Article

Ethology, Evolution, Mind & Consciousness

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ABSTRACT

A model is presented of the mind of free living animals, expressing evolved normal behavior, and the steps between such minds and the conscious minds of people. Animals recognize each other and changes in surroundings. This requires two sources of information, from memory and the senses with a comparitor. Constantly comparing all sensory input with memories requires memories organized into maps that allow any change to be detected. Change elicits an Orienting Response, a moment of high attention, emotion, learning and decisions. Awareness involves monitoring and ORs, but living only in the present. These OR moments are stretched in emotion, hunting, interaction and exploration. They are times closest to consciousness, but memories are restricted to immediate situations. Acquiring story-telling required full access to memory models, of places, social relationships and stories, with the ability to examine these models for planning behavior and social interactions. A model is developed of relations between feelings and specialization of behavior. Attention to details is central to consciousness.

Key Words: attention, behavior specialization, consciousness, emotions, evolution, functions, monitoring, recognition, social relationships.

An ethologist can see the organization of behavior in natural contexts where evolved functions may become apparent. The origins of our brains and minds are in gregarious animals, seen best through their functional behavior. My picture of the mind was built in the many hours spent quietly watching, with time to build a model of what was happening. The picture is complemented by the observations of ethologists working with many other species, from birds to primates.

Animals receive pictures on their retinas of every scene they pass. These pictures are then transferred to the brain, the visual cortex, where we and presumably other animals 'see' something very similar as an image constructed by the brain. We and animals have a central skill of specializing attention, an attendor, by which animals can attend to that whole mental image or any small details in it, for essential signs of food or danger may lie in those details. The brain has created the image so effectively that we think we are seeing surroundings, not an image quite separate from the surroundings. Within our mind picture, the ability of an attendor to direct attention to any detail of that mental image is a skill that I believe is central to understanding consciousness. That attendor also controls the redirection of eye orientation, allowing animals to consciously look at details within or extend the field, without understanding how.

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We and animals can also recognize anything we see, or detect any change since we saw that familiar scene yesterday. Recognition and detecting change is impossible without two images, one directly from the visual senses and one by access to an image from memory of the same scene, object or individual we saw and memorized previously. A comparator to compare the two images allows us to recognize or detect any change of detail. This process requires that the image sensed becomes the key to elicit automatic retrieval of the exact memorized image stored yesterday for active comparison. If there is no change, the comparison is discarded because the images of the next saccade and scene are already arriving for comparison. The comparison doesn't need remembering – short term memory is adequate. But yesterday's memories can be updated, replaced by today's. This monitoring process is endless and ongoing. Without it there could be no recognition of anything, no detection of change, no detection of or recognition of what psychologists call 'stimuli'.

Every ethologist has seen the result of change detection; a tree branch has blown down across a familiar path or a potential predator appears on the sensed image. The animal stops, alert with high attention, presumably examining the change on the comparator. If in a group, they might gather closely, alert. If a predator, is it hunting, resting or grooming? This is an Orienting Response (OR), a moment of high attention, emotion and learning. You have a similar OR when returning home after a partner has rearranged some furniture. There is immediately a halt with an OR, that moment of full attention, feelings and analysis, learning of the new, and a decision for the next action. Memories of other such changes are retrieved. In that OR you notice furniture moved, and perhaps a chair moved out; how can you see something missing except by reference to yesterday's picture of the room? Other issues may be elicited, feelings of irritation since this is happening too frequently or one's favorite chair is moved. To decide on the next movement is a 'what to do' decision, a goal must be chosen. We choose the goal consciously, but do animals also need a moment of consciousness in the OR at the sight of a potential predator? Memories of previous experiences and emotions at this moment would be relevant and important. They too must then decide on their next movement. They have made decisions for millions of years.

The fallen branch loses its OR within a week, it is habituated and quickly becomes the new image in memory. Potential predators are not easily habituated. I have seen ORs retained without change for a week, until I moved away. What happens in these later ORs with no predator present? Has the place become dangerous? Is more detail being learned, more easily to detect predators?

