Article

How Brain Makes Mind: The Principles of Operation (Part III)

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Abstract

We present the principles of operation by which a brain makes a mind, at all scales necessary to cover the whole problem. We inventory the necessary capabilities for a mind. We divide conscious mind into four layers of increasing elaboration. For the principles of operations of the lower two layers, we provide the STFC theory. For the upper two, we provide the STHC theory. We survey the evolutionary progression from first twinge of experience to human capacities. We explain the types of memory and problem-solving we carry and by what structures they are made to happen. We compare to prior works and review the philosophical implications and stance. All of this is done with minimal incoming assumptions, and those made are declared.

Part III of this four-part article includes: 15. What It is Like to Be a Human; 16. Consciousness Architecture Layer 4: Language-Enabled Mind; 17. Evolution; and 18. Conclusions.

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15. What It is Like to Be a Human

As higher consciousness emerged there came the experience and recognition of time, as a consequence of the differences it sees between its world at times t and t0 (where t and t0 keep increasing). Effectively, consciousness moves along time. At a low level there are linked stimulations of conscious events, and the propagation times and stimulus persistence of the brain. These cause the continuous flow of high consciousness time, enabling our "now."

Some opine that consciousness *causes* time (Deutsch, 1998), in the sense of the experience of a physical dimension that would otherwise just be another physical dimension. One might say that time is the progression toward increased entropy, or one might say that time is the *experience* of progression toward increased entropy; this contrast is just a matter of definition. The idea that the consciousness of beings such as ourselves specifically and literally causes physical time, however, we reject. There is insufficient evidence and plausibility to accept that possibility. It remains possible that the sentonic field and time have a very close relationship.

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Time might be a sequence of quantum collapse events, but space might, also.

Humans are action-oriented. The brain exists to decide what to do. The frontal lobe is the motor lobe. Impulses for action are suppressed and analyzed and selected and organized for submission to execution areas. Unlike other animals that go to sleep whenever they can, humans are curious and exploratory and chatty and get bored, stir-crazy, and lonesome. This keeps us active and learning.

The human brain features high-level, complex connections: understanding is pleasurable, novelty is pleasurable. These make curiosity and enhance creativity, itself a mix of compliance and variance.

Things bubble up into human consciousness from "subconscious" areas. Only some parts of the brain are organized to be part of the human-conscious. It is the unity of feeling and the unity of the cognitive and the fusion into a greater unity of these two (plus language) that form the experience of what we call our minds. For the base feeling this fusion is done in and by the sentonic field. For the cognitive, this is done by networking of neurons. The final fusion is done by the connection of cognitive (information-processing) neurons with feeling neurons, which connects cognition to feeling. This creates both complex deep emotions with a cognitive component, and rich thought embroidered with, encouraged by, discouraged by, and steered by emotion. The two things that make all this possible are the information processing and communication ability of all neurons, and the (strong) connection to the sentonic field of some neurons.

To "make sense" is a pleasurable condition related to high discovered recognition and correlation, and low ambiguity, as seen in strong standing signals against a relatively quiet background of alternatives. It brings comfort and is sought. Confusion and unsureness are negative, and we seek to eliminate or avoid these. The neural circuits for this are imaginable.

The human mind loves order in all things. It has grown through evolution to where it is possible for it to see a whole big picture (and even to describe that to another), wherefrom flows its great power.

Organized mind appears when awake, as opposed to when dreaming. One possibility is that the mind would be organized when we sleep were it not for interference caused by signals that are generated (or removed) during sleep (Sipfle K. , A Neurobiological Theory to Explain the Lack of Rationality in Dreams, 2021). Another possibility is that the operation of perceptual regions close to the senses, which are inoperative during sleep, ordinarily organize the flow through the rest of the brain, to restrict what is thought to what "makes sense." Both factors could well be significantly contributing. A third possibility is that prefrontal centers that impose a critical evaluation upon earlier cortex are disconnected during sleep; this is supported by EEG studies (Sipfle K. , A Neurobiological Theory to Explain the Lack of Rationality in Dreams, 2021).

