond, we had presented above. We can now understand how cognitive communication (content) can induce the strong emotional pain of bereavement. For example, if a mother believes her infant to be dead, the basal social bond is cognitively broken (via belief), and intense emotional pain will rapidly follow. In this case, we can clearly see the basal role for belief in strong social bonding. Resistance to belief displacement is also a basic and robust feature of group identity (and language). Both beliefs and language are initially established (usually in young) by a process of learning (such as associated learning). This results in a pattern of thought or memory that resists other patterns or displacement by additional sensory information (subsequent learning). There are fMRI data which suggest that the human brain processes belief-based reasoning distinct from the regions that process information that does not have belief status. As shown in Fig. 9.7, clinical circumstances that examine belief neutral and belief laden-based reasoning show distinct patterns of brain activity. If such belief attribution originated as part of a social identity system, then the belief attribution system would also be part of a social mind. A social mind requires that learning be restricted once a social belief becomes set. In the transfer of group identity, there is generally only a developmentally limited period during which transfer is allowed (in this case learning). Thus, as mentioned above, open and closed learning become crucial aspects of identity transfer to social minds. The factual correctness of a belief need not matter, if it is not highly destructive to social survival. And if such social beliefs are factually incorrect, they will still resist factual correction. Human development seems consistent with this scenario. For example, the high tendency to acquire factually incorrect beliefs by children is considered an endearing feature of childhood (Santa Clause, boogy man, etc.). The learning needed for such early belief acquisition has various features. A source of authority (parents) is often involved. Also, coincident events that become

generalized (not requiring an understanding) can set beliefs. The uncritical acceptance of such associations thus becomes the basis of superstition, a culturally invariant human feature. In contrast, the formal evaluation of coincident events for factual correctness usually requires formal education. Not all learning is conscious or uses declarative memory so consciousness itself would not have been needed for the early evolution of belief (or associative) learning. For example, associative learning such as habit memory is not conscious. Trial-and-error learning can also have a pre-conscious habit memory characteristic. Thus learning even complex pattern recognition that cannot necessarily be consciously explained can contribute to belief states (gut feelings). This scenario suggests the existence of distinct processes of belief acquisition. One is social, implicit, associative, pre-conscious (unschooled) and emotion laden (aka, gut feelings and religious beliefs). Another is less social (individual), formal (schooled), explicit, deductive and can be seen in some socially hampered individuals (savants). It is thus most interesting that researchers in learning have proposed that dual mechanisms exist for the theory of reasoning. These two mechanisms conform to the above characteristics.

Odd, Illogical Beliefs and Drug-Induced Mystical Experiences

It thus seems likely that a basal human tendency to associate with learning and a strong tendency for belief acquisition are due to our social mind and are involved in various forms of non-critical thinking. For example, jump-to-conclusion thinking (JTC) can be evaluated psychologically by various clinical measurements. JTC generally follows a process of data gathering and then some unconscious reasoning, but does not appear to involve critical probability judgment. It is very interesting that a JTC tendency is also found in people with delusional proneness (via Peters et al. Delusional Inventory; PDI). Thus JTC and delusional proneness appear linked. People with profound religious experience also show some pathology of the delusions via PDI, but in these cases they are not usually associated with other symptoms (such as those of schizophrenia). This suggests that irrational thought in the context of specific delusions is not a sign of abnormal pathology. Instead, delusions seem to be part of continuum that connects normal and pathological mental states. Believers in the paranormal can also be considered as delusional. They too display reasoning abnormalities. People that hold strong beliefs in the paranormal make many more errors in reasoning than skeptical individuals. There appears to be a dissociation between experience and beliefs. Possibly, these individuals have an exaggerated belief stability. Delusions can also be rather specific, not affecting other mental functions. Studies of people that hold alien abduction beliefs indicate that aside from these very unconventional beliefs, they appear relatively normal by most psychological criteria. Interesting that in many such individuals, the experiences associated with acquisition of the alien abduction

belief mostly occurred during sleep–wake transitions, when sleep paralysis is still operating and frontal streams are likely internalized. From these results, it seems clear that belief attribution can be partitioned into specific domains of the mind, which allows cognitive dissonance and dissociates experience and logic from belief stability. In such states, individuals fail to adopt principles of scientific thinking and learning appears precluded by beliefs. Curiously, these odd beliefs can often provide emotional comfort. Even alien abduction beliefs appear to provide spiritual meaning to those that hold such beliefs, suggesting the engagement of strong cognitive addiction modules. Along these lines, the spiritual experiences induced by some psychoactive agents also appear to be relevant. Most relevant are psychoactive agents that induce altered conscious states and include transient loss of self-identity. That these agents can also induce intense mystical experience is especially interesting. Psilocybin is known to be able to induce intense mystical-type experiences and such experience will provide sustained personal meaning and spiritual significance to exposed individuals. In one study, 61% of participants reported a complete mystical experience, which was indicated as one of their most significant life experiences. Also, 79% reported they had increased their long-term sense of life satisfaction. However, not all experiences induced by psilocybin were positive. Some participants instead experienced extreme fear and were highly emotionally distressed. Both of these positive and negative reactions are consistent with the existence of emotionally intense addiction modules that relate to belief states and can be induced by either belief, psychoactive agents or mental disease.

Autism and the Social Mind

Human studies demonstrate that witnessing the actions, sensations and emotions of others appears to activate brain areas normally involved in performing the same actions or feeling the same emotions. Thus the social brain has dedicated neural substrate that links individuals. Understanding other minds also seems to be due to specific domains of cognition that are distinct from those of reasoning. We have discussed hypnotic induction, out-of-body experiments, voice of God, alien control as pathologies of the social mind related to a sense of self and volition and/or loss of agency. In addition, most of these states can also be drug induced, consistent with an underlying biological basis. Diseases of the social brain are not limited to schizophrenia. Recently, it has been proposed that autism may be due to problem in mirror neurons that are also involved in empathy. High-functioning children with normal IQ but with autism were reported to show no mirror neuron activity in inferior frontal gyrus (pars opercularis). Mirror neurons link observation of others to emotions and intentionality. Although autistic children can recognize a range of facial emotions, they seem to have specific impairment in recognizing negative emotions, such as fear, in others. Such a state resembles patients that have sustained specific

damage in the amygdala. It thus seems clear that our large social brain also host a social mind that normally links us to extended social structures.

Interestingly, it has been suggested by D. Dennet that the neurological system which connects our minds to those of others (via mirrors and theory of mind) also creates an overactive mind-agent detection device that will inherently assign agency (actions of another mind) to unexplained, mystical events, by association. In other words, our theory of mind promotes us to explain events by the intentions of others. As described below, this inherent tendency has also evolved into assigning mental agency to mystical events due to the mind of God. However, as described below, by applying the social mind and connecting individual human minds to an abstract (or non-existent) mind of God, we also see the underlying biological basis that promoted the formation of the most extensive of all group identities, religion. Religion constitutes a strictly cognitive group identity in which only belief states define identity.

Social Mind and Extended Social Groups

With the emergence of the human mind as a participant in social group identity, we can see the congruent emergence of extended social structures mediated by the contents of social minds. Beginning from the maternal–infant bond, to the nuclear family to tribes, much of these social bonding could still be mediated by biological parameters (kin relationship). However, a mind-based social membership now extends group membership well beyond any specific biological constraints and will instead be based on shared learning experiences (memories, language) and beliefs. If such membership can also compel cooperative group behavior (both supportive and aggressive via addiction modules), the combined capacity of the group will far exceed any biologically based group fitness. Below, I trace the development of some of these social structures.

Adolescence and Male Social Groups

It seems clear that groups of adolescent males that have no kin relationship can form strong social bonds during the period of their common development post-puberty. Such social bonding between males is similar to that seen in chimpanzee adolescent males when they begin instruction from older males in group hunting and group defense and aggression. We might suggest that chimpanzee and human males express some XY-mediated phenotype along with puberty that promotes the formation of strong bonds that can even displace the maternal bond that was stable for 10 years (as seen in chimpanzees). However, in human adolescent males we see an additional development in their social brain that is not present in chimpanzees and involves the frontal cortex. The human frontal cortex is not fully developed until about 25 years old. This appears to

offer a second round of brain development (post-language) during which group identity can be further developed. This is a period prior to adult maturity where young men are prone to risky impulsive decisions, physical risks or 'fraternity'-like behavior. This period is used by traditional tribal societies to indoctrinate males into hunting behavior and tribal warrior culture. Male group formation seems inherent. For example, spontaneous urban gang formation can occur in unsupervised male groups during this period requiring little external or adult promotion. From these features, it appears adolescent males have an inherent biological tendency to form social bonds and further develop group identity. This provides a window during which many young males can be developed to be aggressive to other social groups (such as in national armies). During this development, no kin relationship is required. Instead, group identity involves a shared learning experience and shared beliefs. Also, strong and stable religious indoctrination can occur during this period. Such stable states of mind, I suggest, underlie all other extended human social structures.

There appears to be some sexual dimorphism between men and women regarding group behavior. This can be seen on a population basis by measuring emotional reaction to unknown (non-group) faces. Men and women can differ with response to recognition of facial emotions. For example, arginine vasopressin (AVP) is known to influence behavior of humans and other animals in a gender-specific way. AVP can be administered by intranasal instillation, then subjects can be shown various faces of the same sex with different emotional expressions. The rapid facial responses of the observer can then be monitored to indicate their subconscious emotional reaction (via brow muscle movement). Such studies show that males react more with either anger or threat to emotionally neutral faces whereas women respond with an increased approachability. It is likely that this male characteristic develops after puberty. Males, however, do pay much attention to female faces and forms, and affects on the right amygdala can be seen in response to highly attractive female faces. Yet male mate choice is not simply the product of a facial emotional response. Evidence for this comes from a large cohort of twin studies involving 738 couples and examining 74 psychological variables. The results regarding mate choice indicate that the choice phenomenon is inherently random. The most common determinant seems often to be that of romantic infatuation and personality. Clearly, human mate selection does not follow any discernable biological marker. And it seems that cognitive features involving personality are important, but highly variable.

