SECTION 8

Control of Memory Management

THE PROBLEM

As described in the prior Section 7, the neural interconnections for the MMS cause a statistically valid sample of the separate entire brain region for each sense and memory region, [the distinct separate brain region dedicated to each sense that each sense is recorded in] that miniature sample created and kept updated in a region of the MMS, a region dedicated to that particular sense or memory region. In effect the "little" MMS becomes a reproduced sample of the entire "big" brain's collective set of sensor and memory regions as they currently are as well as their various predecessors in time to the extent not partially overwritten by successors.

Those data in the MMS are created by the appropriate set of MMS neurons being caused to fire, by the firing of the statistically valid sample set of neurons in the brain sensor regions, resulting in reduction of the thresholds of that MMS set's neurons, which defines the particular thing recorded there.

Not only that, the neural interconnections are such that each neuron in an MMS sensor region, by firing contributes to activating the corresponding neuron in the sensor's brain region that was part of the original statistically valid sample.

Given the independent separation of the brain regions serving each sensor as a necessary condition for the proper independent operation of each sense, a means is needed for activating, recalling, overall memories, by the combined activation of all of the separate sensor regions of the MMS collectively. A means for such control of the MMS is needed, which means is called the Executive System [ES]. Experiments show that the functions of the ES and related functions are performed in the cerebral cortex in the brain's prefrontal section of its frontal lobe Its means for doing that is as follows.

THE EXECUTIVE SYSTEM

Analogously to the neural interconnections for the MMS, the ES has neural interconnections such that a copy of the total overall MMS [every neuron regardless of its current status] is installed and kept updated in the ES. Likewise those neural interconnections are such that each of the neurons in the ES is connected to and can cause the firing of the corresponding neuron in the MMS but only IF SELECTED [presented further below].

Figure 8-1 below is a guide to this overall memory structure.