We note also that *emotions* are quite in their normal form and understandable even during sleep; it is the cognitive, which is intrinsically of structured nature and of high continuous relatedness to many patterns we know, that loses good form and becomes disjointed.

A related possibility is that our simulation centers- our imaginations- are only constructed to run coherently for seconds at a time, because that's what is needed. In sleep we also don't playback our memories verbatim in long sequences; memory centers are executing a consolidation process and bubbling and burping as a result when they are active at all. Thus, disconnected splotches of memories start up short sequences of reconstructions and predictive simulations with no sensory perception or memory circuits activation to police for order.

Human-level consciousness occurs from adding to lower animals

a) Full language, with its ability to precisely manipulate symbols and abstract objects

b) A strong sense of what "makes sense"

c) Much increased short-term working memory and richer interconnections

(b) is what is not acting as much when we are dreaming. We may say that a scene or utterance is "incomprehensible," which means it does not comprehensively hang together (make connections) that result mostly in recognitions of things and relationships deeply honed over the years, rather than confusion resulting from a lack of this. Things make sense when there is high recognition and sharp inhibition, connected to feeling. In sleep the contrast is lost, and things bleed over into each other.

Humans are so advanced that they are aware of concepts as high as feeling confused and feeling sure they have "got it" (which are indeed feelings and may even be misplaced ones). Knowledge is not feeling. But feeling convinced of knowing something is a feeling (and generally a positive one). "I feel that X" means that X is coupled with a feeling of some certainty.

The mechanics of a working mind run on Recognition and Value. Direct pain and pleasure served as the first source of Value, allowing bootstrapping. Now, many local inter-neuronal circuits have likely generalized Value informationally, and no longer feel pain and pleasure, there being no evolutionary need to maintain them. At the micro level of large networks, the original pain and pleasure are too crude to serve- at least, globalized pain and pleasure are too crude.

Mouse consciousness is surely emotional and very action-oriented. It lives in a world of smells and touch and motor movement. In contrast, a grown chimpanzee has the intelligence of a 2.5-year-old human, and probably his emotional life as well. Such a human is no longer an infant but a toddler, with rudimentary language ability. Human consciousness is visual and analytic. Humans inhibit action until selected and initiated after analysis of the world.

Returning to time, consciousness has *duration*, necessarily. The actual "remembered present," as Edelman called it (Edelman, 1993), gives a more *global* (across space) and *constant* (across time) existence to an object than the millisecond/millimeter world of neural-neighborhood-scale operations.

This very short-term memory is very useful to sophisticated cognition, a sort of object cohesion and permanence enabler. Coupled with the connections that compare between different parts of

this time snippet and those that react to it and supply it with emotion, to a first approximation this *is* low-level, higher-animal consciousness. It is the now in which all thought and feeling occurs, about three seconds long.

Consciousness has a smidgeon of usefulness even without net emotional affect. Change and novelty and distinct form cause this impact (which on repetition fades, both as it happens and from (nonmotor) memory). But consciousness without net emotional affect, which supplies positive and negative values, is very limited in what it can do.

The emotions we feel affix value to things, including objects to study and courses of action to choose. In principle in another universe another mechanism could have been used to supply value but feeling is what evolution discovered in our universe that could be used.

And why did evolution use this means? What is helpful about feeling, is that it has its own intrinsic value- positive or negative. That means evolution did not have to manage to use valueless connections in a consistent way to emulate the same thing, or invent centers as assigned positive and negative places that must be connected to. Consistently labeled positive and negative things were available in nature to happen upon, and then use again and again. This made it easier, and thus more likely, and thus the way, that summary value is implemented in the brain.