Emotions for Extended Social Binding

Extended social structures include gangs, armies, city states, cultures and nations, with religion being the most extended of all social structures. The common fabric that holds such structures together are similar learning

experiences involving social pleasure and pain as noted above in adolescent males. Loyalty (adherence to group identity) is a core feature. The various social pleasures involved are amongst the strongest emotions. If we define such social pleasure as mental states of feeling of happiness, satisfaction and exultation, we can see that fame, adulation, praise and pride are also all strong social pleasures that can have addictive character. The rock star, sports figure, Hollywood lifestyle all involve similar pleasures. Such feelings are known to be associated with dopaminergic signaling and it is likely that endogenous morphinogenic mechanisms (endorphins) are involved. Clearly, these appear to involve addiction centers and it appears that various drugs can artificially tap into such states of social pleasure.

Negative emotions are clearly part of social bonding. We have already considered the intense emotions of bereavement expressed by a mother and father upon death of offspring. Similar types of emotional toxicity, involving depression and disassociation, are seen in other broken but more extended social bonds. Males bonded during adolescence, for example (such as warrior groups) can also display intense and similar bereavement at the death of a bonded group member during group conflict. In terms of larger extended social structures, there will typically be an individual leader for such extended groups. Although any individual member of extended group may not actually ever meet or know or even see their leader, here too bereavement can be intense upon the death of the leader. It will be interesting to consider how such distant but intense social bonding can occur onto individual minds (discussed below).

The Invention of Writing: Emergence of a Modern Individual Mind from an Ancient Social Mind

In the Paleolithic mind we see evidence for a large social brain that was promoted by the development of recursive language. This mind was predisposed to use abstraction and symbolism (both images and vocal) as identifiers of subtle (sparse) emotional content of faces and sounds associated with group membership. This social brain allowed the emergence of greatly extended social structures (culture). Such an enhanced brain and a recursive language had an inherent capacity for complex and abstract pattern recognition that has also promoted a large expansion of the general intelligence and the learning potential of humans. However, as presented above, since learning mostly evolved for social functions, social learning also had developmentally determined limitations (seen with language). Mostly oral and ritual traditions that supported group identity were maintained and provided by language. The learning of language was a natural competency for this large social brain (especially due to the left hemisphere). This native learning of language, however, was not highly demanding of cultural resources to maintain. Children, simply being raised by speaking parents, will become language proficient. This inherent

symbolic capacity of our social brain, however, also promoted the development of the visual but symbolic recognition of words. Symbolic (abstract, artistic) representations of things and words takes advantage of and uses the two main sensory systems that were evolved for social (emotional) recognition: faces (visual) and voices (language). Consistent with this, the human brain has a patch of cortex next to fusiform area dedicated to face recognition that also responds very selectively to visually presented words. Clearly, such recognition capacity was present prior to the evolution of written language and words, so it seems likely to have existed for abstract pattern recognition, but also promoted the development of symbolic visual pattern recognition, pictographic words.

There is much evidence that early modern humans used abstract representation in ways distinct from Neanderthals. For example, in the Blombos cave of S. Africa, which is considered as the earliest to house modern humans, engraved geometric plaques on the cave walls were most likely for symbolic cultural purposes. Some arithmetic capacity and abstraction was also likely present in early culture. Early modern humans would likely have some degree of 'folk sense' of knowledge. Folk sense can be defined as knowing something in the absence of education or other cultural experience and can be found in great apes. Although humans seem least endowed with instinctual knowledge, relative to most mammals, humans, like great apes mentioned above, have an inherent sense of numbers. Numbers are important for chimpanzees' social behavior, such as knowing when to attack or when to be quiet regarding other chimpanzee groups and chimps will engage in lethal fighting when numbers are appropriate. (i.e., three or more males encountering a lone male from another troupe). Chimps also have some capacity to learn Arabic numerals, but unlike humans fail to generalize (abstract) number concepts. Untutored human children can represent small numbers but they can also represent comparative ratios between numbers. In contrast to chimps, children will quickly generalize numeric concepts and are able to represent a large, infinite list of numbers, even though not all human cultures can express large numbers precisely. This human ability with abstraction was likely present in Paleolithic cultures and may have evolved from recursive language that requires the ability to deal with infinite recursive word combinations. Thus humans seem inherently able to 'symbolize' and quantify large numbers precisely and to use symbolic representation of this.

Historic reconstruction suggests that the earliest forms of writing were symbolic in a pictographic sense, symbolizing things directly, not symbolizing phonetic content (i.e., ideographic writing of 3–5,000 ybp, Mesopotamia, Egypt). Logographic writing (cuneiforms, hieroglyphics) could be found in India and China also at around this time. It seems clear that much of this early writing was for the purposes of some form of folk math or for accounting purposes, such as for the fair trading of agricultural products and animals or taxation. Thus initially writing was mostly for arithmetic accounting but it slowly evolved to become more symbolic with additional images and definitions. With the Phoenician language (3,100–3,500 ybp), and Greek language we have an early example of languages that became fully symbolic, in a phonetic sense,

representing the sounds of words and thoughts. This alphabet was also able to symbolize many emotions. However, such a visually symbolic but phonetic language poses some significant learning hurdles for our human brains. Symbolic visual patterns (letters and words) are mostly visualized via systems in the right hemisphere of our brain that appear adjacent to or related to regions for visual face recognition. However, phonetic learning and recognition of language is mostly a left hemisphere function. In order to learn a written language, our brain must link the capacity to recognize visually symbolic information to our capacity to recognize and express recursive language. Thus, such capacity requires the integration of the symbolic pattern recognition capacity of the full visual right and language left brain. This is not a type of learning that is innate or biologically promoted by the human brain. In sharp contrast to learning a spoken language, learning to read is inherently difficult, time-consuming process requiring extended effort, with much repetition and much instruction by adults. Starting just after age 5 learning to read extends into pre-puberty to master. During this extended period of learning, clear and major alterations have occurred in architecture of the human brain. Thus reading forces the combined use of our two major pattern recognition capacities inherent in our large social brain but this required a restructuring of nerve connections.

What about emotions and reading? Above I have stressed the central role emotions play in facial and vocal pattern recognition regarding our social brain. It is known that the emotional content of faces, for example, is recognized in distinct brain regions from emotional content of speech. The emotional content of written language must somehow reach this speech–emotion reaction from a symbolic visual input. For example, an emotional narrative activates amygdala (site of some negative emotions) as well as temporal pole (belief attribution). Thus, a significant reorganization of the brain (cortex) has occurred regarding pathways to emotional memory. This cross-connection I would argue has also resulted in a much enhanced capacity for abstract deep thinking and cognition in general. Highly abstract concepts are otherwise essentially impossible to learn without the type of immersed and extended learning that reading has required. In terms of evolution, since reading has a clear requirement for symbolic visual recognition, an inherent capacity in modern humans, as well as a period of extended brain development after age 4, it seems most unlikely that the Neanderthal brain with its limited symbolic recognition and limited development after age 4 would have struggled to learn to read a recursive language. The difficulty and duration of learning to read, however, placed major restrictions on human group functions and social structures. Teaching of and learning to read were much more demanding of cultural resources than other forms of instruction and remain so today. The product of this extended instruction was a much enhanced general mental capacity. The mind that emerged was equipped with the foundations that led to our modern mind and consciousness. This modern mind, with its large symbolic vocabulary, is much more capable of introspection and internal voices of consciousness. It is also more capable of learning independently of social identity. In this, reading

promoted the development of a critical thinking by an individual mind as described below. However, this emergence was not without some significant and continued resistance from the prevailing social minds, basal to human cultures.

Writing: the Importance of Stable Ideas for the Social Mind

Clearly, extended human cultures were developed prior to the development of a written language, let alone any phonetic written language. In such cultures, we see many of the same social structures, characteristics and hierarchies. These include the prevalence of a leading class (chiefs, kings, queens, emperors), the presence of a religious leadership (priests, shaman, often the kings and emperors also become recognized as deity) and the frequent presence of a warrior class, all would not appear to have been dependent on writing. In these early societies, however, the cultural acquisition of new information (overall learning) came from various uncoordinated sources. This included the use of internal voices and visions, especially from leaders. Visions and voices remained an accepted and significant source of new information up until the time of the Greeks and their oracles. In general, early societies had no formal or schooled system, such as science, dedicated to a critical process of learning or objectively evaluating new things. Most new knowledge was acquired by a trial and error, associative and passive observation-based process. All such early cultures also held mystical beliefs that were mostly specific to their culture as well as an array of ritual behavior, often involving chants and dance (consistent with a social mind). Strong emotional links to leaders were also typical. I have made the assertion above that the forces that create these extended social bonds and structures are similar to and evolved from the basal maternal and paternal bonds. Social bonds now form with non-parental cultural leaders. But we might extrapolate how this evolved by considering the development of male bonding in post-adolescent great apes. Up until 10 years of age, male chimpanzees are tightly bonded to their mother. At puberty, this bond loses its tight grip and young males become associated with other males then form tight and stable social bonds with them. Similar transitions occur in humans. How do these post-maternal social bonds get established? In humans, the mind becomes a social element and belief is involved. The development of high social cognitive capacity in humans led to a mind that itself became available as a substrate for the formation of social bonds. Here, however, it is ideas and their emotions that link the group members and leaders to each other. Biology (kinship) is much less needed and not a necessary criterion. Humans thus have the capacity to become bonded to the idea of something, such as the idea of a king, belief or religion, for example. Such bonding can be very strong, even able to displace the strong and basal maternal bond in some cases. For example, a young adult male joining a warrior group will become much less dependent on his prior maternal bond. In this regard, the invention of writing was a powerful stimulus for the use of ideas

(information) in forming much extended social structures. Writing stabilized ideas and their relevant metaphors (emotional rationalizations). Writing both expanded and promoted the use of ideas of leaders, religion and culture to create vast group identities. Indeed religious books have always been and remain the most numerous books ever produced. However, in contrast to kin-based parental or familial bonds, these more extended social bonds do not require any close visual, vocal or physical contact. These are established and maintained by ideas, cognitive mechanisms that operate on the mind via cognitive and emotional addiction modules. They are learned at crucial periods of development. Yet, to be able to maintain a social identity. These learned ideas must be stable and must resist alternative or subsequent sources of information. A belief state thus required for the stability of learned ideas. Such states are fundamental to being able to use cognitive information and the mind to create group identity. In this case, group membership becomes equivalent to believing the information, and that information can be written. Here we can clearly see strong promotional effect that the development of writing had on the evolution of idea-based group identity. Writing served as a powerful stabilizing and amplifying media better able to retain and transmit cognitive information for the establishment of even greater and more extended social structures: cultures, nations and religions.

