

The Integrated Model of Consciousness

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Consciousness is simple by definition, and complex by extension. For the first time we may have a look into some of the complexities of Human Consciousness, and how they may have accreted to core consciousness over millenia. From a Core Consciousness that can be traced to the Optical Tectum in early pre-amphibious ancestors, or even earlier in the evolutionary record, to an advanced model that includes at least 6 different sub-models, and grew from an early model of consciousness, we will see the accretion of layers of consciousness upon the basic core consciousness despite setbacks and variations in the evolution of the brain. Similar to some theories that make the mistake of Scala Naturae this theory shows a scale of elaboration that is not meant to reflect the pattern of evolution, merely a list of elaborations that has become standard within the human brain. It is not meant to be exhaustive, merely indicative of the complexity of consciousness as experienced by human beings. That the stages in development of the human brain make a track through time, is not meant to mean that in fact this track was as straight forward or simple as the model might suggest.

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Consciousness, definition of consciousness, Human Consciousness, Core Consciousness, Optical Tectum, Superior Colliculus, Basal Ganglia, Insula, Precuneus, Integrated Model of Consciousness, Elaborations

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When asked what consciousness is, most people like John Searle, think of the fact that they awake every morning and stay awake until night-time when they fall asleep again. This Creature Consciousness as it is called, is a very simplistic view of consciousness. We don't know exactly how the brain does it, yet, but the function of being awake, aware, and responsive to stimuli, is not all that complex. It has a long history of conservation in evolution, and most animals have enough of it to be visibly awake.

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One is tempted to think that all consciousness is, is this trivial function, but human consciousness, true human consciousness is much more complex, and trying to merely describe it has taken centuries of philosophy and thousands of philosophers, and is yet not quite complete. The discussion continues.

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It might be thought that trying to define consciousness when philosophers have failed so many times is counter productive, but, that is not exactly what I am trying to do. Instead what I am trying to do is to create a Model of consciousness that will open new discussions, and thus open the subject to greater scrutiny. It has been said that all models are wrong, and there is no attempt on my part to suggest that this model will be anything more than that, but it offers a new perspective on consciousness that I hope you will find interesting, and will, I hope, pave the way towards conscious machines some time in the future.

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When Yinsheng Zhang wanted to define a Mathematical Model of Consciousness, he depended on the work of Jean Piaget, and Norman Malcolm. From this he was able to suggest that consciousness had both a transitive and an intransitive nature and that the transitive nature was the primary sense. From this he developed a mapping routine that mapped from the entity in the environment to its representation in the brain. [Zhang 2014]

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0050 The formulation takes less than a page of his paper which indicates that in mathematical terms it
is trivial. Could consciousness be so simple? Domasio suggests that it might just be. In his many
works on consciousness Domasio [Domasio 2010] points to a point in the brainstem near the
0055 Peri-Aqueduct Grey as the location of consciousness as proven by lesion studies. In the sense
that lesions in this area cause loss of consciousness, consciousness is dependent on this area of
the brainstem. In essence it is the core of consciousness and everything else is extended
consciousness.

I for one am not persuaded that this is all there is to consciousness, or at least that this all there is
to human consciousness which in my opinion is much more complex. Like the label “Creature
0060 Consciousness” suggests, this is a base case on which other types of consciousness have formed.
To say that it is Creature Consciousness, however suggests that all creatures except man have
this and only this form of consciousness, an assertion that I am every bit as far against. That is
why I have chosen to call it “Core Consciousness” as suggested by Domasio. Essentially I
choose to think that evolution has added new functions to an existing core.

0065 It is tempting to think that the brain has evolved to be more complex, but in fact that is Scala
Naturae thinking. Evolution is neutral towards complexity often reversing elaboration. Instead it
is best to think of Evolution as having an ebb and flow, and sometimes flowing in such a way as
to become more complex, sometimes ebbing and simplifying. That the brain has become more
0070 elaborate over time, is pure happenstance and nothing can be made from the point.

One area near the area Domasio points to is the Optic Tectum. (Tectum is another word for
roof, the optic tectum is in the roof of the midbrain.) In humans this area is called the Superior
Colliculus. Although it is the target of neurons from the retina, that is not all that this area is
0075 connected to. It also has connections from auditory and somatosensory neurons. It has been
suggested that this might be the seat of consciousness.