We don't call it thinking unless we can feel it happening. There are also underlying processes to our thinking which we can't see (e.g., associating). Crossing the boundary is what happens when things "pop into my mind." We are able to deliberately reflect to encourage these unconscious processes to happen, and to deliberately turn down our attention and fixations to allow broader and freer flow of proto-thoughts and metathoughts.

We can feel the thinking process partly because cogitating kicks feeling parts (rather like feeling limb motion), and probably because of the changes in blood vessels (which we can see in imaging).

It is probably even important to our thought processes that we can feel our thoughts and where we are paying attention, and probably there is specific sensation of that because the sense-ability has utility.

General "awareness" may include arousal (which increases intensity of attention behavior) more than emotional response, which gives value to things. A high level of arousal can be pleasurable or stressful; it is an intensifier.

Our emotions are different from an awareness of things. We can just feel sad or fearful, *then* start thinking or noticing or inventing supposedly why. Sad can be purely dysphoric, without knowing "why," which is cognitive (in contrast, the more complex *dread* is also dysphoric, but *refers* to something).

People use the word "feeling" to refer both to emotions and to intuitional judgements. This is natural, because our processing circuitry includes a bed of elaborate, general recognition circuits effectively much-interwoven with feeling circuits so as to develop finely detailed value

processing of things under consideration, resulting in a net high-level score, and the distinction between emotion and cool judgement can be difficult for us to tease apart.

It is possible both to have a "feeling" (observationally) of a large object in front of your face without net caring, and also possible to feel positive or negative for no apparent reason. As to the former- impact- it is the shapeless glob of feeling that is doing the reacting to factual stimuli. You still hear emotional white noise even though it doesn't settle on organized tones. The white noise activity is impact. Everything noticed makes "you" feel something- even if only a unified agitation.

Concentrating of pain or pleasure is relatively unusual in the universe (rather like the very big molecular machinery of life being unusual). Thus, it is a specific achievement of evolution that is useful. Pain and pleasure allow advanced minds. By the Anthropic Principle, that is why it's here.

Physical consciousness was exploited in vertebrates just as the laws of mechanics and chemistry were. It serves the functions of learning and assigning general goodness and badness to large and complicated and long-lasting experiences and plans, and in bonding social groups.

Higher consciousness is like multicellularity, something that emerged as a complex system incorporating many points of occurrence of base consciousness, allowing novel survival niches by supporting highly elaborate, flexible, and effective structures.

While our consciousness is observable and organized, this does not mean that simple consciousness does not happen all around us. The organization of fundamental consciousness into high-level consciousness was done with our brains by evolution (or preceding mind to whom we are the artificial intelligence). As one of the available forces, fundamental consciousness probably has been exploited elsewhere, and elsewhere there will be pain and pleasure (and therefore perhaps good and evil).

Is consciousness "just" an epiphenomenon? Yes, in the sense that it was not necessary that we actually feel, only that the same values be attached to things as feelings allow. No, in that the values consciousness provides form a key part of what our minds are and how they work.

Value is needed for how we think. It is what steers the cognitive centers to make decisions. The cognitive centers can recognize things and recall candidate action sequences, but it is the emotional input that determines the selections- the "voluntary" behavior. Volition equals emotion.

The nature of our human-level consciousness is that we react emotionally to (and perceive) our thinking, and we cognitively notice our feeling, and we talk to ourselves about all of this in a chorus of stream of consciousness (James, 1890). Our words then evoke feelings and more thoughts and around it goes. We talk to ourselves like a friend (or enemy), and our real friends' words are in there, incorporated.

I feel. What is I? An assemblage of interlinked cognitive and feeling events. I am intellectually aware that I am feeling, and I can feel and have feelings about my thinking. The human mind is

everything it is because it contains not only thought and feeling but can think about feeling and feel about thinking, and do so under the organizing and evocative presence of language. Higher consciousness is the interaction of knowing and feeling, and each of each other. The deep mutual interplay of feeling and thought, and of these with language, comprise the mind.