Choosing what to do next seems conscious; then subconsciously planning the next movement to that goal is planning a future, however brief. But movement can't be planned without a "to where?" Can this be answered without reference to the maps of these surroundings held in memory? Attention must remain on that danger? If flight is chosen, a familiar path might give an advantage over the predator.

Anyone who has watched animals has seen such situations. What I have described is an awareness system, general throughout mammals and birds. Except for the OR, it needs no consciousness, but is probably the first step on a long path towards human consciousness. The philosopher of science, Daniel Dennett in 1991 described it as 'the unconscious driving experience'. For much of our lives we too walk or drive around familiar places, aware and

monitoring, but, without an OR, remembering almost nothing about our trip. There is no real consciousness. We, like animals, are living only in the present, dealing with the images as they arrive, paying increased attention and remembering only when change is detected, but every change must be then learned and mental maps updated for tomorrow. Some ORs precede immediate and dramatic changes in behavior, flight is obviously one, but a 'where to' is needed.

My best account of planning behavior to achieve a chosen goal comes from Miller, Pribram and Galanter, (1960). They suggest that to do anything, to stop work and have a cup of coffee requires a plan for the future behavior, to stand up, to take several steps, change direction to enter the kitchen, pick up the jug and fill it by turning the water on, waiting, then off, then switching etc etc etc. You get the coffee but there are a hundred component movements nested hierarchically. You monitored them all. And of course, the coffee was itself part of writing your book. The significance of this digression is that making that plan un- or semi-consciously involved fitting you and your behavior into the rooms and arrangement of your house. You can't make behavioral plans without referring to that memorized model of your house, fitting you and each part of the plan into your mental model of your house. Then your attendor must monitor the process unconsciously, modifying any step, finding the missing sugar etc. The plan made, you get up and make that coffee. For most behavior, deciding on the goal may be conscious, but the planning details and the ongoing monitoring, mostly unconscious.

Our ancestors were arboreal. They had no simple two dimensional house to walk through to get a meal. Every movement needed plans through a maze of branches. The plans they made to move somewhere were always through a complex array of branches, a model of which was stored in their memories. It had to be if they were to race quickly in an emergency. Every day as they moved through this world, they were comparing everything they saw, and thus moved through, with the pictures they had made yesterday – or last week. Change detection was essential. That python or broken branch could turn up anywhere. We and other animals are *change detecting organisms*. Our memories are maps or models of our worlds. Frith (2007) describes similar complex mental models in human minds.

One component of this memorized model of the world around them is always a mental model of self, their weight, the distance they could jump, could they fit into this space, how long were those arms, or legs, how each leg must be raised to step over a log, where and what shape was that head and mouth for fighting and eating, what could fit into the mouth and what could not? Plans could only be made by integrating that mental model of self within and through the mental maps of the immediate surroundings. The attendor has always had freedom to move that self through the mental model of surroundings; behavior plans could not be built without a self. Decisions not integrating self were meaningless.

My point is that those mental images or models of the world they moved self through daily were always available and essential; always the images compared were the latest, sometimes required urgently, always updating with any change found. Every OR ended with decisions, innumerable decisions, eons before any human consciousness was present. These mental models were the context for any new behavior being planned, consciously or subconsciously. Mental models of places included danger, security, experience. They were functional and natural selection cares for nothing but function. Perhaps for animals during an OR, there were some moments of

consciousness? But a known world was an expected world, a predictable world, changing life from a tactical to a strategic existence.

When a new fruiting tree was discovered, getting there demanded a new path to be planned. When chased out of familiar range, new and unfamiliar spaces had to be explored. Is exploration like an extended OR? There must be extended periods of high attention and learning, knowing and attending carefully where potential dangers might lurk. We know there is spatial learning, since animals move into new spaces, explore, then very quickly arrange their daily cycle of activities into selected places for the daily cycle of resting, sleeping, feeding, body care etc. They have created new functional mental maps of the place. In time, experiences and emotions become attached to the maps of every place.