If Domasio's core consciousness concept is correct it could also be the seat of core
consciousness. In essence the nerves from the retina, auditory, and somatosensory areas are
0080 mapped topographically within this area creating an organism-centric mapping of the senses. It
is important to note that this area is before massive analysis of the senses, and so it represents a
very basic form of consciousness.

One way of looking at consciousness is that this core consciousness supplies just the basics of
0085 consciousness, layers of sophistication are added one upon the next on top of it, but because
they all depend on the core, a lesion on any area that the core depends upon will cause loss of
consciousness.

One reason for bringing all the senses together into a single location early in the development of
0090 the brain, might simply have been to reduce the complexity of the control circuits needed to
control the body. This was conserved because it allowed the body to react well, even when
massive damage or illness struck the brain.

The idea that layers of sophistication are built on this basic core consciousness is not new,
0095 Domasio suggested such in his works. However, for the first time we can begin to understand
just how they work together to create consciousness as experienced by humans. The first clue

0100 lies in the feedback from the Basal Ganglia to the Optic Tectum. The Basal Ganglia area
migrated forward from a location in the midbrain and became significantly more elaborate. In
essence the basal ganglia allows operant conditioning to overcome classical conditioning. It is
Reactive in nature. What it seems to do, is separate all types of stimulus into two types of
reactions, it either becomes attractive to a reaction or becomes aversive to a reaction, depending
0105 on the balance of pleasure to pain. Because this is an important improvement over straight
classical conditioning it bypasses the optical tectum when it is active.

While feedback loops are not as easily determined for other higher functions, and thus higher
functioning layers of sophistication, the reason is simply that there is too many connections
0110 between the cortex and the optic tectum to trace them to specific locations in the brain. The
Optic Tectum feeds the thalamus which in turn is richly connected to the cerebral cortex.
Feedback from the cortex also finds it's way back to the optic tectum, but the exact locations it is
coming from are a matter of speculation.

0115 Part of the problem is that the general structure of the brain is conserved but the exact details are
quite different depending on species. Working from comparative vertebrate neuro-anatomy, it is
obvious that despite setbacks in elaboration in any specific branch of evolution that human
evolution has resulted in a gradual increase in elaboration over time.

0120 It is thought that each time the brain has become more elaborate it has resulted in new functions
that were either later dropped or conserved depending on their utility. The conserved functions
at the present represent those that have had the best impact over time. Brain elaboration has
resulted in some immense changes to Human consciousness.

0125 While it can't be called a progression, the list of specific elaborations of the human brain will
help us explain the nature of the evolution of consciousness in humans. Looking back at only
the conserved items, gives us no idea of the richness of the intermediate stages, but does seem to
indicate some inexact order of evolutionary development. This might be useful because it hints
at the structure of consciousness. Even though it is misleading to assumptions about preceding
0130 states, and doesn't cover the richness of the real thing.

It is thought that the Secondary Eye Fields, the Basal Ganglia, the Insula, and the precuneus, all
bypass the optic tectum. If this is true, and the optic tectum is the seat of core consciousness as
Domasio has suggested, then if we determine the order in which these elaborations on basic
0135 consciousness happened, we will have a map to the development of human consciousness. This
map may have some utility in understanding how to design a conscious machine.

The Secondary Eye Fields allow the brain to do anti-saccades. This means that far from looking
at every new stimulus, the brain can choose to look away from the stimulus, even to the point of
0140 looking in the exact opposite direction. To do this the brain has to overcome the optic tectums
immediate reaction that brings the eyes towards a new stimulus. In real life it means that eye
contact can be maintained between prey and predator despite intervening stimuli. This is a
useful example of how the basic responses of the optic tectum are bypassed by more advanced
sophistication. In essence the more primitive responses can be "Ignored" but still are there if
0145 needed, or if no reason is there to do things differently.

0150 The Basal Ganglia as I have mentioned before bypasses the basic classical conditioning paradigm allowing the more sophisticated operant conditioning to be done. This means that instead of acting in a learned reflex, the organism has the ability to decide not to learn a specific reflex if it makes more pain rather than pleasure. It is thought by some that this capability came with the early vertebrate shift from sea to land, and thus with reptile-like amphibian ancestors.

0155 We have to be careful here because some popular brain development theories have missed the clade analysis that makes mammals an earlier offshoot than reptiles, evolutionarily speaking, and therefore means that reptiles have no part in human brain design, this will become more clear when we talk about MacLeans triune brain theory.