Social beliefs are most responsible for defining current human social group membership (religion, nationality). Belief in cultural, political and religious identity and their leaders is core to such group membership. These are basal aspects of a social mind and belief stability (faith) is inherent in such states. And although social beliefs clearly prevailed prior to the development of writing, these were much smaller and less stable social structures. They depended principally on oral traditions and were limited by language. Nor were oral traditions as elaborately rationalized or communicated and they lacked stable written directives. Thus the invention of writing had a profound effect on the human mind, promoting the development of a much more extended belief states on a larger social scale.

However, there was a major unintended consequence that was to quickly emerge following the invention of more abstract phonetic writing. Learning to read indeed promoted belief-based social cohesion. But it also provided the vocabulary, internal voice, enhanced mental capacity and facility to develop and understand abstract concepts. This was to promote the emergence of an introspective mind, one that developed a sense of self, distinct from a social mind. This was to eventually lead to the emergence of the modern mind. We can define a modern mind with these very features; one capable of deep abstract introspection with a clear sense of self and a capacity for objective analysis not bounded by social beliefs. It is apparent that the Paleolithic mind lacked these characteristics. The difficulty of learning to read required the development of structured learning as a cultural resource. But the minds that were thus produced became able to examine the observeable consistency of their own, unquestioned social beliefs (described below).

Initially, learning to read was relatively restricted experience, used mostly for the ruling and religious classes since these individuals would be most responsible with the maintenance of cultural identity and the transmission of beliefs. Reading, however, likely transformed the brain architecture of these leaders. Recent studies suggest that the acquisition of literacy appears to affect various other cognitive skills, especially the ability to visualize two- and three-dimensional representations, including representations in pictures. Interestingly, when some members of isolated and illiterate tribal groups were first shown photographs of people, they had great difficulty in seeing what the photo represented. Curiously, chimpanzees that have been taught some limited symbolic reading are also much better at recognizing pictures. Learning to read has measurable consequences to brain organization as established by fMRI studies which show alterations in auditory–verbal language system of readers. It thus seems that the functional architecture of the brain is modified by literacy. Yet the brain does not need to be able to learn to read in order to establish high general intelligence. Humans with otherwise normal and sometimes high intelligence and schooling can have great difficulty in learning to read, for example due to dyslexia. This is a reading disability due to a left temporal region problem involved in converting written to phonological units (merging left and right brain functions). Dyslexia, although uncommon, is seen with all languages in all human populations. However, it is not likely that difficulty in learning to read could have been a problem for Paleolithic human cultures, thus the reason our brain mostly has a capacity to learn to read but can be biologically inhibited is not clear since this skill seems not to affect social or general intelligence.

Thus we can expect that writing also promoted the development of the cognitive capacity, especially in the ruling and religious classes. It aided abstract and deep thinking by this literate group that likely led to more elaborate and emotional rationalizations to defend and promote group identity. Writing also promoted the emergence of more ideas and words. One of the ideas that may have emerged from this would include the concept of a monotheistic God, an idea to which group members could form a personal relationship via a strong emotional social bond (i.e., to become one with God). Thus, the capacity of literate leaders to influence and convince their populations was greatly enhanced by the emergence of writing. As language was the main media for both group identity and its defense, writing became more diverse and expansive in its vocabulary for such purposes. Much of this word expansion, however, involved terms that carried an emotional charge (metaphors) and were often used to define both good and bad group membership. Perceptual, descriptive and objective words also increased, but remained a minority of all languages. The intense use of metaphors in all religious writings remains prevalent. This character of language has been culturally maintained by the Humanities, which has promoted and developed the use of rhetoric (emotionally charged terms) in argument. The purpose of this is to promote social dynamics. The emotional content and communication of such words can convince and bind social minds. Such rhetorical practice of language prevails to this day in social situations,

especially in political debates and other social discussions. Thus, the ability to defend one's ideas (and group membership) by applying rhetorical methods and rationalizations is an essential political skill needed to sway most social groups. Rationalizing is a basic human tendency, a cognitive and language-based mechanism used for group defense that need not use or depend on objective evidence. It represents an inherent (almost instinctual) defense feature of the ultra-social human mind. Its importance to social identity, however, suggests that it likely has a biological basis. The use of rationalization for belief defense thus relates to the patients noted above with various forms of brain damage that dissociated sensory information (such as observing their paralysis) from their belief state (believing they were not paralyzed). They become biologically compelled to strongly rationalize their clearly false beliefs. Belief becomes a core and biological feature of a social mind and also requires the evolution of the corresponding biological substrate to maintain it. The state we call 'closed mind', as demonstrated by these same brain-damaged individuals above, is crucial for belief to function in group maintenance. Accordingly, 'belief-based' group identity also requires the establishment of a state I now call 'cognitive immunity'. This is a stable state of belief that can resist other beliefs, including believing sensory and objective information. Group identity then becomes defined by belief. However, like other group identities, this form of immunity not only resists displacement, but also needs mechanisms to defend itself. Our inherent instinct to rationalize based on emotionally charged terms is a defensive component of cognitive immunity. Since group identity can also be expressed physically, it can be expected that such cognitive defense reactions will also sometimes engage powerful and ancient emotional systems (such as group anger and denial of empathy) that can provoke lethal group violence against non-members. The emergence of written language thus promoted a much extended belief-based group identity.

The Unanticipated Emergence of the Modern, Critical Mind

In an evolutionary sense, writing was a basal novelty that promoted the emergence of new and greater forms of complexity and group identity, in this case, a mind-based social group identity. However, with the development of written phonetic and abstract language (such as Greek), we see an almost simultaneous emergence of an alternative mind state: what was referred to above as the modern mind. The emergence of this state appears to have been an epiphenomenon of culture and education of a social mind. As asserted by various authors, a modern mind is introspective, has a strong sense of self and is analytical in that it is able to accept sensory information that can displace belief states. Thus, a modern mind, can dissociate itself, to some degree, from the common belief state needed for binding a social mind. In a sense, such a mind partially transcends the ancestral, normal biological state. A modern mind is mostly the product of intense education or training, and unlike the learning of

language or other mental abilities, it does not have a specific or dedicated biological substrate in the brain for its development and maintenance. Thus it has an inherently dynamic (fragile) character to it. It is a bit unnatural in that it is developed in an individual, thus can be somewhat asocial. Because of this, the evolution of this mind has been slowed and often opposed by prevailing culture (social minds) due to conflicts in belief states. It can even be internally opposed in individual's mind due to dissonance with their own underlying social mind (i.e., religious beliefs, see below). As noted above, written language, when used for extended group membership required much extended and structured education. But this restructured the brain and also developed deeper cognitive potential, including highly abstract pattern recognition. The emergence of this modern mind promoted the disassociation from the social belief states, based on objective sensory experiences (especially visual). Such sensory experience thus becomes a major source for the acceptance of new information. This state of information acceptance (learning) is similar to but distinct from a social 'belief state' (discussed below). This concept of the modern and social mind, as I have outlined it, resembles in several respects, an early idea put forward in 1976 by Julian Janes, the bicameral mind. The Janes idea of a bicameral mind also addresses the importance of writing for the emergence of a modern mind but this proposal has been mostly ignored or dismissed by neuroscientist. However, Janes did offer explanations for states such as voice hallucinations in early societies and hypnosis, which remain unexplained by neuroscience. Although many features overlap between the idea of Janes and the social mind (the importance of written language, left–right hemisphere integration, importance of internal voices, a commanded early social consciousness, etc.) the significant distinction between the two ideas that I am proposing is that a social mind is the biological predecessor needed for human social identity. In the context of a social mind, inner voices, hypnosis, schizophrenia and religious experience can all be accounted for. Furthermore, although this mind is biologically based and existed in all early human culture, it also required abstractions (symbolism) and stable belief states that are supported and maintained by selected brain systems. Thus all earlier human social group evolution was dominated by voices, visions and emotion as a mediator of social bonding. The capacity for reasoning was often used for the support of group belief. In contrast a modern individual mind is not looking to emotion or to hear internal command voices to attain new information or belief states. In an individual mind, external sensory information becomes the primary source of new information and is manipulated by thought, abstraction and imagination which provide the basis of new learning. The modern mind did not so much displace this more ancient social mind but rather it became able to superimpose itself and sometimes override these innate mental and emotional tendencies. Thus, with writing, we see a parallel development of an expanded social identity along with the emergence of a much more individual-based modern mind. Below, I will return to consider the details of the development of this modern mind. However, it is important to first consider the expansion of human mind-based social structures.

Modern Aspects of the Social Mind, Asocial Beliefs

The establishment of more extended social structures was directly aided by the development of language and its writing in the transmission of beliefs. Beliefs were used in support of extended social structures, such as beliefs in kingdoms and gods, which were clearly prevalent prior to the development of writing. Both a king and a God, as a socially bonded entity, appear to have evolved their bonding systems from the basal paternal and maternal bonds. In many cases there is little that emotionally distinguishes social bonds to a living king from the bonds to the concept of God, thus these two social states clearly overlap (including the power over life and death of individual social members). By including the idea of establishing a social bond to a God, belief-based social membership, however, now provides what may be the most stable of all social bonds: religion. Such resulting social bonds are sometimes so strong they can even displace the most basic and ancient of all mammalian bonds, mother–offspring bond. Social bonds of this nature are also clearly able to subjugate the individual, even induce self-sacrifice of group members, especially during group conflict (a 'god-like' control by leader over individual survival, resembling apoptosis-like death of the individual). We have seen that the death of a leader, even one that is never seen or met, elicits similar forms of grief to the death of a child or parent. It thus seems clear that belief-based group membership (religion) holds tremendous power over an individual and in some cases this power can be absolute. In such cases, no objective evidence may be able to displace such beliefs, and unending rationalization can be presented as a defensive cognitive response. The 'word of God', loyalty to emperor or king, for example, can often elicit an unwavering and rationalized cognitive defense, excusing all failings or foibles of the belief or leader. Such states are reminiscent of rationalizations made by stroke victims and may engage similar mechanisms. Other beliefs, such as persisting occult explanations are similarly defended unwaveringly. In such circumstances, the purpose to reason is clearly not for analytical purposes. In this situation reason is employed in the service of and defense of belief states. Thus, rationalization appears to originally function in a social mode that supports social bonds and counters the perception of cognitive dissonance that would otherwise occur between sensory experience and social bonds.