16. Consciousness Architecture Layer 4: Language-Enabled Mind

There are two major elements added to make a human level mind beyond just scale. These require new brain tissue. One is a refined sense of what "makes sense" (that which is lost when dreaming). One might call this our reality detector. The other is language.

Language organizes all the little fits of proto thought, and one's own assembled phrases stimulate those same fitful centers to recognize and remember and churn out new proto thoughts. Language crisply organizes associations and spatial, motor, and intuitive thought. This is done using the new language centers of our brain (notably Brodmann 22, 44, and 45). The appearance ("hearing") of the sentences to our non-language-centric brain centers evokes in them the unstructured thought that is then organized into language again. This cycle, along with emotion, is the fundamental stuff of our highest-level consciousness (mind), as we talk to ourselves about our thoughts and feelings and react to what we have heard from ourselves.

We have coined many words for various kinds of feeling (and thinking), which attest to the richness and complexity of human-level minds.

16.1. Human Evolution of the Prefrontal Cortex

While 99% of human DNA is the same as a chimpanzee's, 80% of the proteins differ between the two species (Passingham R. , 2021), which diverged 7 Mya. By about 2 Mya humans (Homo Erectus) had evolved, left Africa, and made it to China. In another wave, by about 0.6 Mya archaic Homo Sapiens appeared and made it to Germany. Modern Homo Sapiens appeared by 0.3 Mya in Africa, 0.2 Mya in Greece.

The frontal cortex- particularly the granular prefrontal cortex- and medial parietal cortex, was expanded in Homo Sapiens.

During the evolution of the anthropoids (monkeys through humans), there was an expansion of association cortex within each lobe, and not just within the frontal lobe. The human prefrontal cortex, though, expanded more than the middle and inferior temporal cortex, the premotor, and the motor cortex. This means there is more human prefrontal cortex for re-representing visual information from the ventral visual stream and for generating goals as opposed to just directing the actions that achieve them (Passingham R. , 2021).

16.2. Goal and Feature Memory of Humans via Parietal-Prefrontal Network, Temporal Area, and Prefrontal Adaptations

Parietal-Prefrontal capability advanced from representing relational metrics to supporting generalized relational reasoning. Temporal areas advanced from representing the signs of resources to supporting semantic generalizations. Prefrontal cortex adapted its top-down biasing function to memory retrieval. (Murray, 2017).

16.3. Social-Subjective Memory of Humans via New Granular Prefrontal Cortex

New and higher levels of hierarchy emerged courtesy additional prefrontal areas. Representations of self and others developed in these areas. These came to influence existing medial and lateral networks (Murray, 2017).

The medial network came to support perspective-taking, recognition of situational contexts, mental simulation of past and future events, and knowledge of self and others from participatory experience.

The lateral network came to represent social goals, norms, and concepts, categories, groups and roles of individuals, and generalizations about self and others.

16.4. Explicit Memory of Humans

Explicit memory emerges from interactions between the forms of memory, each having evolved at different times. The hippocampal memory system learns about what happened at a particular time and place while granular prefrontal areas learn about what happens in relation to behavioral goals. With the appearance of humans, these came to work together (Murray, 2017).

High order, human-specific representations of self-contribute to both the perception of participating in attended events, and the perception of knowing attended facts. These self-representations become a part of conjunctive representations that are explicit memories. When individuals retrieve memories containing this part they re-experience the participating in events and knowing of facts (Murray, 2017).

16.5. Language-Enabled Mind

On Earth, only humans operate at this level. Other species have not achieved true grammatical language. Universal capacity for grammar is literally wired into humans (Pinker, 2009).

As we have noted, observation of the experiential parts of the mind by the verbal parts results in the spontaneous forming of sentences that crystallize precise statements of observation. This

evokes responses of meaning in the experiential parts of the mind, forming our loop of realize-and-comment that operates continuously in our waking hours.

These mental abilities enable long-chain serial thought and precision and abstract languages such as mathematical notation.