0160 The next most obvious bypass is the bypass for the Insula. Essentially the Insula is a walnut sized adjunct to the cortex that is connected to the limbic system. In essence this area is involved in emotive drives, and is indicated in cases of addiction. Lesions in this area have allowed people to walk away from well established addictions. It is important to realize that the insula bypass is an important improvement since it means that instincts can be informed by emotions. It is thought that this particular change happened sometime during or after the shift from cold blood to warm blood. Certainly by the time of paleo-mammals.

0170 The last obvious bypass is the bypass for the precuneus. Essentially the precuneus is a small area of the parietal lobe verging on the central cleft between the hemispheres. It is thought by some that this bypass occurred late in the development of the brain, and while the exact details are still controversial, the current theory is that it happened at about the time of the first primates. The function of this bypass, seems to be the overcoming of the emotional drives by (out of band) thought trains. In essence this bypass allows the brain to break free of its emotional drives, to change it's actions to reflect on the work of the prefrontal cortex. For the first time deliberation was possible.

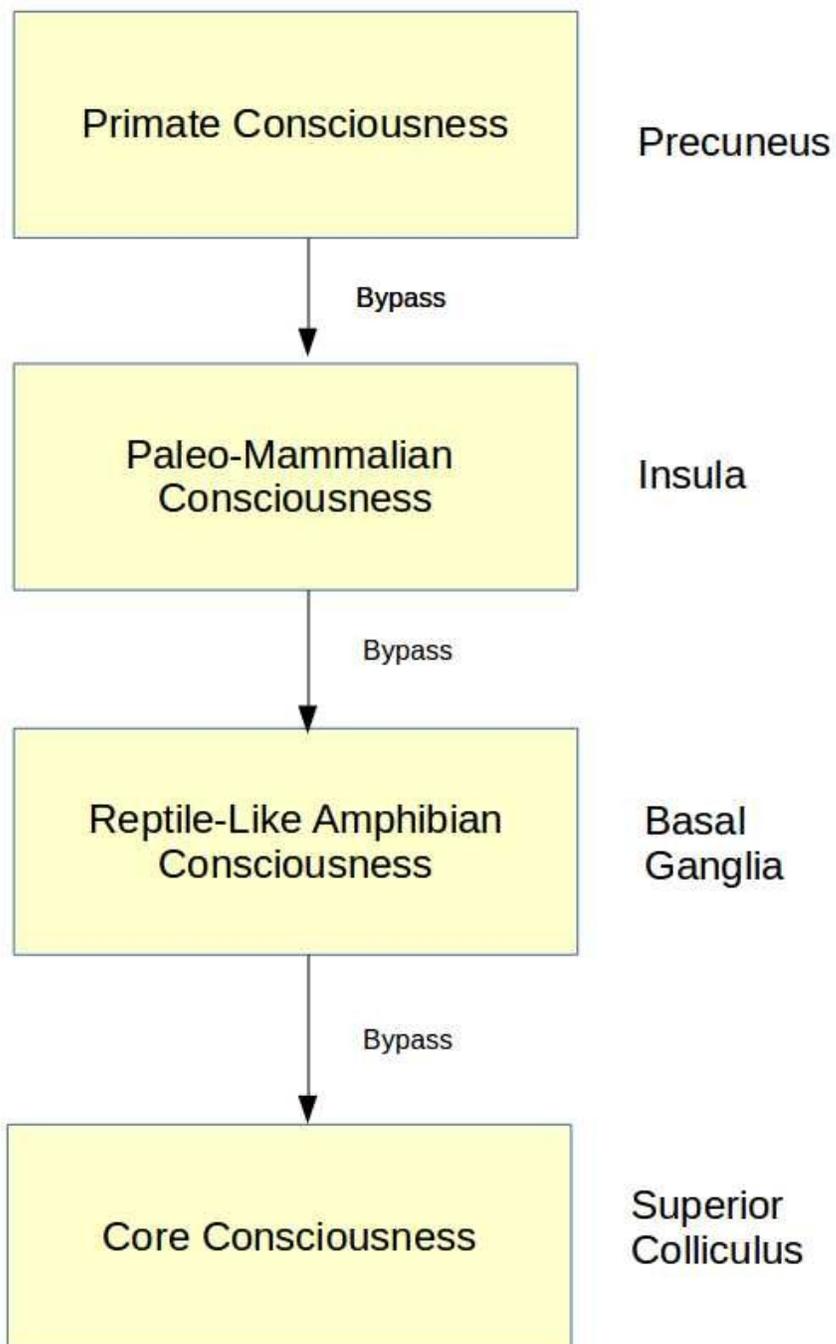
0180 While the timing of these bypass elaborations is speculative, and controversial, and their development was important to, but not obviously the only developments in the human brain, they represent distinct functions of consciousness that are not shared with every animal, and thus give us and other primates a distinctly different consciousness than most of the other animals. It cannot tell us why humans are different from other primates, but it at least indicates how primates might be different from other mammals.