New Emotional Requirements for Highly Extended Social Structures

We might imagine that if bees had cognitive instead of olfactory-based group recognition, the queen would likely be their god as well and all the drones fully commanded by the will of and belief in the queen. Human social structures have historically approached this level of control by the social leader. If this leader is

the 'idea of God', however, all humans become potential group members. Religion does not depend on biological, kin, family, language or national group identity for its membership. Religion uses strictly cognitive identifiers in defining membership. The individual must believe in the religious dictates or deity and submit their individual will to those of the group beliefs. The question is then raised if such extended membership would need to employ emotional addiction strategies beyond those we have so far considered. We do know that in some cases, non-belief can be the basis of out-group identification and violent attack, so clearly the strong emotion of aggression can be engaged. Examples from history of an inherent linkage between belief in social leader (kings, emperors) and beleifs that social leaders are also gods are too numerous to mention but include most Pharos, emperors, kings and queens. Does such a state engage distinct emotional modules? This seems possible. Even murderous leaders that may have had tortured or executed primary family members (including parents) of subjects, such as Stalin, were still revered and bereaved when they died by these same abused subjects. All truly was forgiven (rationalized) in this submission of will to a distant and sometimes cruel leader or cult. And even the most basal maternal bond can be violated by beliefs in emperors and gods (as witnessed by Japanese soldiers killing their own parents in service to the Emperor during World War II in Okinawa). Clearly very strong bonds indeed can be involved. The submission of will inherently demands the merger of and subservience of the individual mind and this would seem to be at odds with a fully independent self-conscious mind. There do indeed seem to be numerous emotions that are group associated and could provide the basis of emotional addiction modules which range from loneliness to being 'one' with a leader or deity. Negative or toxic social emotions include feelings of group hate, fear, loathing, disgust, shame, guilt or embarrassment. Positive social emotions include feelings of group superiority, purity pride, loyalty, joy, adulation and fairness. Euphoria and rapture can also be a potent group emotional experience, especially in religion. Such euphoria is interesting in that it is almost always accompanied by analgesia. Thus, strong emotional group reactions clearly exist. We know, for example, that during ritualistic dancing and choral chanting common to most tribal cultures, the release of endorphins is seen which may lead to global activation of opiate receptors. Other powerful extended social emotions are also clear, such as the adulation and popularity of entertainers and professional sports figures and teams, which must naturally tap into this reserve of group-based emotions. In addition, it seems some drugs can amplify such group emotional states, such as ketamine as used in extended contemporary social dancing.

Although we appear able to identify the existence of powerful social emotions, we do not currently understand the mechanisms of such extended emotions or how they mediated bonding. They seem to involve many of the same neurological and endorphin-based emotional systems as do other social bonds. That drugs can also induce powerful social emotions, such as mystic experiences that provide meaning to life, is consistent with the existence of neurological

substrate for such emotional systems. Perhaps this is why these agents are so threatening to extant social structures, as they may undermine many cognitive-dependent (belief) and emotional states of social bonding and hence are often prohibited from all forms of study (such as psilocybin, LSD). Although it seems that social-based emotions evolved from maternal and paternal bonding systems, they have clearly developed beyond those parameters. Thus the development of a social mind appears to have introduced new sets of social emotions that were not likely present in our primate ancestors. However, it is not clear that such social emotions are present in feral humans that have grown up without learning a language or culture. For example, more socially complex emotions such as embarrassment are absent from these individuals and thus appear to require learning. Another strong social emotion can be called purpose. Most human social structures express a need for purpose in which purpose fulfills an emotional, not intellectual need thus it defines an emotional state. Human will often claim they need purpose to justify life. This too, it seems, is a byproduct of culture and education of the social mind as it is also absent from feral children. It seems learning language also provides the capacity for learning more complex social emotions and that purpose is one of these, which is otherwise not relevant to the lives of feral hominids. Nor is this relevant to the lives of our great ape relatives which share many of our less extended social bonds. Such emotions are relevant to our ultra-social mind. However, in having an emotional need for purpose, a social mind expresses dependence on beliefs in leaders and abstract deities which in turn provides the very 'purpose' and belief they seek. This situation has the clear hallmarks of a T/A emotion module that would help create, stabilize and extend group identity system. We now start to see how ultra-social emotional addiction modules can link abstract leaders and deities to individual minds, and why this would be supported by biological substrate that is susceptible to drug manipulation. Clearly, belief in religion is an extension and abstraction of belief in leaders. But religion trumps leaders in one crucial feature. Religion can be even more extended and more emotionally bonding than belief in a mortal king or actual leader. Religion provides social and emotional bonds that extend even beyond the death of loved ones, including dead social leaders. In this feature, only religion provides some emotional comfort (antitoxin) during the trauma that follows the death of a socially bonded person. Thus religion provides a meta-social (or trans-social) group identity, crossing the even boundaries of life and death to maintain an emotional social linkage to those that no longer exist. Religion appeals to and employs our most basic social emotional needs since the death of loved ones and the breaking of such social bonds is the most toxic of all emotional experience. Any social system that can offset this intense emotional toxicity can also potentially provide the most powerful T/A module. Religion and other related mystical beliefs provide such powerful emotional and social identity.

Much has been learned about mechanisms of social bonding from brain damage studies. Some brain researchers, such as Paul MacLean, have long been interested in the evolutionary basis of human social behavior as demonstrated

by such brain lesions. Consistent with the above thesis, he and others have come to think that the parenting social bond is a basal bond from which other more extended social behaviors appear to have evolved and that this is reflected in observed evolutionary changes, such as human audio-vocal communication as used to bond parents to offspring. But such physical lesions (brain damage) do not inform us well regarding the evolutionary pressures or molecular mechanisms that created these brain and/or social-mind structures. For example, explaining an ultra-social emotions such as 'purpose' is not clarified by phenotypes that follow brain lesions. But here we can return to the overall virus-first perspective of this book for guidance. In explaining the origin of our large social brain, what has been consistently absent from the thinking of evolutionary biology was to consider the major consequences of genetic parasites to this evolution and how colonization by them have affected (and displaced) prior social identity systems. Human biological evolution has continued to be affected by genetic colonization, but in ways that remain mysterious (such as HERV Ks). For example, GLUS2 is restricted to hominids and is a brain- and testis-specific glutamate dehydrogenase (GDH) important for brain energetics that originated by retroposition to the X chromosome under positive selection for unknown reasons. Clearly, this has the hallmarks of a genetic event that affected hominid identity and deserves to be evaluated from this context. However, human social evolution has continued since the emergence of our social brain, resulting in a social mind that no longer appears to depend on genetic alterations for its development. The emergence of self-awareness and introspection is a recent and fragile state of mind, appears to depend on social education for it to develop, not genetic colonization. Biological or genetic alterations do not determine our expression of self-awareness. The emergence of such a mind seems to be a recent event in human history, thus it seems unlikely that any biological adaptations were involved. Yet the social behavior that has resulted has clearly affected the pattern and the rate at which genetic parasites affect humans. Our culture and technology allow us to survive the onslaught of genetic parasites like no other species in the history of life. Intentional vaccination is the product of culture. Without this culture and this technology, the product of our social minds, diseases like smallpox, influenza and HIV would have very different outcomes and very much limit the growth, diversity and evolution of our human population. Our minds thus provide us with the most potent antiviral immunity. But our minds have become host of different systems of information. Other type of 'brain colonization' events that involve language, ideas, beliefs and other cognitive addiction modules now provide group identity. But the resulting states of social addiction are also states of interdependency. Thus the origin of human social cooperativity stems directly from such states. Empathy involves visualizing and experiencing the emotions of others, likely mediated by emotional responses linked to the mirror neuron system. Diseases of the mind that affect social capacities, such as autism and schizophrenia, can also affect empathic abilities. A strong role of empathy in social bonding appears well established. Empathy and cooperation

also seem closely connected and available for members of the same social group. Yet empathy is not necessarily applied to non-group members. It can clearly be withheld. Empathy can be denied to those that have different cognitive contents (beliefs). Cognition, not genetics, now mediates human group membership.

Cooperation, Empathy and Group Membership

The strong cooperative aspects and altruistic tendencies of human social structures have long been a puzzle for classic evolutionary biology. Applying kin selection or other conventional evolutionary models, such as game theory, has never worked well for explaining such extended social behaviors. To field researchers, such theories have often seemed contrived, overly specific or restricted by specialized calculations. They do not provide robust, generalized solutions for cooperative human social behavior. We know, for example, that humans clearly defy rational choice theory by cooperating in simple dilemma games. In this, how they think in groups is distinct from how they think alone or with non-living computers (a social mind set). In large human social structures, such as extended tribes, city states, nations, kinship is highly diluted, yet altruism remains (sometimes called indiscriminate altruism). Thus human cooperation remains an evolutionary puzzle. In this book, I have proposed the concept that addiction strategies can establish group membership, including extended group membership. This can explain and compel cooperative and altruistic behaviors. As mentioned, sympathy and empathy are core emotional elements that bind large social groups. Empathy also provides the foundations for most moral behavior, yet social groups will deny empathy in some conditions. Non-members can be perceived as having few emotional links to a group, in which case both empathy and morality can become compromised relative to them. The capacity for empathy is hard wired into our social brains, via mirror neurons, and is seen in our primate relatives. Thus an inherent moral tendency is an outcome of a social, cooperative brain, and need not be the product of any particular religion, in spite of the strong beliefs on this issue of most religious people. Clearly empathy exists free of religion. And clearly, damage to the human prefrontal cortex can leave intelligence intact, but massively affect moral reasoning. Our brain has a neurological substrate involved in empathic behavior. So when then is empathy is withheld? Under what conditions does one human decide that another human is a member of a positive group worthy of empathy? To what species, family, tribe, culture, nation, religion or belief must they belong? This is a core issue affecting moral behavior.

Semi-rational Decisions and Rationalization

Humans appear to develop beliefs by various processes and have been characterized as quasi-rational decision makers. Although economic theory

assumes that humans operate by rational-based decisions, clearly this is often not correct. Group behavior has a significant impact. Instead humans apply heuristic-like processes that seem to underlie decisions and some of these processes can clearly be driven by emotional states in which rationalization can be applied after the decision is made. Others decisions are the result of reiterative adaptations based on experience. However, once a belief is developed, it tends to be defended. If the belief is odd, its defense can clearly defy rational thinking and confabulating of rationalized explanation is experimentally established. Psychological studies, for example, have provided strong evidence that people will often confabulate explanations to justify even false beliefs that were introduced as part of the experiment. In such cases, reasoning is clearly not applied for critical evaluation of evidence but simply to defend the belief. This is a very common mental tendency which can even be found in scientists (see below). Rationality in decision making is thus at best an uneven practice.