Plans for behavior may be for a future of a minute, many hours or even days. The males of a chimp troop may set off to hunt a monkey – lasting a few hours. A bird may build a nest taking several days. Jane Goodall, in a film, "The Baboons of Gombe", showed the arrival of a large male, remaining outside her troop for days; it finally made its move to join, fighting senior males and winning, then approaching the alpha male, submitting appropriately and then joining the troop. Had the male spent those days observing to build a mental map of the hierarchy of social relationships within the troop before joining? The plan covered several days and included knowledge of that hierarchy. Of course such plans are revised and modified throughout, but so is the process of making that cup of coffee.

There are many modern books on the organization of brains, but none allow me to see the organization of behavior within its environment. Yet Chris Frith (2007) presented an account of an exciting mental model of the outside world, with its ability to predict ongoing behavior, a rare treat among books on brain and behavior. To use such models, I also see it as essential that animals need some attendor, directing the brain to operate semiconsciously while aware, then in an OR, consciously examining details in sensory input, then making decisions relating to that input, to find food and avoid predators. There needed a command centre, part of a mind. This mind needed immediate access to all information arriving from the senses with an attendor to examine this information constantly for relevance – food sources, danger, suitable sites for shelter or resting, and for gregarious animals, distance from neighbors. It also had to have all details of its host, the individual's body. The tasks were never to deal with the environment, but to fit that body and all its functions into and through the environment. Function demanded the total integration of body and surroundings. That attendor had also to control the sense organs automatically, redirecting eyes, ears and noses to where extra information was needed. It was this attendor that 'looked at' the mental picture the eyes were delivering and the brain was reconstructing. In an OR, the attendor function in the mind had to have access to memorized images of yesterday's scenes, previous relevant experiences, and the ability to make decisions, choose goals, behavior plans and order their delivery. It then needed the ability to monitor the progress of the plans, modifying them as detailed relevant information arrived, for example, the need to step over an obstacle. In ordinary living in the present moment, it was that attendor 'looking at' the pictures the eyes and other senses were delivering, moment by moment, stepping over logs, but not conscious of the endless comparing them with memories of yesterdays images – normal awareness. Dennett (1991) described this model of a mind overlooking a 'Cartesian

theater'. He though the model inadequate, I believe it essential. I have included a mental model of a physical self, which he does not.

I see that attendor/mind command centre as the subject of natural selection, for it alone dealt with every functional behavior; it demanded that the brain evolved to provide both a mind and every function that mind needed to control by decisions, leaving the brain to quietly and subconsciously deliver every service required, leaving as much as possible to occur automatically, an unconscious system. The animal doesn't need to 'know' how it detects change or recognizes by a comparison system any more than it needs to actively control its heart beating. The amount of information its sensory and comparing systems are handling is stupendous. Yet the animal 'sees' images of where it is, its neighbors, their ranks and locations, but all is expected, familiar – until a change occurs. Mostly it lives in an expected world, aware but not conscious. The same awareness system operates for all social organization; presumably spatial and social environments use the same awareness/monitoring/OR/deciding system.

In an expected world, animals need only awareness. The Orienting Response had to be 'invented' to deal with the unexpected. That OR was central to functional living, a triumph of evolution. Is it where the first moments of consciousness evolved, attending to the details of any change or recognition? Those moments were critical to life, at the heart of survival. I see those moments being stretched for learning new ranges or social situations during exploration, and for hunting, fighting or playing where quick analysis and responses were needed. Yet these situations still only needed memories of direct relevance to the immediate situation. The centrality of attention, the need for conscious access to experience, memories and emotions, the need to decide and make new goals for living are what natural selection provided for dealing with problems. Where better to look for an existing set of talents to modify further into a human consciousness when this became a functional requirement?