The Generalized Memory System

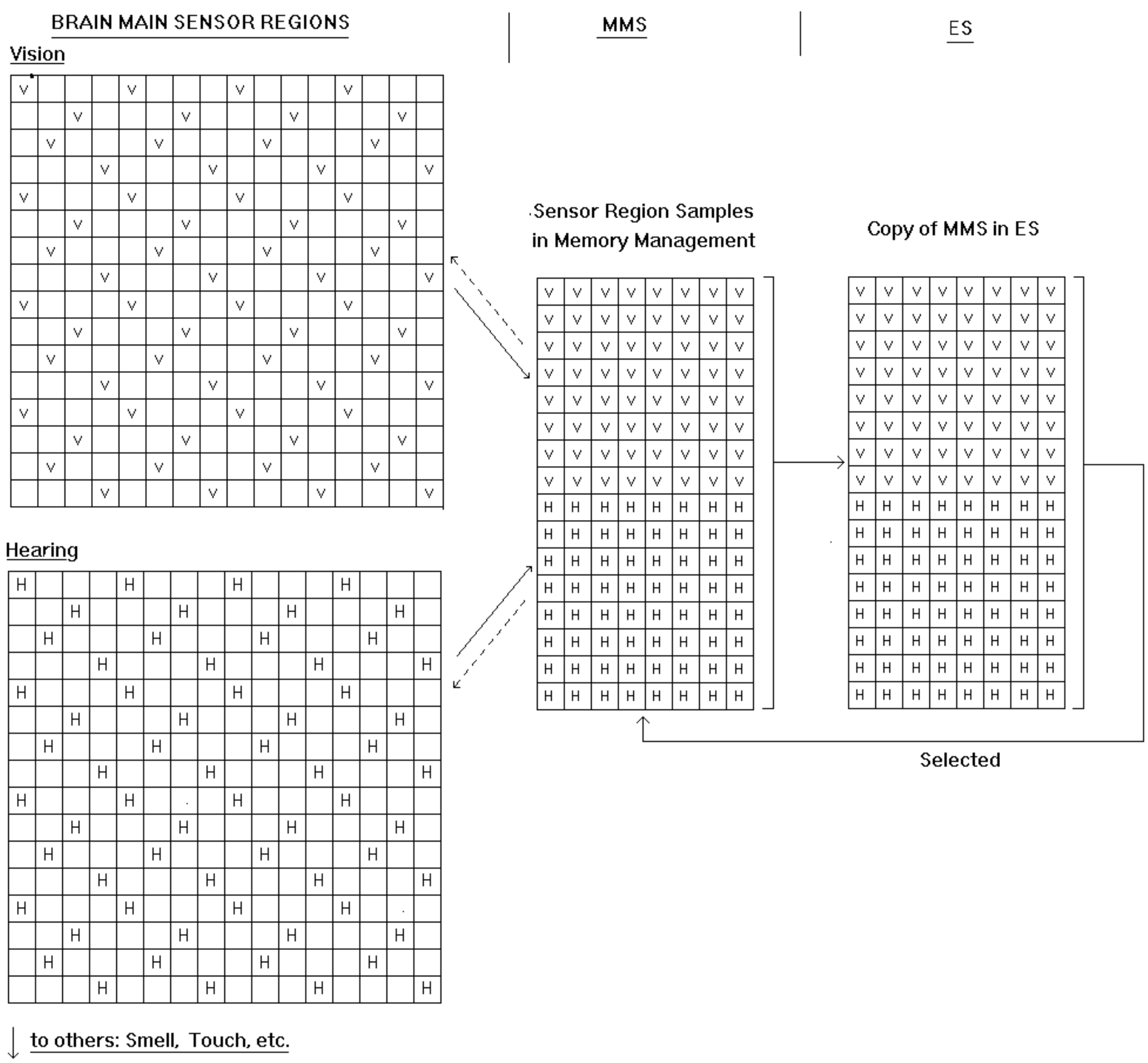

Figure 8-1

Each sensor region in the brain contains all of the memory objects for that sensor, a record of all inputs to that sensor. Any one of those memory objects is the firing of that memory's particular specific subset of the total available neurons in that sense's brain region. Each sensor region in the MMS contains a valid sample of the corresponding overall sensor region in the brain. And the ES contains further a copy of the overall MMS. Thus the ES contains a valid sample of all of the brain's memories.

Those valid samples in the ES are the ID [for search and retrieval purposes] of . the overall memory object corresponding to the ID for each ID. The ID's are all there, the latest, the recent, and the long past; each is that memory object's particular specific subset of the total available neurons in the ES, that is a specific neural pattern out of the myriad possible patterns that the MMS and the ES are each able to display. The ID's become very gradually blurred by being overwritten by the just occurring latest, [but we personally know that we can remember some things from the far distant past].

"IF" a particular specific memory object's ID were selected, that is identified and activated in the ES [out of the myriad memory ID's in the ES, all in the form of specific "snap shot" examples of the overall MMS when it had just received the, in the past, then latest statistically valid sample of the brain sensor recording regions for that memory], that firing of the ID's neurons would activate that particular record of the overall MMS, activating the corresponding memory in each of its MMS sensor regions, which combined are the overall MMS, which would activate the corresponding sensor memory's original samples in the main brain in all of the senses sensor's brain regions, which would be recall of that overall memory that was identified and activated in the ES [slightly degraded because obtained from the statistically valid sample of the memory object, not the actual total original of which the sample is a sample] .

That "IF" is a big one. How does a particular specific memory out of the myriad memory samples in the ES become so identified and activated ? It is the operating system [OS] which is the means to access of memories.

THE ES OPERATING SYSTEM

It is the operating system which "plays" the "continuous relatively undirected narrative" always with us in our mind when we are not focused on, not concentrated on something specific.

In a manner analogous to the behavior of a digital computer the brain, whether human or of a lesser animal, functions with an Operating System, which is the primary activity of the brain.

The operating system of a digital computer is a piece of software, the master program of the computer. It operates by calling on various sub-programs, called sub-routines, as needed to perform whatever the computer is to do. So long as the computer is turned on the operating system so conducts the affairs of the computer.