Charged Language, the Word 'Believe' and Group Identity

Our large social brain is particularly adapted to use language. And language itself has taken on a strong role in group membership. It is used to define and defend membership. Within language, there is an inherent tendency to specify out-groups in negative ways and in-groups in positive ways. The strong use of metaphor in language, as discussed above, demonstrates this tendency to attach an emotional charge to words. Our language readily allows essentially any group or circumstance to be tagged with a charged term and assigned to a bad (or good) group membership. For example, if one is knowledgeable about something that others do not know, one can be called a smarty-pants, arrogant, know it all. If one does not know what others know, one can be called a naive, simpleminded, know-nothing. Either way, a person with different knowledge on a topic is subjected to being tagged with language as a bad out-group (or a good in-group) member regardless of any objective information. And such rhetorical tags are emotionally effective. Thus, the ancient social tradition that promotes the use of charged terms is still used in teaching rhetorical argument and to develop debating skills. The objective is to influence beliefs and objective evidence is not crucial for such debates. Since beliefs define group identity and all groups defend their beliefs, this promotes some curious perceptions; beliefs are inherently equal. That is all systems of belief (group membership) have attained a perception of equal footing and are thus equally entitled to hold and promote their own views. This itself is a common belief. However, as outlined below, systems of belief are far from equivalent. Objective and reproducible criteria can be required for information before we come to accept (believe) it as correct, as in science. In contrast, accepted information based on faith, authority or other sources (voices, associations) need not adhere to any

criteria and it can be simply a historic or cultural identifier with no basis in reality. Yet, these two systems are not in this same realm regarding reality and cannot be equally compared. The tendency to assign group membership to systems of thought is so ingrained, it is even applied to scientific thinking. What is often called 'Western thinking' or 'scientism' by some includes the formal and highly structured system of thought and analysis we call science. But as described below, science has clear criteria by which it comes to accept information and no one source of authority can provide or assure the validity of such information. It must retain consistency with reality (observation, experiment) and logic if it is to be retained. Its stability is not otherwise assured. If it should come to lose this consistency with future observations, it is discarded and does not attain a belief status. What is fundamentally confusing and promotes fallacious arguments is that we use the same terms to describe the mental states of accepting this scientific information as we use to accept any other belief. When we believe something, regardless of how we came to this state, it feels the same to us and involves related if not identical neurological and emotional systems for stable information. The word 'belief' itself is thus problematic because it applies equally to specific and reproducible criteria in science, as well as no criteria in the culture at large. Anyone can believe anything for any reason. These two states should no longer be considered equivalent, otherwise we continue to promote rhetorical debate between these systems as if they are on equal footing (e.g., science of evolution versus intelligent design). I strongly recommend that science abandon the use of word 'believe', just like science once had to abandon the use of the word miasma when germ theory was developed. As presented below, I recommend the word 'convince(ed)' be specifically defined and adapted for scientific use. Science is not a group identifier and should not allow itself to be so viewed. The science of Japan, India, Mexico or the USA can be written in different languages from different cultures but are not distinct, or 'Western'. They all, however, adhere to the same criteria for accepting new information.

The Scientific Mind

Early History

We now come to the last topic of this book, tracing the events that led to the development of formal scientific thinking and how science has slowly illuminated mechanism of human group identity. Scientific thinking must also stem from our social mind and was much influenced by language and the invention of writing. Scientific thinking closely associates with the emergence of the modern individual mind. The biological foundations of a social mind, however, with its dependence on belief states for religious and cultural identity are the necessary back drop for the emergence and development of scientific thinking. Because of

this, the evolution of a scientific mind took much more time to attain than many might guess as it was (and is) often hindered by the social mind and group culture. The foundations of modern formal experimental science appear to be mostly monophyletic in human history, originating in Greece. However, the formal and high structure of science writing has only recently attained its current structure (i.e., formal separation of observation from interpretation), mostly being formalized during the last 200 years. Although elements of science are native to most human cultures, and even most children express scientific reasoning tendencies, in only this one place can we trace the direct development of science into the experimental, formal and written structure we now recognize. It was in Greece where we see these foundations. And the dependence on objective observation later separated from interpretation (beliefs) led to modern science. These descriptive and objective foundations can be found in the ancient writings of Aristotle (for example, his description of fish from the island of Lesbos). Written or objective descriptions such as these would not inherently appear to present a conflict with social or religious beliefs. In fact, the naturalism and natural philosophers of the sixteenth and seventeenth centuries, who sought to observe and classify all life, were mostly interested in collecting and writing observations that would support religious beliefs concerning the role of God in origin of the cosmos and life. However, it was eventually through such observations and their classification into patterns that the interpretation of these patterns as theory would often confront religious beliefs. This approach would transform the thinking abilities of humans and lead to the emergence of the critical, but individual mind. This would also eventually result in the emergence of the concept of 'scientist' (or a 'scientific mind') in the nineteenth century.

Observation and the Source of New Knowledge

Aristotle was a student of Plato, but differed from his mentor regarding sources of new knowledge. Plato had proposed the existence of psychic link to 'formopolis' as source of knowledge. This term is difficult to define with current concepts, but appears to be some type of subconscious or emotional knowledge, resembling an ether. It seems likely this represents an innate ability for complex pattern recognition that may not be conscious or the product of cognitive reflection or analysis. Such a view of new knowledge would be congruent with 'inner voice' or 'visions' as also contributing sources of knowledge thus consistent with the proposed Paleolithic mind as described above. Aristotle thought this idea was wrongheaded and instead introduced empirical bases, such as observation, as the starting point for new knowledge (hence the first fish descriptions from Lesbos). Aristotle became focused on the use of observation as a basis to categorize and understand life. Other ancient Greeks had similar views. These early systemic observations and categorizations by Aristotle

would later be referred to by Darwin in his own writings. The importance of objective observation was to remain a core feature for the evolution of science and was often referred to by those that contributed to the development of science. For example, around 1,500 Leonardo da Vinci developed the 'conviction' that all science must stem from visual observations, hence his attention to visual records in notebooks. By 1,600, Galileo Galilei had further developed scientific thinking and has become considered by many to represent the first modern mind, judgment based on critical evaluation of experimental observation. He applied the approach urged earlier by Roger Bacon (13th century Franciscan friar), but unlike Bacon, confronted religious beliefs. Galileo is an important practitioner and founder of experimental method in science in which observations are no longer casual, but interventional, focused, formal and aimed at resolving ideas that were imagined to explain observations (theory). He rejected the authority (belief) from the ancient thinkers that did not adhere to experimental evaluation and clarified the application of critical and imaginative thinking from scientific observations. Imagination in linkage to experiment was to prove a lasting and productive process for science. Galileo imagined no friction in his thinking. Later, based on Galileo's observations, Newton would imagine no gravity whereas Einstein would come to imagine traveling at the speed of light. This process was so successful, scientists themselves came to 'believe' that reason and evidence were the core mental processes by which educated people all come to accept new information. However, this is not the inherent process by which our social mind establishes its identity and this 'belief in reasoning' by many scientists remains a problem. Interestingly, most of these scientists, including Charles Darwin, initially held religious beliefs that were often used to motivate and rationalize their initial investigation in which science itself was a manifestation of God's design.

Science Criteria for 'Belief' Status

The discussion above presents the argument that the word 'belief' is inherently problematic when used by science and I have suggested adopting the term 'convinced' to describe tentative acceptance of such objective information (as most or likely to be correct). With this distinct term and criteria, the acceptance of information in science can avoid the confusion of being considered as another 'belief' system or an element of cognitive-based group identity. I have presented various studies and observations that suggest that native thinking habits of most people that lack formal training can often allow a belief status to be attained by illogical or inconsistent reasoning processes. Deductive reasoning as process of drawing conclusions from a given set of premises can be considered as a closed system, from a logical view. Yet, clearly beliefs can offset such rational thinking. And it even appears that our brains inherently compartmentalize these two processes. Formal and deliberate reasoning, for example, is

associated with the right brain function whereas religious beliefs, implicit or preconscious and emotional thinking is mostly associated with a left brain. Clearly, formal reasoning can override emotional thinking in some people, but the converse also occurs, as observed in stoke victims or highly religious scientist. One complication in reasoning is that humans can clearly learn to recognize very complex and rapid visual and audio patterns, which remain subconscious and elicit an emotional response. This is the gut-feeling phenomena familiar to most people and used by them to develop beliefs. These patterns can be correct and provide much insight. However, they can also be erroneous and many people accept or believe their 'gut-instincts' without subjecting them to formal or objective evaluation. Formal reasoning is necessary to sort this rapid pattern recognition from what should be permitted to attain a belief status. In addition, formal reasoning is essential to evaluate more abstract or counter-intuitive explanations. This is especially the case with regard to the natural tendency associated with the human reaction to other group members (race, class, sex, religion, etc.) as these tendencies have biological foundations. Group definition reactions require a rational and ethical examination before they should become accepted information. It is through the application of formal and ethical reasoning that we can provide a more coherent moral foundation. Religion has often been proposed (by its proponents) to have provided the foundations of most moral behavior. In my judgment, historical records do not support this assertion and such records are rather clear on this topic. Indeed, secular governments have been much more successful on this issue. Consider the example of the history woman suffrage and the attainment of the equal rights for half our human population. This issue did not benefit from religious dictates and remains a problem in many religious countries. Religious thinking also fails to explain some of the clear biological basis for empathic tendencies, noted above. It has been secular law and its protection of individual freedom from religion that has most promoted and protected basic human rights and overall advanced ethical judgment. The proposed role for religion in such development instead appears to be a rationalization offered in defense of 'belief' or group identity that does not depend on much objective data. As a scientist, I am thus not convinced by the historical evidence that religion has been anywhere near as positive regarding evolution of ethical behavior as its proponents maintain, although it has clearly provided a strong (but sometimes violent) sense of community and purpose.

Scientists' 'Belief' in Reason

The major early success of science was the strong impact it had on the ruling and religious classes when it first emerged in the seventeenth century. This period corresponded to the age of reason and it was predicted by many scholars that the decline of superstition and religious-based explanations would soon follow.