(None of this capability has anything to do with Goedel. Recognizing mathematical truths is a combination of learned discernment skill and natural machinations of our evolved brains that live in a naturally patterned world. Also, many people cannot make these recognitions so it cannot be fundamental to the human mind.)

Language is long, sequential chains of symbols, especially with the advent of writing, which provides external memory much as the real world of objects is itself persistent.

16.6. Hypothesis Contained in STHC

Hypothesis STHC-2: Cyclically, language organizes thought and stimulates new thought to organize as language centers interact with earlier non-language centers (Sipfle K. , 2018).

16.7. Problem Solving 6: Reasoning, Imagination, and Planning and Generating Goals from Instructions and Imagination via Enlarged Polar Prefrontal Cortex of Humans

Polar prefrontal cortex is Brodmann area 10, located right behind the forehead. Brodmann 10 is now the largest Brodmann area.

Through human-level general intelligence exploiting human capacity for instruction, imitation, and mental trial and error in internal re-representations of the world, humans are able to reduce errors in action choices- which are dangerous in the wild- to nearly zero. The imaginative abilities, even of actions planned but not executed, that emerged to reduce errors in specialized situations, created the internal world that provides modern insight (Passingham R. E., 2012).

16.8. Problem Solving 7: Language via Areas 44 and 45 and Culture and Social Rules via Medial and Orbital Prefrontal Cortex and Amygdala

Functional brain imaging studies and meta-analyses thereof have revealed the following knowledge (Passingham R. , 2021).

There is cerebral dominance in the left for speech, but also for performing skilled actions other than speech, regardless of hand used. The same precision manipulation mechanisms are used.

The prefrontal area Brodmann 44 is active when words and sentences are being assembled (but not when speaking them). Left areas 44 and 45B support generating verbs appropriate for nouns (that is, verbs that make sense for nouns) , with 44 generating sentences by hierarchical rules. 45A supports learning association pairs and names associated with things (tagging with words). Names can evoke visual imagery (elsewhere in the cortex) of the named objects.

Left 44, 45B, and 45A plus the middle frontal gyrus are critical for the semantic system.

Observing demonstrations activate 44 and 45B. Verbal instructions can be acted on immediately without first learning. Instruction activates prefrontal cortex linked to cortical areas specific to the requested tasks.

The interconnected medial and orbital prefrontal cortex and amygdala are activated in anticipating punishment, feeling empathy, and feeling guilt.

17. Evolution

We have presented an architecture, which itself stands for study irrespective of the specific explanation as to how it is "implemented" by Nature. But as evidence of its truth, it must be a plausible destination of evolution. Here we summarize that journey. We can recapitulate the evolutionary development sequence because the needs and difficulties are obvious, and because we have the animals around us as evidence.

First needed would be basic stimulus/response. This could be viewed as the degenerate case of the cognitive. Then would come totally dispassionate ability for slightly complicated perception and actions. In other words, calculating ability- pure, passive cognitive- would appear first, and still exists in primitive animals.

Feeling provides for the first operant (reinforcement) learning opportunity, and certainly for more complicated organisms. It offers a broad whatever-you're-doing-is-bad (or good) signal for learning, and it provides the second needed, broadly distributed system- Value- which determines what action impulses are let through, the first system being Activation. Third is Attention, targeting and focusing the cognitive portions. Even before well-developed learning appears, feeling allows for generalized real-time changes in decisions in creatures with some neural complexity, and serves Attention.

The wholesale march into feeling began with the evolutionary outgrowth of the allocortex- the olfactory system and the hippocampus. The paleocortical piriform cortex, a.k.a. posterior orbitofrontal cortex (posterior OFC), is heavily correlated with the cingulate gyrus and the septal area, which is part of the basal forebrain. The OFC mediates the expectation of reward/punishment in response to stimuli. The paleocortical olfactory tubercle plays a role in transmitting positive signals to reward sensors.

