VII. FREUD'S PROJECT FOR A SCIENTIFIC PSYCHOLOGY IN THE 21ST CENTURY

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The recent resurgence of interest in biology that has invigorated psychiatry has penetrated the hallowed halls of psychoanalysis. Now, therefore more than ever, Freud's "Project for a scientific psychology" (Freud 1950a [1895]) has relevance for those working within the general framework provided by the psychoanalytic metapsychology. In this essay I shall summarize some of Freud's propositions regarding brain function in the light of what we have learned during the past century.

My interest in "The Project" was aroused by two propositions:

1. a memory based theory of motivation and
2. an Ohm's law of neural processing.

Two other interests developed as Merton Gill and I began our studies prior to the publication of our book *Freud's Project Reassessed* (Pribram & Gill 1976):

3. the brain mechanisms involved in primary and secondary processes and
4. brain mechanisms in unconscious and especially conscious processes.

1. THE MEMORY BASED THEORY OF MOTIVATION

During the 20th century drive theories of motivation flourished. Freud began this trend with his (or his patients') discovery of the untrustworthiness of remembrances of childhood traumatic experiences. Many arguments have recently occurred regarding Freud's honesty in retreating from a veridical memory interpretation and more generally the legal status of memory as evidence. My stance is that there is record that Freud was deeply upset by the discovery that necessitated a complete revision of his theoretical stance. Accepting the importance of drive stimuli in distorting memory did not come easily. And Freud had little to lose or gain by the revision: he was already castigated as a rebel because of his emphasis on sexuality, adding that libido could distort remembering did not add (or subtract) much from how he was then viewed.

But the discovery of the fallibility of memory did shake the very

foundation upon which Freud's talking cure was based. The Wuerzbergers had shown that once a question had been thoroughly understood and accepted, the answer was preordained irrespective of the paths of thought taken to reach the conclusion. Franz Brentano (as did William James) highlighted the issue by noting that now the ACT of Thinking needed to be investigated. Freud, having taken 7 courses from Brentano came up with the technique of allowing "free associations" to be vented. (The freedom was of course automatically constrained by the patient's problem that needed solution). Freud stated that his hope was that the cognitive structure of the memory process would by this technique be uncovered: voila, the issue of "The Act of Thinking" was addressed. But if remembering could be skewed by current drive stimuli the cognitive structure became as mysterious as the dancer covered by her seven veils.

In today's purview one would simply hold that memory is forged by both sensory and biochemical receptor input, and being reconstructive, is vulnerable to current input from both sources. How much distortion occurs needs to be painstakingly established in each specific situation.

2. OHM'S LAW OF NEURAL FUNCTION

Freud has often been misunderstood as holding a hydraulic view of the neural process. This is in part due to the use of this metaphor in discussing electrical circuitry and in part due to translations of "The Project" by persons who did not know the neurological terminology in use when Freud was writing and even now. Thus "action currents" become currents in flow and local potential changes (Besetzte Energie, QsubN) become cathexes. These quantities of local energy accumulate because of resistances at contact barriers (synapses) and act much as capacitors to facilitate discharge and thus the generation of action currents.

What intrigued me was the inclusion of local potential changes in the process, a much neglected inclusion even today when neural circuitry based on axonic propagation of spikes (action currents) is invoked to the exclusion of telendrendronic pre- and dendritic post-synaptic local processing. It is in the local oscillatory hyper- and de-polarizations that much of the processing that is coordinate with thinking occurs. As Sherington (1906) as well as Freud noted, the more automatic a process "the less that mind accompanies it". More on this under the topic of consciousness.

3. PRIMARY AND SECONDARY PROCESSES

Freud made a distinction between primary and secondary processes, a distinction that is missed despite the current popularity of cognitive science and cognitive neuroscience. Primary processes are associative. Secondary processing is hierarchical consisting of a double loop of attentional matching involving reality testing. Much current thinking in cognitive science is still constrained (shackled in fact) by an attempt to fit processing into an assocaiative frame. Attention is conceived as being allocated within a limited fixed resource. Closer to Freud's view is the fact that the resource is flexible and sensitive to both the situation in which It occurs and the organism's current state of readiness (see Pribram & McGuinness 1975, 1992). Effort (reality testing) is expended when the situation and the readiness state are not readily reconciled.

For Freud cognition itself is much more akin to what we now conceive as a computer program made up of lists that are addressed. Items in the list contain the code that instructs the next step to be taken in action or thought. The code itself may be associative, that is, primary process but it is utilized in the service of a hierarchically arranged cognitive structure (see Pribram & Gill 1976, pp. 72–75 for evidence).