So long as we are alive our Operating System so conducts our affairs.

It is the brain's Operating System [OS], an intangible procedure, operating in the tangible physical Executive System [ES] structure, which is the means to access of memories. We are not usually overtly conscious of our brain's operating system but it is essential in that without it we are "brain dead" and with it we have access to memories and thoughts.

The next neural firings in the ES under the control of the OS will be to some extent modified from the just prior, modified by the effect that the prior firings slightly changed the thresholds just fired or not fired and modified by the effect of one or more external inputs, [vision, hearing, touch, etc.] and/or the effect of internal inputs [body functions, body parts locations and actions].

That "continuous relatively undirected narrative", that stream of consciousness in our mind, is a browsing, is a thinking about the ES's various ID's but not experiencing them. There is no activation of the MMS, no recall of memory, merely a brief flash of evaluating whether to select that ID for Attention or not.

Characteristics of the last recalled memory form part of the ID to be next searched for, the process being automatic. If one "stops and watches one's OS and what it produces" interesting results can be observed. For example [this really happened to me]:

> The music that was playing in the background while I was eating breakfast suddenly had a peculiar rhythmic pattern that went a quick ***booma*** *bada* ***booma*** *bada.* To my OS that pattern apparently was the most significant of the instantaneous last recalled ID and, my OS, immediately delivering to me as the next ID to be considered in my "continuous relatively undirected narrative", said to me "**Hick**en**loop**er", a name I don't know, wasn't interested in, maybe heard once over more than at least a year ago.
>
> That wasn't my idea. I didn't intend, was not consciously aware of, anything about, related to, Hickenlooper.
>
> Apparently, it was what my OS "thought" should come next, so to speak, not me.
>
> A Google search for Hickenlooper found About 2,120,000 results in 0.50 seconds which would be about one evaluated ID per quarter millionth of a second. The speed of our human OS is comparable to that computer speed.
>
> The speed of our OS is also comparable to the speed of our computer spell check essentially instantly verifying every single word in a lengthy document.

That high speed stream of consciousness activity goes on continuously. The process is akin to that of thinking described in section 6 and repeated below.

> *Thinking* is associations and sequences of *thought*s, that is associations and sequences of specific examples <u>of</u>, *i.e.* specific examples <u>fitting</u>, certain universals. Each (momentary) thought is a particular subset of (momentary) neuron firings that represent, implement, a set of universals. Thinking is sequences of such firings of particular subsets of neurons, the content of the set [the universals the set constitutes] changing somewhat from firing to firing. Such sequential firings, such thoughts, associate, that is form a succession, become a sequence, develop the trend of the thinking, by having in common parts of the logic for their universals.

> For example, and greatly simplified, suppose that thought `#1` consists of universals `[a, b, d]` out of the `26 [a … z]` total universals available in this simple example. The next following thought, thought #2, consists of the prior `[a, b, d]` plus `[k]`. The third thought consists of the set comprising the second thought less `[d]`. The three such thoughts in that sequence and because of those changes in the included universals are "a line of thought", *thinking*, about the subject of the common universals `[a, b]`.
>
> Suppose further that that particular subset `[a, b]` appears as part of another subset, for example `[a, b, e, k, q]`. That tends the line of thought to including new information, to going in a new direction.

The firing of the `[a, b, d, k]` set after the firing of the `[a, b, d]` set and then the firing of the `[a, b, e, k, q]` set is the "moving on to the next related object" referred to above. That kind of undirected thinking is more a quasi-random browsing in memory than real serious thinking but in it we have the basis for accessing memory.

We experience that kind of an effect when we dream. A dream is a sequence, a series of specific thoughts not under our conscious control [and accompanied by reduced physical activity and metabolism]. A "day dream" is the same except that the physical activity and metabolism are less reduced.

The effect, the sequencing through sets of related universals is like a video. The sequence of thoughts is like the frames of a motion picture or a video. Few memories can be of a single thought. All memories play the video of their memory, "play" it by the related-connected-sequence of thoughts the result of successive firings of slightly varying subsets of neurons, slightly varying subsets of neural firings. That effect, the brain's operating system, goes on continuously, "playing" its "quasi-random browsing" in our mind so long as we are alive.