0185 To understand this properly we need to model the steps in some sort of development pattern. We have to be aware however that this development pattern is post-hoc and therefore represents guesses based on the current state of the brain, rather than facts gleaned from the past. As such the theoretical boundaries of these guesses can be wrong, or even misguided without the development pattern being wrong.

0190 The first theoretical model that I would like to introduce is MacLeans Triune model of the brain. [Maclean 1990] In it, he suggests that what lies within the brain is three evolutionarily distinct stages of development that have been conserved by evolution. The Reptilian Brain, the Paleo-Mammalian Brain, and the Primate brain.

0195 Now as I have alluded to earlier, the exact boundaries between the stages of the brain are controversial, Maclean's Reptilian Brain is not possible because mammals preceeded reptiles

The Triune
Model of
Consciousness



0200 but the main detractor is that it is obviously another form of Scala Naturae, it hints that there is some scale at which man is the top of the evolutionary ladder. If we look at it from another angle we see that it has some very good correspondences to our bypass list, which suggests that while we might allow the scala naturae detractor to influence us, it does have some value as a model.

0205 In the Triune Model of Consciousness, I suggest that in fact a similar model might cover the development of bypass architecture in the human brain. This suggests that there have been elaborations of the brain which are conserved in the human brain that might reflect evolutionary epoches during which the list of bypasses of the optic tectum were developed. This by no means suggests that humans are the pinnacle of evolution, merely that the human brain is the most
0210 elaborated brain in its own branch of evolution, and that these features still remain within its design.

The second theoretical model that I would like to introduce is the Sanides-Hassler-LaMuth Model of Neocortical Development. Again this smacks of Scala Naturae thinking which is one
0215 reason why it has been more or less ignored by science, and the boundaries are speculative and controversial but it does suggest that there are developmental elaborations in the Cortex that might have contributed to the development of the bypass architecture. In this theory there are six progressions that eventually result in the human cortex.