Once all of these lower mechanisms were in place, the neocortex burst forth into high growth. Warmer/colder is a powerful concept (complementing recognition and association).

The older and deeper parts of mammalian cortex form the connections to pain and pleasure that guide the cognitive circuits (literally) above. With this basic plan in place, the stage was set to scale up- with the same basic brain architecture- to more and more, and more refined, cognitive mass. Summary good/bad/pain/pleasure/warmer/colder is key to advanced brains and simplifies genetics in that action selection circuits can be built to pursue summary "good" and avoid "bad," while other independent ones connect perceptions and relationships to those values, rather than trying to wire together myriad situational aspects to individual acts of plans.

As the ability to manipulate objects became more abstract, true language first emerged and then became not just a communication feature but integral to human thought; communication itself became internalized and reflective. Metalanguage (grammar, new notations, compound constructed words, and descriptive theories) emerged and itself became introspectively manipulable.

Pain and pleasure have been discovered and harvested by evolution. (There are likely other worlds in which pain and pleasure don't exist to organisms, even complicated ones.) Pain and pleasure might not actually be the same force. And there might be animals that feel pain but no pleasure. Use of one may have come first in bio-evolution.

Intensity of experience increases by way of more spots in the field, and so indirectly, by more related brain interconnections. Harvesting fundamental consciousness by evolution would mean "crafting" the shapes and/or construction and constituents of neurons, and possibly sets of neurons.

Feeling continues to guide cognition at all levels. This allows three-pound brains to handle situations usually well enough that would be impossible to handle with combinatoric perfection, and provides an edge to conquer, in evolution, competitors and challenging niches. With bacteria and others optimized for the easier (in terms of complexity) niches, we populate the harder ones, requiring large-scale sophistication.

If not already on Earth, comets or asteroids could have provided batches of particles rich in sentonic charge. They could have come from anywhere or anyone. They are the seeds of advanced minds.

18. Conclusions

We have presented an Architecture (FLA) and compliant theory for every major constituent of mind from nothing but the existence of this universe up through human minds.

The STFC metatheory does not presume that human-level consciousness is everywhere. It does assert that primitive fundamental consciousness is distributed throughout the universe and the field carrying it is everywhere. The universe does not understand things or feel as a whole in a unitary fashion. It does contain such "flecks."

The STHC theory of animal-level consciousness assumes that it is probably the result of activity of networks of physical neurons that calculate and harness feeling.

The nature of our human-level consciousness is that we react emotionally to (and perceive) our thinking, and we cognitively notice our feeling, and we talk to ourselves about all of this in a chorus of stream of consciousness. Our words then evoke feelings and more thoughts.

On the way to our solution, we have laid down some postulates and presented hypotheses, to wit:

Postulate 1: Physicalism is necessary and information - and computation-based theories cannot provide for the source of conscious experience.

Postulate 2: Consciousness functions within the same basic rules (including mathematics) as all other phenomena that also exist in Nature.

Postulate 3: Something basic is missing from, and must be added to, our physics.

STFC Hypothesis 1: Fundamental feeling is freestanding and requires no separate feeler. At most there is a physical interaction between two fundamental elements.

STFC Hypothesis 2: There is a physical process that is fundamental feeling.

STFC Hypothesis 3: The fundamental feelings are pain and pleasure.

STCF Hypothesis 4: There exist pain and pleasure in minimal discrete bits independent of any brain, at the sub-molecular scale.

STFC Hypothesis 5: Some biological brains have evolved to organize and exploit pain and pleasure.

STFC Hypothesis 6: The fusion of feeling across the brain occurs in a force field.

STHC Hypothesis 1: It is by way of feeling and information processing that aware and intelligent minds have developed that can solve problems and set goals.

STHC Hypothesis 2: Cyclically, language organizes thought and stimulates new thought to organize as language centers interact with earlier non-language centers.

(*Continued on Part IV*)