How did it start ?

As the brain formed in the embryo two effects set it to start. The first is that some of its neurons have initial thresholds that they are created with by the process of the development of the embryo under the "guidance" of its genes. These are what we refer to as "instincts". An example is the sucking instinct of mammalian embryos.

The second starting effect is the various sensory systems. So to speak, the first sensory input to the developing brain is the first "frame" of the "video" that it will "play" until ultimate death. Between those initiating and final events it results in continuous accessing of memories, of instances of whatever is currently stored in the memory automatically progressing from one to the next.

At any moment our brain's operating system is conducting the affairs of our body, firing all of the neurons whose firing is some specific object in the ES, that object consisting of a number of universals, then moving on to the next related object.

The OS is continuously "playing" the "video" that is always going on in our heads. That "video" is playing the samples of the original sensor regions' memories which is the ID's in, the content of, the ES.

Pain, Motivation and Schemas

The rate of repeated firings by a sensory neuron delivers information as to *how much*: how loud a sound is, how bright a light is, the magnitude of a touch, and so forth. That kind of information is essential to an organism's functioning. It greatly enhances the sensory information's description of the material world, and for motor purposes (muscle operation, physical action) *how much* supplies progress reports so that, for example, an object can be grasped without over-reaching or under-reaching, without squeezing so hard as to crush it or so lightly as to let it slip out of the grasp.

The *how much* data is natural to biological electrochemical sensors. Brighter light or louder sound or larger touch delivers more energy which more easily triggers the sensory neurons' firings. But if the sensory input is too large it can be destructive:

- too loud a sound damages the ear (and may also represent an external threat of some kind)
- too bright a light destroys the eye (and also may signal an external danger)
- too large a touch (cutting, breaking, burning) injures the body.

The most (evolutionarily) early, simple neural networks in early, simple organisms received *how much* data from their early, simple sensors. If it was a signal of *too much* the sensor might be destroyed and the organism most likely would fail to survive. But, some organisms responded to the *too much* sensory inputs by action to avoid the cause of the excessive input, by action to get away.

That must have been fairly common because in simple neural systems the sensors were closely linked to the motor action neurons. The most simple such early neural system was a single sensor neuron that was connected directly to a single motor neuron. Such a mechanism could, for example, produce opening in response to light (like day lilies), closing in response to a touch within the food receiving-digesting cavity (not unlike the action of today's sea anemones), or flagella waving in response to excessive temperature (effectively causing swimming away). The *too much* sensory signals producing a rapid neuron firing rate deliver a rapid rate of pulses to motor neurons tending to produce action.

Whether that kind of response was initially naturally common or rare, it would have significantly increased the survival rate of the organisms behaving in that manner. They would have become the dominant type organisms surviving into their future and contributing evolved characteristics to their successors. Avoidance of danger, of destruction or harm became an evolved operating principal of simple, early neural networks very early in their existence.

The pattern of

- too much sensory input producing
- greater sensory neuron firing rates, producing
- greater motor neuron excitation, producing
- action, motion, that changes the situation,

naturally became an evolved survival characteristic of simple neural systems at a very early stage in their development and as such contributed down the line to descendants.

In only quite slightly more sophisticated yet simple early neural systems the same response would develop to *too little* sensor input. The `not` Boolean operation is an essential of the logic of neural nets and neurons have both excitatory (normal) and inhibitory (`not`) input dendrites. The `not` applied to a *too little* firing rate would be a rapid firing rate, a *too much* signal. Of course some cases of *too little* can be just as dangerous as those of *too much*. For example, we humans react strongly to *too little* good air to breath.

We humans retain the kind of behaviors as produced by those same early-developed mechanisms. If one puts his finger on an oven at room temperature he can keep it there all day if he wishes. But if the oven is burning hot, then the moment that the finger touches the oven it is quickly withdrawn, withdrawn automatically without any thinking about it. The *too much* neural signals from the finger's sensory neurons directly trigger the arm motion motor neurons by interconnection in the spinal column without the brain as neural logic intermediary. It is a sensor-motor direct connection bypassing the brain when the sensor signal is *too much*. For a room temperature oven the touch sensor signals go to the brain for processing.