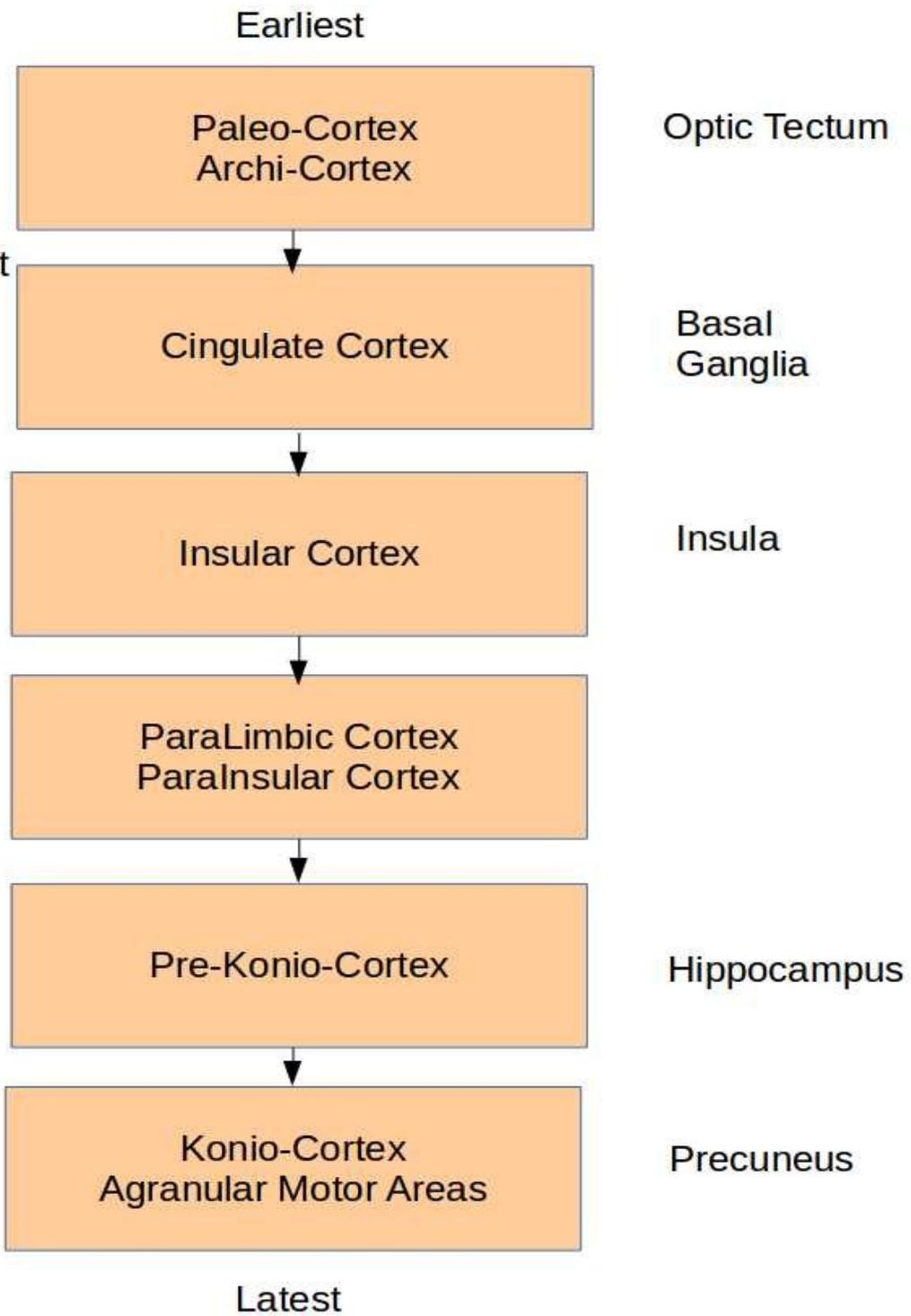
0220 In this theory the Paleo-cortex and archicortex are the earliest forms of the cortex, then the cingulate cortex then the Isular cortex formed, then the Paralimbic and ParaInsular Cortexes formed, then the PreKonio Cortex, and finally the Konio-cortex and agranular motor areas. All in all 6 different stages of evolution. Part of the reason that this is Scala Naturae thinking is that it assumes that the Konio-Cortex is only found in primates. Sanides original work was panned
0225 for his insistence that areas that were thought to be related to sensory input were so late in the development.

LaMuth by rewriting Sanides work and integrating Hasslers work with it, came up with 6 stages instead of 5, the last one of which expanded the parietal lobes and the prefrontal lobes as the
0230 latest stage. This moved the 5th stage back in time so that it was less obvious that it included the sensory inputs at a very late stage in evolution. He integrated Hasslers work on the thalamus to show that there were six stages to thalamus evolution also. It is important to note that while this is a list of elaborations of the cortex and thalamus it does not represent evolutionary progress, merely illustrates how that progress caused elaboration within the cortex and thalamus during
0235 various setbacks and advances.

Part of the resistance to Sanides, and Hassler probably comes from the fact that they were German Scientists that operated during the Nazi period of Germany. As such their work is questioned by serious scientists in other parts of the world and their conclusions are questionable by modern science.

0240 The Growth Ring model of Consciousness is a very basic model based on the idea that the cortex has become elaborated over time, and the last stage was the development of specific parts of the parietal lobe, and prefrontal cortex. The Growth Ring model suggests that the Insula was evolved early and the Parietal cortex late in evolution which supports Maclean's model
0245 somewhat.

Sanides
Hassler
LaMuth
Growthring
Model of
Neocortex
Development



0250 The next theoretical model I would like to introduce is the hippocampal Model of Consciousness, wherein I suggested that the hippocampus is the seat of consciousness. This model was panned because the classical hippocampus removal patient HM, had no noticeable problems with consciousness. It was suggested that consciousness couldn't have come from the hippocampus without some loss of consciousness when it was removed.