Science seemed to offer explanations for most of life's mysteries. However, this anticipated decline in religion did not happen then and is not happening now. The seventeenth century also saw the introduction of the printing press and the distribution of affordable reading materials to a broad populace, greatly expanding modern literate minds. In the USA, public literacy and education were introduced as a social right, a process that has since become global. Interesting that this major expansion in the number of people that learned to read did not significantly diminish interest in religion. Given that the Bible was far and away the most published book, perhaps this should not be too surprising. With regard to science and beliefs, the seventeenth century in particular saw development of natural history as a way to affirm the existence of God. Most naturalists thus initially approached their studies from a religious perspective. For some, however, scientific thinking clearly led them to accept reason over religious belief. In 1796, Von Humbolt wrote Kosmos, a compendium of scientific thinking that some thought of as anti-Bible for the age of enlightenment. However, such an anti-Bible never became popular and certainly did not displace the Bible or any religion. Such scholarly views at the time were based on the notion that belief was mostly the product of reason and that a strong treatise on reason should displace most belief-based reasoning. In a sense, it seems that scientist started to 'believe' in reason, rather than subjecting this hypothesis to scientific evaluation. As it now seems clear, beliefs are not inherently stemming from reason, but were evolved to support group identity, thus they can be expected to resist displacement. Instead a curious inversion of reasoning will often happen in that reason has been used to defend (confabulated) religious beliefs. This process is still prevalent (i.e., intelligent design). Thus, for a brief period in the seventeenth century it appeared that belief-based knowledge was 'believed' by many of the ruling class and promoted the development of some rational but secular political documents, such as the American Constitution. In current culture, however, many would seek to superimpose religious beliefs onto such political documents, such as 'Christian or Muslim law' claiming and rationalizing that such beliefs were the foundation of secular government. Many scientists still 'believe' in reason and consider that the ability to do causal reasoning is thought to be particular human strength. Such beliefs provide unending frustration for many scientists in their interactions with non-scientists.

The Individual Mind; 'Sense of Self' in Conflict with the Social Mind

We live in our brains, where our consciousness and sense of self reside. Consciousness can be considered as a collective and dynamic aspect of intellect involving thought, perception, emotion and memory. From a religious perspective, such a sense of self has been considered to be a God-given feature that cannot be studied or measured, a soul. Our sense of self, however, is a fragile

feature of our mind that can be readily disrupted by clinical and pharmacological actions. Our concept of a 'person' requires the capacity for conscious experience, which needs an active frontal cortex. Science can indeed measure aspects of consciousness, such as cortical response to sensory perception. Recall the situation of Clive Weaver in that his consciousness was 'rebooted' every morning after awaking from sleep to new sensory perceptions. Our sense of self and person is also often associated with a sense of free will. In fact, it can be argued that society generally 'believes' in the existence of conscious free will. What then is free will with respect to consciousness? It seems these two issues can sometimes be separated. Consider that hypnotic techniques can induce a state of consciousness where a degree of volition, free will or sense of self becomes externally controlled and even sensory perceptions can be thus controlled. Meditation and psychoactive drugs can similarly suppress the sense of self and will. Nor does it appear that the sense of self or consciousness has a fixed biological residence. Sensory perceptions can be experimentally manipulated to create altered states of consciousness (such as out-of-body experiences) in which consciousness appears to reside in virtual bodies. Why would such a fluid and fragile state of self exist? Why is consciousness not firmly affixed to a specialized region of the brain, like face or language recognition? The sense of self can also be regarded as the perception of existence of an individual (asocial) mind; a mind that has independent will unassociated with mental states of others. One implication of this fragility is that sense of self is not a biologically ingrained feature. It is a dynamic state, the product of learning and language, hence a recent emergent mental phenotype from our social brain. If so, what is the relationship of sense of self to sense of other or social/external control? Do chimpanzees have a sense of self and self-awareness? Self-awareness requires mental (not sensory) visualization of the mind and would inherently appear to require an awareness of other minds, thus it may have emerged after the development of theory of mind (a social, empathic feature). This would infer that sense of self developed along with language following the development of a social brain. Until the recent introduction of fMRI and other neurological techniques, the study of the mind was mostly approached by amassing hundreds of case studies or anecdotal observations regarding mental states. This is a chaotic process which is also much like how education tends to be studied. With the application of CNS-based measurements, however, we start to see neurological correlates. Thus we realize that much of our recently evolved brain capacity seems to be dedicated to social functions, such as language or visual face/emotion recognition. The ability to rapidly communicate emotional information appears to be built into domains of our brain and can clearly be subconscious (rapid facial emotions, vocal fear). But the purpose of such emotion communication must be mainly social. Will is individual action from thought which requires ongoing communication to the frontal cortex and this must be where rational mind and personhood are generated. Yet the nature of action (will) is highly socially influenced. Clear examples of this include epidemic fear or anger which can control actions of individual in groups. Clearly,

groups can respond in common to emotional signals and they inherently tend to perceive out-groups (both good and bad). This social will is a collective, group response that is biologically mediated and involves a social mind. Since this is biologically ingrained, it is also robust and not a recent development, as has the sense of self.

It seems clear that a sense of self and the reasoning abilities of an individual mind were crucial prerequisites for the development of deep and rational thinking. Conscious, formal thinking is an acquired, learned skill that is an essential aspect of scientific reasoning and the modern mind. Thus it seems both the sense of self and the capacity for conscious and independent scientific thinking emerged after the social brain had evolved. However, the emergence of individual-based critical analysis creates an inherent conflict between the individual mind and social minds. Such individual minds can confront the beliefs which define social minds (and their group identity) and thus can encounter group hostility.

Spontaneous Social Identity and the Unaffiliated Individual Minds

There is a biological tendency for humans to spontaneously classify other individual as a group member or non-members based on common beliefs. This tendency, however, also promote spontaneous group generation. We have noted spontaneous urban gang formation in young adult males of otherwise identical social, ethnic or cultural background (primate-like male group formation) that can sometimes engage in lethal intergroup conflict. However, in such cases there may be few beliefs (or other features) that distinguish such groups, aside from a belief in loyalty to group membership. Yet these groups still must share a social bond. An even more basic tendency to group membership assignment may differentiate between individual (independent) and socially bound minds. An individual that fails to establish social bonds, fails to believe in or adhere to group loyalty will likely be perceived as a non-group member. In this way, the modern individual mind, which has emerged with the acquisition of abstract language and reading, and become capable of much more self-reflection, can also create a mind that is perceived as a non-member. A mind with critical and scientific thinking skills can question social beliefs that are not consistent with objective observation or that conflict with formal reasoning. This will in turn weaken the hold that a social belief has in group identity. However, since humans have an inherent tendency to assign group membership to belief-based mental states as held by others, individual thinkers will also tend to be assigned into 'non-member' status and be perceived as belonging to another version of a belief-based group. How this tendency affects popular perception of the scientific mind is presented below. Yet, the situation as just outlined above is likely to be oversimplified. That is because the concept of an 'individual critical mind' appears to be more of an idealization than a reality. Most people will retain many elements of their underlying social mind which can often exert major (subconscious) influence on our reasoning.

Truly individual independent critical thinking is very difficult to dissociate from this underlying (often subconscious) social mind. Yet, as outlined above, there is some biological variation in the 'social-mind' phenotype of humans, such as autism. Indeed, scientists have some tendencies to think, as individuals may have some biological basis as well. Let us consider autism and various other mental disorders known to specifically affect social or asocial tendencies. Above, we discussed the apparent link of autism to mirror neurons and social empathy. However, some autistic individuals (savants) can have highly enhanced and specific cognitive skills, such as in the realm of math, memory or vocabulary. They can also have highly outstanding observational skills, accurately remembering details of scenes and landscapes well beyond that of normal individuals. Such savants can also show obsessions or compulsion toward creating order. Other autistics can also have an ability to focus their interest into narrow topics. The most basic tendency, however, is to be socially disconnected and not to perceive fear properly. It is thus most interesting that scientists, as a population, have many of these same cognitive and social tendencies. Scientists need to have an 'independent' individual mind that is not overly influenced by widely held views in order to explore and develop new domains of thinking. A mind that can resist the social consensus and stubbornly pursue narrow thinking and observation is well suited for science. Interestingly, scientists are often stereotyped to have a general reputation for being socially disconnected (socially labeled as nerds). Although I know of no population or scientific-based study on this inference, it could provide a most interesting topic of study. In this way, scientists would also tend to be perceived as non-members to many social groups.

However, scientists are not the only members of society that have developed critical thinking skills. Various other endeavors also come to depend on evidence as a primary criteria for establishing belief. However, scientists are probably an extreme example of this formal skill and mind set. Indeed critical thinking is a general objective of higher education and can be demonstrated in substantial sections of the population where education levels are high. Yet, it remains that regardless of occupation, the skill of critical thinking still emphasizes the abilities inherent in an individual mind needing a strong sense of self and it also remains that such a thinking style tends to place such people in conflict with 'belief-based' social reasoning. A spontaneous group assignment is thus expected to be applied to critical thinkers. They will appear to constitute a distinct 'system of belief', hence be assigned a common social membership. Thus critical thinkers can be considered as members of a social group that holds distinct 'critical thinking beliefs' (a clear oxymoron, but rhetorically effective). In this, they represent just another belief system. It is precisely such a general trend in perception that may underlie the prevalent concepts of 'conservative' and 'liberal' group identities. Although it seems clear that some degree of ideology can be applied to both sets, it is also clear that educated people that may otherwise hold no ideological positions or strong religious beliefs in common are also generally labeled as belonging to 'liberal' groups. For example, centers of

higher education, regardless of the political foundations or histories, are almost always considered from such a perspective, and entire states have also been labeled liberal ('blue') states in the USA. The common denominator for these states appears to be the average levels of formal education that exists. There are some additional features, characteristic of 'group identity' labels, that appear to correlate with the conservative and liberal assignment. One measurable characteristic is relevant to issues of the sense of right and wrong social judgments. Psychological profiles can be used to distinguish overall group behavioral characteristics of conservative and liberal populations. Some of these profiles have evaluated the relative importance of harm, fairness, in-group membership, authority and group purity found within these populations. Interestingly, such evaluations have resulted in statistically clear results. Conservative populations tend toward counting purity, authority and in-group membership (including loyalty and obedience) as much more relevant than do liberal groups (which emphasize fairness and harm concepts). Moderates are intermediate in placing the importance of these characteristics. These characteristics are clearly relevant to social group membership. Conservatives display that overall features we would associate with more social minds, tending toward group membership and belief-based reasoning whereas liberal populations (the products of more education) show characteristics of individual critical minds, with weaker group affinities. These overall tendencies toward group membership also show some clearly associated tendencies in moral thinking and in right/wrong judgments. People with a strong sense of belief and group membership tend to judge non-membership harshly. Since such a social mind set seems more ancient, it was likely this tendency has resulted as some consequence of biological selection. In this light, the appropriate emotional communication in social settings can be very important (hence autism is under some negative selection). An autistic person would tend to communicate the wrong emotional valence regarding fear in a social setting. In early human groups this could easily have been a lethal phenotype. Consider, for example, a lone 'autistic' chimpanzee that mistakes anger for smiles in other male chimpanzees. This could easily mistakenly incite lethal attack and thus be a lethal social phenotype. Partially asocial human (scientist and autistic), with some highly specialized or developed thinking skills, would also not likely fare well in such early social group settings.