Further, we humans exhibit examples of only a moderately more sophisticated neural response to *too much*. The eye, for example, automatically and very quickly shuts when an object is moving rapidly toward the eye.

That response is not a direct sensor-motor type of action. Significant neural processing is needed to convert the raw visual picture into information that says:

- a strange object is in motion in the visual field,
- its trajectory is such that it will endanger the eye,
- it is moving at rapid speed,
- therefore immediate, quick, protective action is needed.

That requires a pre-learned, pre-planned, pre-arranged automatic response in order to be sufficiently quick. Such a pre-planned, pre-arranged course of action is called a "*schema*".

SCHEMAS

A scheme is a plan for attaining some particular objective or putting a particular idea into effect. It includes the specific step-by-step procedure to be executed to implement its objective.

In its analogy to the role of a digital computer's operating system getting things done by calling up subroutines, the OS operates in the ES by "calling up" the appropriate *schemas*. A neural *schema* is a set of neurons, a portion of a neural network, so interconnected, and the thresholds of which are so adjusted, as to cause the progressive step-by-step procedure through the execution of the *schema* to result in the accomplishment of its specific objective.

We function largely by executing *schemas* a large body of which we acquire over our lifetime by living experience, study, and practice. The brain's *schemas* can be programmed and function in a manner analogous to that of a digital computer. They can: copy and transfer data, select call and open other schemas, sort data, choose among alternatives, and perform other data processing and mathematics. See Appendix A.

We humans develop patterns of purposive behavior with which we become so familiar that we can initiate them and then cease to pay attention to them for a while. A common such experience is to be driving a car and suddenly realize that you have been thinking about work, or dinner, or whatever, and that you don't seem to know, for a moment or two, where you are or how you got there. You then realize that, obviously, you did it without attending to it. Your attention was on some other purposive behavior running through your mind.

By analogy our *schemas*, managed by our *Master Schema* [MS], the OS mediating all of our various activities, are the equivalent of the digital computer's various subroutines controlled / selected by the computer's master program operating system. In our case our OS is the *Master Schema* [MS] which "runs the show", orchestrates the calling of the various operating *schemas*.

In more sophisticated neural systems, such as that of the earlier example of the eye's response to danger from a rapidly approaching object, the response is, again, a motor response, the closing of the eye; however in this case it does not take place by direct sensor-motor connection. Rather, the applicable *schemas* conduct an analysis of the sensory data and send a motor signal to close the eye if the analysis indicates that such a response is called for.

With the evolution of species, as their neural networks became larger, more sophisticated and more complex, the evolved type species' operation of the *too much* response became such more sophisticated *schemas*, that is:

- larger,
  Involving greater numbers of neurons and in more numerous universals which described more complex thoughts.
- more sophisticated,
  Including logic to determine whether a response is really needed, to consider alternative responses, and to put together patterns of responses.
- and more complex,
  Including the ability to deal with multiple *too much* signals at the same time, the ability to arrange the corresponding multiple responses, to relate and prioritize the responses.

Such behavior is the setting of goals and the making of choices among alternative courses of action. It is *purposive behavior*, as are s*chem*as, which are naturally progressively evolved from the early original patterns of sensing "too much" and developing corrective, avoiding, actions.

The *too much* signal and the reaction that it triggers ranges from the very simple sensor-motor type cases (the hot oven) through the significant neural processing type cases (the eye shutting) to more and more sophisticated motivations and resulting actions.