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The next theoretical model I would like to introduce is my Angular Gyrus Model of Consciousness. Originally designed to deal with problems suggested about my Hippocampus Area Model of Consciousness, the Angular Gyrus model used information about the white matter in the Tempo-Parietal Fiber Intersection Area beneath the angular gyrus to suggest a link between the parietal lobe and the prefrontal cortex. Under the assumption that the outputs of the network suggested continued on down to the hippocampus, it was the next most likely location for the seat of consciousness working back as I was from full human consciousness and trying to deal with objections that loss of hippocampal function didn't seem to have any effect on consciousness.

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It was because of this work, that the next theoretical model became possible. Called the Inferior Parietal Lobule Model of Consciousness, it integrated what was known about internal and external trains of thought. Brought about by different networks, internal and external trains of thought use the angular gyrus and the supramarginal gyrus the components of the inferior Parietal Lobule as their output buffers and were originally thought to report to the precuneus. However research into connections suggested that in fact only the external trains of thought reported to the precuneus, the internal trains of thought reported instead to the posterior cingulate cortex immediately below it.

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This brought back the need for the hippocampus area model of Consciousness if there was to be room for internal trains of thought to be conscious. But the objections were still valid, how could the hippocampus be the seat of consciousness if consciousness was not lost when hippocampal function was lost?

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The answer was simply the idea that consciousness was bypassed once more by the hippocampus, and thus earlier states of consciousness would be available. This would bring both the hippocampus area functions and the internal trains of thought out in a single pass.

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If internal trains of thought were conscious without the precuneus, why would external trains of thought become conscious by going through the precuneus? This suggested that they were a new network connection that came after the internal trains of thought, possibly created by growth both in the prefrontal cortex, and inferior parietal lobule. That the precuneus was thought to develop this link only in the primates supported the Triune and Sanides-Hassler-LaMuth models.

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As I developed the Integrated Model of Consciousness, I went back to courseware on the philosophy of mind, to determine if there was any more aspects to consciousness to integrate. The model seemed to suggest answers to most modes of consciousness, but needed to work on explaining access consciousness and self-consciousness. [Brown 2014]

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Integrated Model
Of Consciousness

Latest

Self-Consciousness

Prefrontal
Cortex

Trains of thought

Precuneus

Hippocampal Consciousness

Hippocampus

Emotive Consciousness

Insula

Reactive Consciousness

Basal
Ganglia

Core Consciousness

Superior
Colliculus

Earliest

0300 Access Consciousness was first suggested as a result of Global Workspace Theory and “Fame in the Brain”. Essentially what it suggests is that a portion of what is conscious, is “Broadcast” by a central network to modules that do work upon it, and report back to the central workspace, where they compete with new knowledge for rebroadcast.

0305 Evidence seems to suggest that there are central networks running down the central cleft on either side that are highly connected to both modules in the brain, and to the inferior Parietal Lobule. Thus messages that get output in the inferior parietal lobule, are broadcast to modules all over the brain. This suggests that Access Consciousness falls under the inferior-parietal Lobule Model.

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That leaves Self-Consciousness unexplained. Self-Consciousness is a relatively new study, so there isn't much science on it, but it seems likely that it is a result of prefrontal cortex development. As such it would show up in the Sanides-Hassler-LaMuth Model of Cortex development at the last stage in development. However Dolphins and Elephants have passed the mirror test so it does not limit itself to primates. This might suggest an earlier implementation, or it might suggest that the Sanides-Hassler-LaMuth Model of Neocortex Development is too badly connected to Scala Naturae thinking by insisting that the later forms of development happen only in the primate brain.

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0320 *Conclusion:*

The result of combining all these theoretical models, is a super-model I call the Integrated Model of Consciousness. Because it is based on all these other models, it deals with evolution in a number of ways, and fleshes out a much more sophisticated definition of consciousness than the simpler definition would suggest.

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The Super-Model suggests a heierarchical Ordering of priority between layers of elaborations. Each layer seems to have a higher priority than the previous ones, yet damage or illness does not preclude the substitution of previous layers of consciousness for the damaged layer. Because previous layers are substituted, no major difference in consciousness has been noted despite major damage to a higher layer.

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The priorities may indicate a relationship to the evolutionary epochs involved. The earlier the epoch, the lower the priority. This may not be all that valid, depending on evolutionary factors that are not yet obvious. Part of the problem is that we do not have consensus on the historical nature of evolution, and the theories that go into it in depth are controversial.

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Integration is only starting, there may be a need to add other details that have yet to be determined. This theoretical model is open to new integrations as more becomes known about consciousness.

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