Conflicts involving belief-based group identities are still very much a part of current human culture. National and cultural identities continue to provide overall group reactions and retain the potential for promoting group conflict. To this day, such group (belief based) conflicts can escalate to social pathology and attempts at ethnic or religious cleansing have yet to be eliminated in various parts of the world. We as a species evolved with some inherent social tendencies to subconsciously recognize other groups (races, languages, cultures, beliefs) and react to them as out-groups, typically in a negative way. The sources of so many 'groupism' are thus ingrained into structures in our social brain, and these include cognitive or belief states. Unlike all other life on Earth, we have become less dependent on biologically (genetic) based identity (such as olfaction) and

evolved to use the mind and what it has learned for the purpose of group identity. What our minds believe most define our group membership. Still, these group identities retain the same strategies (addiction modules) as were used to define essentially all ancestral group identities in all other life. Given the biological basis of this situation, it might seem depressing to contemplate the prospect of preventing human group conflicts. Yet, our social mind must learn and it is clear that education which does not promote virulent group identity can, to a large degree, offset these inherent group tendencies by developing a social mind that is controlled by morally sound individual and critical reasoning. Education can promote fair and ethical group behavior. We are endowed with an inherent tendency toward empathy which can further be developed to underlie much good behavior. We must exploit this tendency and inhibit another feature of the social mind, the development of virulent anti-group responses (denial of group empathy which can also be learned). Appropriate learning and education becomes the main key to offset human conflicts. This thus deserves the most serious cultural investment.

A Science Mind Is Not a Group Belief: the Difficulty of Recognizing and Unlearning Belief

A significant problem with beliefs is seen in how they affect science instruction and learning. Beliefs generally elicit subconscious cognitive defense (rationalizations), thus they can promote an often insidious capacity to resist learning and new knowledge. Individuals will often not realize they are defending their beliefs unless or until objective evidence is specifically consulted and formally evaluated relevant to a topic of new knowledge. Most people (even scientists) normally hold subconscious beliefs on various topics which are unapparent. For example, I have been involved with and experimenting with science education for several decades. Many of my colleagues similarly involved in science education have often expressed unquestioned consensus views regarding what is important for learning science. Clarity (simplicity) of material presented and developing motivation of the student to be interested in the topic are generally accepted as major teaching objectives that must be addressed. These views seem intuitively obvious. Yet when I ask for any relevant data on these specific topics, specifically what evidence supports these views, I will usually hear a rationalized answer as to why this should be the case, with no reference to specific evidence; not even anecdotal evidence or extended personal experience is usually offered. When they do consult their own personal experience, they will often realize their own development did not occur this way. These scientists readily become unscientific when defending such beliefs but will usually see the problem when I point this out to them. We are all prone to similar insidious and unapparent belief states and their defense. In the context of education, this is even a greater problem. Students believe in many things, especially regarding what constitutes a good educational experience, but almost never know of any relevant evidence

that supports their beliefs. In spite of 30 years of experimenting on student education, and observing how students learn to think critically, it is not at all uncommon for a new science student to unhesitatingly dismiss my experience and defend their own views regarding education. In every instance I have experienced this, students have rationalized their views, with no acknowledgement to any objective evidence for any of their assertions. They are defending beliefs which are considered equal to all others (including mine) and they do not even realize that they hold beliefs on this. To formally train a scientist we must undo such mental states and the training generally begins in earnest as a graduate student. The student must learn to 'think' like a graduate student, that is with some independence and knowledge of relevant evidence and theory. They must learn to question their own rationalizations. But this strikes me as a highly delayed and wasteful process. After 16 years of formal education, why is this process just starting with college students? Why will it normally take over 20 years of formal education to train a scientist? Contrast this with the rapidity of learning to speak a language (also a very demanding but natural learning process). My conclusion is that it is basically 'unnatural' to reason by this objective and individual-based way. Such reasoning depends much less on belief-based reasoning and one must learn to inhibit (suspend judgment or belief) one's own associated instinct to defend beliefs with rationalizations. Thus this formal training of a critical 'unemotional' mind, in a real sense, goes against the evolutionary foundations of our social–emotional mind. We must dislink our thinking from our charged, emotional subconscious, reactions and not be overly influenced by group consensus and beliefs. This while keeping in mind that this subconscious-emotional system is capable of amazing pattern recognition, which can provide valuable insight. The mental discipline required for this takes years to develop and is probably never complete, even in scientists.

Learning to write was difficult relative to learning to talk. But learning a scientific and critical mind is much harder and less natural. An independent mind is not supposed to be influenced by what others think and should be free of social influences and dependent on evidence and logical support. This is much more difficult to do than is generally appreciated and even the most disciplined scientist will often struggle as described below. Since we all learn with our large primate social brain, we have many ingrained social learning tendencies that set beliefs and inherently limit how and what we learn. We very much tend to believe consensus, for example. Learning is not an inherently open state. If anything, I would suggest that there is an inherent resistance to learning. We must always be vigilant to guard against defending unconsciously learned beliefs based on rationalizations instead of evidence and logic. However, such defensive reactions are not too difficult to recognize when we chose to do so. Rationalizations and group defense will often use rhetorical methods, charged terms, negative group identification and name calling or invoke some convoluted logic for which direct evidence is generally absent.

Thus we come to understand why a consensus strongly affects individual learning. This tendency is from the foundations of our social brain. We want

(perhaps need) to believe as others do. Beliefs are not simply a cultural attempt to explain the mysteries of the world, but they are a biological legacy of our social mind and cognitive group identity that elicits a cognitive immune reaction (defense). That all humans hold beliefs, regardless of educational status or knowledge of supporting evidence, should be acknowledged as a biological characteristic of our species. And since beliefs underlie identity, we will inherently defend them as valid, sometimes even in the face of convincing evidence to the contrary, similar to that seen in some stroke victims. We have come to accept the political reality that indeed beliefs define group identity and recognize in most societies that freedom of belief does limit group strife. Strong and even violent defense can be provoked if belief is questioned, regardless of the relevant evidence. However, it is one thing to realize this characteristic of belief and avoid confronting them in order not to inflame a violent defense, but it is quite another thing to accept such views as inherently equal especially those that stem from critical thinking (objective observation and logical consistency). It is because of such a tendency to treat all beliefs as equal that science finds itself being considered as merely another belief system and as such can also be considered as another (equal) group identity system. Thus, most religious people will react to scientific reasoning accordingly. It is ungodly, therefore an amoral and defines an out-group with bad characteristics. Even the 'most' developed and 'Western' countries (which ironically includes Japan) have been surveyed regarding the social significance of holding beliefs and rank 'atheist/scientist' as less desirable than any other social, sexual or ethnic grouping. It therefore seems clear that the *absence* of belief is used by most cultural groups as a way to assign a negative and false group identity to science (hence the use of the term 'Scienceism' by some religious communities).

Science is not a belief system or an identity system, nor is it a Western culture. Scientists do not adhere to any particular belief. And as I have suggested, science should drop the use of the term 'belief' to describe the acceptance of valid scientific information to avoid this confusion. Data and reasoning can 'convince' a scientist, but 'beliefs' should apply only to cultural membership. Science has developed slowly during history, often in strong opposition to prevailing local culture, sometimes with lethal outcome to it proponents. Unlike other writing forms, formal science writing was also long and slow to evolve and it took most of 2000 years to develop it into current formal (and emotionally dry) format (much to the dismay and criticism of the humanities). Science was not the product of an easy or natural birth, and developing a scientific mind remains a long and arduous process.

Beliefs of Scientists that Oppose Science

Since scientist themselves are the product of evolution, they too are prone to develop social belief states which are easily confused with scientific thinking.

Thus science like all other systems of human thought tends to operate via a group social process prone to consensus and beliefs. From this tendency, we can understand why new scientific ideas are often strongly opposed. Opposition to new scientific ideas is considered by many as a normal, positive and rational feature of science. However, such opposition can even occur in the presence of strong logical argument or supporting initial evidence. Such opposition, when it co-occurs, has the characteristics of a rationalized defense of belief. In some cases, it indeed seems clear that belief defense is being invoked and scientist can clearly become invested in consensus ideas and will defend them, even with emotional and rhetorical methods, including name calling. Thus essentially every major paradigm shift in scientific thinking has encountered such a group reaction. For example after the British astronomical team confirmed Einstein's prediction of light travel with respect to the Sun concerning his theory of relativity, a group of rightist physicist protested the positive public attention given to the theory of relativity and labeled it as the product of a liberal, Jewish and pacifist author. Many German physicists at the time resisted the theory on these group identity grounds. In the history of science, such reactions are not uncommon. Essentially all fields of science have similar stories. We previously mentioned some reactions to Darwin's theory of human evolution with respect to the evolution of human language (labeled the 'bow-wow' theory). Relevant to the thesis of this book (genetic parasites and viruses in symbiosis), however, there is also a relevant story of belief. One early report in the study of phage (bacterial viruses) concluded that they were part of or symbiotic with their cellular host (Bail and Der Colistamm). This report, however, was met with strong opposition. In the 1920s, D'Herelle and many others sharply disagreed with such a concept (that bacteria themselves had produced a lytic agent). He and others refused to 'believe' that phage could live symbiotically with their host, as their own experiments with lytic phage did not support such a view. This belief was also strongly held by J. Bordet. (The Theories of Bacteriophage. Proc. Roy. Soc. London B83, 398 (1931)). These researchers had come to believe that phage were always lytic of host. In this, Bordet and others attained a state belief which resisted displacement. Accordingly, they did not attempt to directly repeat the Bail and Der Colistamm results. They simply defended their belief based on their own experiments. Later, other prominent scientists, such as Max Delbrück and colleagues, similarly came to think that phage were always lytic based on their own experiments that also did not seek to reproduce the other results. They had observed that T-even phage always lysed with their host in a series of well-controlled experiments. Later, some famous scientists (A. Lwoff) even dispensed with any reference to observation and simply defended their beliefs by definition, saying things like 'a virus is a virus'. Thus according to its name, a phage as a cellular predator (eat) lyse cells and that infection necessarily results in replication which results in lysis. Thus we see that observations that did not conform to this view were simply rejected. This belief in strictly lytic virus remains widely held today, including most evolutionary biologists. Explaining these inconsistent results became a rationalization.