Animals live in societies. Birds sing every morning; like the surroundings, they are sensed, recognized as familiar, habituated, expected, and not different from yesterday. We call them communication, signals, but they are merely part of the social environment of every animal. The cock crows, the lion roars, the wolf howls and marks its territory by scent. Monitoring reports to others that 'nothing has changed, today is as yesterday', so the monitoring minds decide to 'ignore' them. They are signals without responses, expected information, just environment. I define environment as '*that part of surroundings that are learned, habituated, in which change can be detected'*. This covers any component of surroundings meaningful to the species, social or spatial. (People have become a group-making species, forming groups to extend the range of our environments, to monitor weather, earthquakes and of course our borders, and set up communication to share the ORs for any change detected in this vast human environment.)

The important point is that animals live in social worlds, created by forming social relationships with each other, even simple ones that create dominance hierarchies or territories. Social relationships are central to social life and stable societies because they are based on agreements between individuals, often little more than spatial agreements. The agreement a subordinate makes is never to intrude into the personal space of a dominant. The dominant does not attack again; every moment it monitors that the subordinate behaves appropriately. These agreements are thus monitored constantly, every moment, just as is the environment sensed moment by

moment by the same change detecting mechanism, the aware mind. Chance & Jolly (1970) described the attention structure in their primate troop where individuals always monitored those higher in rank, and McBride et al (1963), found no random movements in henhouses, each bird turned aside when approaching dominant neighbors. Animals maintain predictable social environments. Change, social or environmental is detected, usually with decisions to restore stable social and spatial structures. Spacing is usually a part of any dominant-subordinate relationship, always with agreement between the two, even if only by acquiescence by the subordinate. Gregarious animals live in whole sets of these social relationships, forming a dominance hierarchy. Alternatively territorial animals fight; on this side, A wins and over the other side, B wins. They glower at each other across what is a territorial boundary, an agreed border. In both situations, life becomes expected and predictable. All are monitoring every moment. In birds, the predawn songs simply allow the monitoring to continue, reminding of the singer's continuing presence before the day starts. Stability is maintained by constant monitoring of everyone by everyone for the expected, detecting the unexpected.

A missing birdsong at dawn is the dramatic change that can occur, with major change in the society as a previously non-territorial individual moves in to take over what will now be a much smaller territory. Other established neighbors ensure this. The newcomer has created new spatial relationships with each territorial neighbor. A breach in society has been restored by the behavior of all individuals choosing to act in their own interest. But everyone 'heard' that missing call with an OR. Monitoring ensured that any societal change detected is rectified. Our minds were designed in this animal world.

Social worlds can become very complex. In a group of n individuals, there are n(n-1)/2 social relationships. Cheney and Seafarth, (2007) watched baboon troops of 80 individuals, which meant that each individual had 79 social relationships. But in their troop there was a further subdivision into matrilines, extended families; individuals had to know the matrilines of each other, and usually some detailed knowledge of important social relationships of others, and even recent history of interactions between others. They were memorizing the experiences of others as well as their own as relevant to themselves! They lived within a matrix of social relationships, dominating every moment of their lives. Mentally mapping such an aggregation is impressive, and monitoring so many details is demanding, for every interaction observed must still be compared with what is expected. Every change observed needed attention and they describe many such changes and the responses of individuals.

In such societies, planning to move among individuals requires knowing and acknowledging the rank and orientation of each individual passed. Could this plan be created without some conscious reference to the mental maps of that spatial and social world? The individual would be in a state of high attention throughout every move, yet this something each animal does daily, every constraint planned ahead of the moving?

In such troops, or in our hominid ancestors living in small bands for millions of years, nothing could ever be done by anyone without always checking the social constraints operating all around them every day. Our ancestors knew each other for whole lifetimes. Our history and evolution occurred in these bands. Everyone knew his/her place and the constraints self-imposed by their agreements with everyone else. Most relationships were not built directly; every

youngster grew and played into all of the relationships in their lives, though probably females moved between neighboring bands at times of plenty when competition between the bands was minimum. Perhaps alpha individuals, male or female in the separate hunting and gathering groups that set out daily may have had some freedom to make unconventional decisions – touches of free will, but not much. Conformity was security, monitored and probably important. Natural selection for any independent thinking and decision making, free will, must have occurred only rarely.