Just as our thoughts are the patterns of which neurons are firing at a particular moment, so our conscious purposive behavior, our performance in life at home, on the job, as parents, in love, and so forth, is various *schemas* in our responses to highly sophisticated and complex sets of neural *too much* (and `not-ed` *too little*) signals deriving from, delivered by, the various senses

The signals involve, are related to, are the equivalent of *pain and pleasure* (*pleasure* as `not`-*pain*). When the signals involve material sensor input the consequent responses normally involve physical action, that is material response to material sensor input. When the signals involve non-sensor input, that is abstract thoughts, concepts, the consequent corrective responses normally involve non-material actions, that which we refer to as *plans*, *intentions and desires*.

Very early in the evolution of neural systems those systems evolved to treat extremes of neuron firing rates, low or high, as being: bad, a sign of danger, something to be avoided, triggers of corrective action. At the sophisticated level we now refer to the effect of excessively non-moderate neural firing rates on us as meaning that the related material or abstract objects (described by the universals the neurons of which are so immoderately firing) are:

- painful,
- unintended
- undesired
- unpleasant.

The opposite, neuron firing rates neither too great nor too small moderate rates signify

- comfortable
- intended
- desired
- pleasant.

It might be said that we spend our lives seeking to have our neurons firing at a rate well between the *too much* of a too rapid rate and the *too much* of a too slow rate. One could say that a state of moderate neuron firing rates is what we call *pleasure*. Or, perhaps, the greatest pleasure, the best sensation, corresponds to neural firing rates that are as near to *too much* as possible without being so strong as to mandate corrective action. Our human experience would tend to indicate that we behave that way in some cases, We crave excitement so long as it does not go over the boundary into real danger.

Of equal importance, with the signal of rapid neuron firings conveying *too much* type information, is the action that the neural system takes when such signals appear. In the simple early neural systems the response was some kind of motor neuron (motion) action initiated by a direct sensor-motor neural connection.

In the sense of the highly evolved system's behavior being a highly evolved response to *too much* signals, it must nevertheless be a kind of response that is intended to remove or relieve the cause of the *too much* signal. That is, no matter how highly evolved and abstract the neural system, its response to inputs signifying “pain”, “bad”, or “unintended” or “undesired” is evolved to naturally be a response that is intended to relieve or improve the situation, to remove, correct, or reduce the cause of the *too much* signal.

That is the evolved natural behavior of our neural system. Our behavior today of recognizing a problem [we are short of cash] considering alternative actions to correct the problem [go to an ATM, cash a check at a grocery store, borrow from a friend] and taking what seems to be the best choice to resolve the problem is merely a complex version of an evolved method.

We can naturally visualize the complexity of many specific muscular actions that have to be "choreographed" by motor neurons for even the simplest of physical actions, like walking or tying a shoe, let alone playing a piano concerto. That choreographing is what the pertinent *schemas* do. The *schema* needs merely to be selected, then let alone to do the task it has so well learned how to do.

Likewise for thoughts and thinking the pertinent *schemas* "choreograph" a complex of many specific thoughts, "thought particles" mostly involving language, some involving in addition: images, emotions, memories, feelings. Physical action *schemas* include provisions for adjustment based on new input data and include provision for mental analysis to accommodate adjustments. Thoughts and thinking *schemas* include provisions for re-direction based on analysis results and new input data.

Schemas are "tree" structured, the "master" calling sub-*schemas*; they calling sub-sub-*schemas*, and so forth. Which brings us to the human system's *Master Schema*.

NEXT

The OS playing the continuous relatively undirected narrative *video* that is always with us in our mind is constantly checking ES ID's in its browsing. But that is "relatively undirected". That process is not a recalling of memories. Rather, it is a [brief] thinking about the memory objects. The operating system "plays" the continuous relatively undirected narrative that is always with us in our mind unless we have specifically directed our Attention elsewhere.

A short while ago, back in treating the "Hickenlooper" event, the discussion treated my OS as a separate entity, separate from myself, doing what it "thought" should be done without "asking" me. If that is the case, then where am I ?

How do I come into the picture ? Who is in charge: my OS or me ?

The next section addresses the problem of exercising intelligent control of our activities, how we select the memories and the *schemas* we presently wish to address, how we impose our will on the system – in fact, how our will and intent even exist in the brain, what is it that does it and how does it do it ?