A prophage, if it indeed existed, was rationalized as simply being a seed, not virus, able to make lytic virus in the correct (germinating) circumstance. Yet the original observations that some bacteria can harbor a stable capacity for phage production remained valid, and is valid to this day as an observation that can easily be performed on the appropriate bacterial strains. And even more relevant, some prophage, like lambda, alter group identity making *E. coli* immune to T4,.for example. Thus even these very early observations showed that a virus was capable of providing group identity. Indeed, both sets of observations (lysis, genomic) could be reproduced. This situation raises a curious but important issue that has regularly occurred in science. Evidence that does not adhere to an accepted belief at the time it is presented is often rejected, usually up front by argument and usually without an attempt to evaluate the specific claim or observation. Such a response clearly adheres to that of a belief defense, but ironically, such beliefs were themselves the product of experimental scientific observation. In this we see a truly insidious characteristic of our social-based belief mechanism in that they tend to apply even to scientific conclusions. Scientists can also rapidly establish states of 'cognitive immunity' and reject clear evidence. This would seem illogical for scientists to be swayed by beliefs, given the objective character of the scientific thinking process and its fundamental dependence on observation. In this regard a belief held by scientists can at times be as vigorously defended by argument as any other belief of non-scientists. However, in the long run, experimental analysis will generally prevail to convince most scientists of the validity of an observation or theory. In this case, those early symbiotic phage experiments were not fully accepted until the late 1950s when molecular evidence was finally overwhelming. Both the genetic symbiotic virus (like lambda) and the strictly lytic virus (like T4) exist in *E. coli* and most other prokaryotes.

Another example that relates to the strong influence of consensus beliefs in science is the theory of symbiosis in the evolution of eukaryotes. In the 1960s Lyn Margulis submitted a paper for scientific publication in which she proposed the symbiotic origin of mitochondria from a bacterial cell. This paper was rejected about 15 times before being published in 'Theoretical Biology'. And the initial response of the scientific community was to heavily reject the concept, which seemed to defy the current neo-Darwinian thinking. However, the observations and scientific literature on which this paper was based did not change during this attempted publication or subsequent years. The symbiogenesis theory of eukaryotes is now orthodoxy and molecular genetic data now clearly support this theory. What changed mostly, I suspect, was the social beliefs of the community involved. This example identifies an inherent cognitive tendency in humans, including scientists, that favors the defense of beliefs, especially when they attain a social consensus. There is strong evidence that even scientists are often swayed by beliefs, as are all humans. A current consensus (and belief) in evolutionary biology is that genetic parasites are junk and viruses are not highly relevant to, and have little significant consequence to the evolution of, host complexity. Viruses are not considered as symbiotic with

their host. This book has assembled a large number of observations and presents many logical arguments that counter such a view. Viruses and their hyperparasites indeed matter greatly to all life on Earth. However, I can expect that such evidence will most probably be rejected or even more likely ignored (since relevant observations are experimentally strong). Thus the views and ideas presented here are not likely to quickly displace those widely held views that have attained a belief status. Viruses and other genetic parasites have helped us define the basic mechanistic character of an addiction module and how genetic complexity can evolve from their accumulated action. In doing so, the concept of addiction modules has helped us to understand and define group identity (immunity) and also how it has evolved. And the concept of group identity has helped us to understand the origins of the large social brain and mind of primates and how olfaction-based group identity came to be displaced. It is from this foundation that we can now understand how the human social mind emerged and how learning and beliefs came to define our group identity. Our human group identity has come to be mostly learned and cognitive.

Beliefs and group identity operate from biological origins but are currently subjected to commercial and political manipulation, often not for purposes that benefit society. Such manipulation has been used with good effectiveness to counter rational and evidence-based reasoning. We can, for example, label global warming as a belief (a 'religion') and thus dismiss all the relevant scientific information that relates to this issue, as has been done by politicians and politically motivated news announcers. The public does not protest such manipulation since it is mostly prone to belief-based reasoning. Unfortunately, such manipulation provokes a dialogue that is based on group beliefs, not rational argument or evidence. And in such a setting, group beliefs often prevail in importance. Thus we witnessed on national television that a Republican Senator, who as a presidential candidate in the USA, openly rejected evolutionary theory as theology posing as science. He feels secure in making such statements because belief of the audience is on 'his side' and to them science is simply a minority belief system that can be dismissed as an out-group. Such a circumstance identifies a major flaw of the 'natural' social mind of humans and helps define a major mission of science, to displace belief-based reasoning via education in critical thinking.

The Mission of Science Education

The biology of our large social brain suggests that every newborn human that is not educated in critical thinking (or does not have an atypical social brain function) will most likely default and learn by associative and belief-based reasoning process. This will provide them with a social mind that promotes various forms of group membership, especially those that are determined by belief status. As science educators, this is the typical mental ground state from

which we must work. Our objective is to promote the development of an individual mind that dissociates beliefs and inherently employs objective observation, evidence and logic to attain a convinced status for new information. However, we must also seek to promote empathy as the fundamental emotional link that provides sound moral judgment. Empathy must not readily be denied to our group membership. Since empathy also operates from a biological basis, it should be possible to develop educational paradigms that maintain this capacity. However, similar to scientists, science educators are also prone to hold various beliefs concerning education that may not be well supported by evidence. In addition, other professionals that work with people and transmit new information, such as physicians, will also be prone to a belief bias in their reasoning. Both physicians and scientists have an inherent tendency to anchor their thought process to initial associations or beliefs. For example, consider the point made above, in that we tend to adhere to the belief that if science is presented clearly, with strong supporting evidence, it will be understood and believed by students. But evidence for this 'belief' in science education is not compelling. Science educators in particular are often puzzled by the resistance that certain individuals can hold against science. Recently, it has been reported that such resistant attitudes are acquired as young children that can persist into adulthood. For example, a Pew Trust pole (2005) indicated that 42% of respondents said they believed that humans and other animals existed in their present form since the beginning of time, dismissing all scientific evidence that supports evolution. Other non-scientific beliefs are also prevalent. For example, belief in the efficacy of unproven medical treatments is very common, as is belief in ESP, astrology and other unsupported views. Much of the general population holds such unscientific beliefs. Given the prevalence and long history of most of these types of beliefs and that their prevalence has not been much diminished by public education, it needs to be acknowledged that science education is working poorly for large parts of the population. Why are they resistant? The answer by now should be clear, resistance to new beliefs is a basal state inherent to the human social mind. During the early development of these people, they learned (were colonized by) some version of a native belief and belief-based reasoning systems that left them resistant to formal reasoning. Thus it has been proposed that some resistance to scientific ideas is a human universal that stems from early childhood experiences which result mainly from associated learning mechanisms that are not declarative (conscious or formal). During such development, trustworthiness of source seems to matter a great. Recall that the trustworthiness of an authority figure can likely be mediated by oxytocin, and that this likely defines a critical period of group identity development and social bonding to group leaders that can be molded by education.

Most science educators essentially 'disbelieve' that their student body resists science education or holds many unscientific beliefs, in spite of clear and abundant evidence to the contrary. Clearly, science education themselves could benefit by adopting a more scientific approach. Our goal is already

clear, education must provide the cognitive foundations to override the negative tendencies of belief-based reasoning. Also, our tendency to develop group membership, associate out-groups with negative stereotypes and a tendency to rationalization or confabulate explanations must all be offset by education. The historic purpose of education was to develop a social mind, which normally stemmed from religious education. But such education is really a version of social indoctrination and tends to develop belief-based reasoning, not individual critical thinking. We should recognize that such belief-based reasoning is inherently flawed and susceptible to being manipulated by social pressure and that such manipulation, if malevolent, can also result in virulent social identities. Science can inadvertently promote such reasoning when it avoids the examination of the mechanisms at work during religious and other social experiences. Also, science education has come to focus too much on passive lectures, in which students are asked to 'believe' in the authority of their teachers. This too promotes belief-based reasoning. Belief-based reasoning needs to be examined at all levels, from biological to social. For example, when people believe they act for the will of God, king or cult, political or gang leaders, they become capable of inhumane loss of empathy toward other groups. Our primate relatives retain both social empathy and its loss regarding social out-groups. Rational, ethical and empathic thinking can override such negative tendencies, but this is not easily learned. We need to now focus the full analytical power of science to better understand how to attain this rational–ethical learned state and how it relates to the biology of our large social brain. We also need to acknowledge that belief-based reasoning is not simply a flawed thinking process, but it is at core of our social mind that provides a social function, promotes the creation of cooperative communities and provides cognitive (mystical) satisfaction. Such deep satisfaction does not stem from a critical mind. The community of science, although clearly an international community of a similar mind, does not provide a cognitive addiction module nor does it provide deep emotional bonds. We do not love, kill and die for our respective scientific societies, even ones that are very fun and satisfying. Thus critical reasoning does not seem to engage these deeper emotional social bonds, although they do seem to be pharmacologically accessible. This could imply that a role of science education in transforming human social identity may be a highly unrealistic objective. After all, our group identities are and always have been fiercely defended thus it may be wholly unrealistic to think we can educate the population away from such biological tendencies. But we cannot predict the successes of science so this should not inhibit our search. Perhaps studies of empathy-inducing psychoactive agents, such as ketamine, could be very informative (if only they were not outlawed). It took 2000 years to develop modern science to its current state, so in another 2000 years we cannot yet imagine what insights might be attained and applied to advancing human development. We must initiate that path.

This book started by examining the possible and symbiotic role of viruses and related genetic parasites in the evolution of cooperation and host group

identity. In tracing this evolution, we have ultimately been led to the biological origin of human group identity. Symbiosis has been a consistent theme of this book. It means living together, and cooperative living together is basic characteristic of humans and their social brains. Our large social brains may have been initially promoted to evolve by the action of symbiotic viruses, but successive colonization of this brain by other forms of information, language, then ideas has led to the creation of the social mind from which emerged the modern mind that transcends genetic identity. The mind, with its ideas and beliefs, is the new substrate for the continuing evolution of our group identity. And here, Science has a large and promising role to fill.

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