The point is that animals can have very complex social and physical environments incorporated into their mental maps/models, with their ranks and experiences with each other. The attendor building any plan for behavior must move mentally through these maps, checking every detail of a move in advance. The concentrated attention must involve or be close to consciousness. Yet most of their lives, even these primates would be living in the present, with normal awareness except for those moments of OR, play, exploration or moving through complex social situations.

Our ancestors evolved speech, something quite different from all other species. McBride, (1968) proposed that this evolved by telling whole stories, firstly by miming exciting events, over time substituting signs and eventually words for missing components of stories. This step needed no new skills; every primate watches and understands the stories all around them daily in their troop; mirror neurones ensure this. We know animals can read the behavior of others, for they see behavior and join in – social facilitation. Frith, (2007) suggests that they even anticipate behavior. Only by everyone gaining hundreds of whole experiences from others would the evolution of this step become inevitable. With every experience shared and those from previous generations told in stories, every youngster faced life with more understanding of dangers and tactics than any adult could accumulate alone. The evolution of such a function was inevitable. But in making this step, the controls on access to memories had to be removed. I have shown the situations where relevant memories are elicited automatically during ORs and periods of high attention. But one couldn't tell stories without accessing detailed memories of the story to be told, not at the moment of excitement, but much later, surrounded by others, watching the story, mirror neurons challenged. Without access also to the hundred remembered experiences of others from stories learned, storytelling could not have carried evolutionary value. Telling stories made that next step to human consciousness – by letting our attention move at will through the memories of any past event or story.

I suggest that we have brought two important functions from animal ancestors, unconscious awareness, (the Dennett driving experience) and the Orienting Response, probably with better control of consciousness of experiences. For these experiences are the hard problem described by Chalmers (2010). From storytelling, we have added consciousness of memories and planning to every event to which we attend; we can also attend to memories directly, of places, of social situations and relationships, and of an abstract world we have slowly created from stories. Perhaps the stories we learned were once of real experiences, but we have added abstract stories of minds, of universes, of mathematical, scientific or philosophical models.

When our ancestors discovered farming about ten thousand years ago, the size of bands grew into villages and then towns. For the first time in our history, our ancestors found themselves living among strangers, albeit strangers of their own tribe. *Living in anonymous groups among*

strangers is probably the greatest change made in our whole evolution, but it is hardly described. We have adapted, building thousands of changes in our behaviors, our mental models and minds. Every change must have elicited new adaptations, all to spread among people, always demanding big changes in the mental mapping of our minds and behaviors. We still live mainly among families and familiars, mixed among the thousands or millions around us. We produce thousands of small groups in which we work, pray and play. Each of us is a member of many of them. The complexity of our society is great, matched by the mental maps we are able to construct, for we have adapted.

Many of us forget that we are a recent and evolving species, still trying to produce fair and effective societies, not by natural selection, but now by our own decisions. Looking at any modern society, we see only crude and primitive attempts at fair societies created by endless trial and error. Living as we do, we ignore that we evolved in small completely familiar bands or tribes. We deal with abstractions so easily that we forget to ask about the steps we made from our simple origins, recently as hominids or more distantly as animals, primates. Possibly all or certainly most of the changes in our primate evolution were behavioral. Behavioral means under the control of minds. The evolution of language, the biggest step, was certainly all behavioral. Minds achieved the transition and brains were forced to find ways to provide so many new services.

What changes came from the ready access to memories brought by language? The attention system could move freely through a whole past, spatial, social, abstract and experiential. Our ancestors had a past that allowed them to attend freely to any memories – they didn't need to live only in the present, though we still do often, remembering nothing of much of every day. The mental maps of people expanded as stories added information they could not have had themselves. A mental story world was added to the already environmental world mental maps of places and societies. A world of abstractions emerged – without images, only words, but still to be mentally modeled. Central is the ability to move that attendor around in this mental world, as animals had always been able to do while planning any social or spatial behavior, to choose a story or part of a story. You can certainly decide to move attention around the image maps you have of your home, or the home of your parents when you were a child. You can certainly move around your social world maps, considering the state of your social relationships, or that world of stories, experiential or abstract. Isn't this what we call conscious thinking, dependent on memories?

As a scientist with mental maps of many biological models, I too can move around any of these, with my monitoring now set to find any inconsistencies between them. I read a new book or attend a lecture and find new information. There are no images in these mental models, yet I can direct attention to and through them as easily as I do to the spatial and social maps. New information means my mental models must be altered. Each detail must be compared with relevant details of every similar model, always comparing and monitoring, always seeking differences, inconsistencies. Every inconsistency elicits an OR, then my close attention to the models to make changes of some sort, or find a way of bringing consistency. Isn't this what any animal does when faced with changes in its physical or social environment? Isn't thinking the ability to move freely through all of the mental models we carry of every specialty in our lives, seeking and comparing? Don't we OR whenever we detect any inconsistency in bringing in new

information? Where does the OR fit in current models of consciousness? Can consciousness studies operate without the OR? It is certainly the most likely part of the origin of human consciousness, and where one might look for any consciousness in animals.

I believe that anonymous societies have created new scope for free will. In our vast cities there are many unwatched pockets where people may choose behavior with fewer social constraints. Out of sight in my home, I can beat my wife. One can behave selfishly or criminally and young people can choose to have sex outside marriage. The constraints of family, neighborhood, religion, work or social groups can be largely avoided. Anonymity favored freedom of action – far more than in tiny tribes.

Free will always involves decisions to make behavior. Making decisions is possibly one of our oldest animal talents, probably unconscious. ORs may have brought experiential and emotional information relevant to any decision, but we can seldom know if they contributed to the decision. The decision was once probably always unconscious. The mind had information to allow planning for the decided behavior. Always there were constraints, mostly social. The decision always felt right – there had to be positive emotional reinforcement. We now make decisions with relevant information, sometimes worrying for hours or days. We probably still make the decision unconsciously, notifying the mind and being rewarded emotionally if the decision feels right. We believe that we made the decision logically and perhaps we did. But I suspect it would be difficult to dodge such an ancient unconscious process. Certainly Ap Dijksterhuis (2004) in the University of Amsterdam has recently shown that such 'unconscious' intuitive decisions can be more effective than those after time was allowed for conscious reasoning. Yet saying 'intuitive' does not eliminate the need for some sort of cognitive process, albeit subconscious ones.

Decisions to plan behavior have always faced the potential of constraints in complex social worlds. I suspect every decision faces a moment of constraint checking. Decisions may be to break moral rules, but a conscience OR will remind us! Always it was better to deal with potential social constraints mentally before, rather than behaviorally after movement has begun. Think of moving through that baboon troop.

As an ethologist, I wonder at the relevance or 'experience' of the qualia of seeing red or a musical note (Chalmers, 2010). Animals probably see colors in whole scenes, seldom single colors unless it is a blue sky. Seeing colors is functional and feelings or experiencing them is from whole or details of scenes. Red might mean certain fruit, food and a momentary anticipation, nothing more. But I remember as a small boy the regular question about my favorite color. The question implied that there must be some feeling about colors, allowing me to choose one above all others. I chose red and my little brother chose green. In the eighty years since, I discovered no function or relevance in that choice. Yet the learning imposed on me by that decision still allows me to like or dislike a color, then forget it immediately. I suspect color and other qualia would not exist without such learning as children.

Emotions are different. Natural selection didn't create emotions just for us. Very early in animal evolution there were situations where animals needed to become specialized, hiding some behaviors and fostering others. Behavioral specialization was a great triumph of natural

selection, allowing specialization for fighting, for play, building nests, for interacting by grooming or sex. Sometimes there was advantage in having feelings that were appropriate while in these states, mildly or strongly. Sometimes there was advantage in expressing those feelings, so that others would recognize them - communicating them. Others certainly needed to recognize anger or play.

Specialization of behavior is common, seasonally for breeding or migration, or for shorter periods, walking and being aware, resting, nursing, playing (Beckoff & Pierce, 2009), body care, anger, and in most interactions. Many of these have feelings or emotion, some expressing the emotion as in anger, submission, pain or excitement. In other cases, the feelings arise from situations, defeat or victory, frustration or resentment. Here too, the behaviors become specialized, appropriate to the feelings. Other cases occur when the emotion is transferred through empathy, and behavioral constraints are present (Beckoff & Pierce, 2009). We seldom recognize that the links between these specialized states we call emotions and specialized behavior are functional and have been created by natural selection, as has their communicative expression when it occurs. It is possible but unlikely that natural selection found advantages in favoring feelings without some essential behavioral functions. Think of one of the powerful emotions, associated with the fight-flight response. The animal is ready for extreme activity, many physiological changes are emerging in preparation for exertion. We and other animals recognize the behavioral specialization that accompanies the emotion. Do all emotions have these properties? Mostly we don't know; we have usually been more concerned with the feelings of people, seldom asking about which behaviors are now ready or unready. Yet I suspect no emotions we accept in people and any accompanying specializations are restricted to people. Perhaps the exception is for the many momentary feelings expressed in our faces or bodies during conversations or lectures, for these too are communicative.

As strongly visual animals, we work through spatial images in very much of our thinking and consciousness. This may seem different from thinking about abstract models obtained by stories, but is it really different from thinking through the rooms in your family home, now or years ago? For we still retain those images. Animals also must have models of the social world around them and be able to move around within them. These talents are certainly functional.

What I have written is not an account of consciousness or thinking, but a model of what seems a likely story of animal awareness and what natural selection might have done to change this into a functional human consciousness in our evolution. It says nothing about brains or the problem of mind-brain divide. For it seems to me that the understanding of brains is far from complete. Yet it seems that the mind and attention system that the brain creates is the command centre for individuals in their environment, highly functional and thus central to natural selection. For it is the behavioral commands produced by the mind that are functional; millions of years/generations have created this system. The way the brain is forced by minds to produce these commands is irrelevant; only the functions achieved are important. I suspect that when changes are demanded of brains, there are seldom new developments, but modifications of pre-existing but now less used functions. We do know that creating new behaviors can produce new circuitry within brains. Brain scientists have this double problem, how is this aware mind created and organized, then how are its operations conveyed and executed.

Trained as a geneticist, I can see the importance of evolving a control system, integrating the self and the social and physical environment, making decisions that involve images of the whole individual integrated within any memorized environment. Any new functions learned/developed by that mind must become subject to natural selection. The brain must also produce any new behavioral responses the mind demands, perhaps at first crudely, then a functional flexible facility to produce them more readily evolves by genetic assimilation (Baldwin, 1896, Waddington, 1955).

My model of the mind is an attention system that mediates between the animal and all its capabilities and its environment. Central is its use of awareness and consciousness to evaluate sensory input and control any behavioral or emotional responses of that mental model of self to that mental image of the outside world. Awareness covers living in the present moment, while consciousness gives momentary glimpses of the attending system, emotions, memories of past experiences, and making decisions for behavior. The brain does all the unconscious work, managing the body and serving the directions given by the mind. In the step from animal to human, language demanded continuous access to memories, to tell stories, build models from them, and to direct that attendor to examine past experiences or the maps and models of the spatial and social world that animals have always built. Story telling enabled a new set of world models to be built; the human mind could access these, locating any inconsistency and planning paths through them as animals could the previous models and maps.

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