Freud was a cognitivist. He coined the term agnosia, wrote a book *On Aphasia* [Freud 1891b] which is still used. One might even say that the current practice of experimental and clinical psychology and of psychiatry is much more in tune with the practices of the late 19th century than with those of the 20th. This is especially true of current views of the role of conscious experience in our dealings with the world we inhabit.

4. BRAIN AND CONSCIOUS EXPERIENCE

Freud is best known for his emphasis on unconscious processes. As did all neuroscientists in Vienna at the time he attributed the organization of conscious experience to cortical processing. He was intrigued by what the rest of the brain might be doing. I was intrigued by the processes he attributed to the cortex: that cortical function is based on "patterns of periodicity" transmitted from the senses. By the time Merton Gill and I began to seriously study "The Project" I had embraced the idea that some important cortical functions are holographic-like. Holograms encode the transformation of space-time patterns into spectra that are composed of interferences among waveforms measured in terms of

their frequency. Frequency is the inverse of periodicity and Freud's idea regarding patterns of periodicity thus comes close to the idea that cortical processing operates (in part) in terms of interference patterns. My hypothesis has been that dendritic receptive fields constitute such patterns and that conscious experience is based on what is going on in these fields (Pribram 1966, 1971, 1991).

I noted earlier that Freud had envisioned a double loop mechanism of attention that entailed reality testing. Following Sherington I proposed that a "temporal hold" has to operate to delay processing for awareness to be experienced. Recent evidence has shown that such a delay is imposed by the frontal cortex on the systems of the posterior convexity (reviewed in Pribram 1999). For example a visual input activates the occipital cortex, then the frontal cortex, and then again the occipital cortex.

This delay has consequences for how experience becomes conscious. Philosophers have argued as to whether consciousness supervenes on brain processes or whether consciousness is an epiphenomenon. Neuroscientists have been puzzled by Ben Libet's findings (1966) that stimulation of the somato-sensory-motor cortex is not "sensed" for a quarter to a half second after the onset of the stimulation (whereas peripheral stimulation is sensed immediately). An answer may be ventured for the neuroscience finding: peripheral stimulations engage a much larger cortical field than do Libbet's cortical stimulations. Electrical excitation of the sciatic nerve, for instance, evokes reposes over the entire central part of the cerebral convexity (including the so-called motor and premotor cortex) even in anesthetized monkeys (Malis, Pribram & Kruger 1953). In addition, local vascular changes may be relayed to the mediobasal (limbic) motor cortex (Kaada, Pribram & Epstein 1949; Pribram 1961).

The classical precentral "motor" cortex is, in fact a sensory cortex for action (the evidence for this statement is reviewed in Pribram 1971, 1991). As such it encodes the environmental consequences of an action, not just the movements necessary to carry out the act. When the precentral process contributes to awareness it is of the errors in the consequences not the trajectory of the movements by which to accomplish the action. The parallel in vision is that we do not sense saccads, only the visual image effected by them. That image and the environmental consequences of an action come to awareness some time later than the movement itself.

Stimulation of the classical central (Rolandic) sensory and motor

cortex should not be coordinate with awareness. If we were aware of our actions at the time they are occurring, we would mess them up (Miller, Galanter & Pribram 1960; Pribram 2003). Imagine being aware of your tongue and palate as you are giving a talk – in fact occasionally when your mouth becomes dry, you do become aware and just can't go on. Or playing tennis or batting at baseball – the adage is "keep your eye on the ball". When taking notes during a lecture, conscious attention is on what the lecturer is saying not the writing of notes. Furthermore, the muscle contractions, the movements involved can vary according to whether one is using a writing pad, a laptop computer or standing at the blackboard. The primary sensory and motor systems provide the encoded intended consequences of an action, not just the particular movements needed to carry them out (see Pribram 1971, 1991 for review of the evidence for these statements). Thus, these systems need to function autonomously during the course of an action; only when, after a temporal hold, they act in concert with other brain systems do they participate in organizing any necessary change in future acts by way of conscious intervention.

There is another piece of evidence that supports Freud's double loop model of attention. When we first began to study event related brain electrical potential changes (ERPs) we learned a great deal by using what is called an odd-ball technique. A particular stimulus is presented repeatedly and a different (but somewhat related) stimulus is randomly interposed in the series. The recorded ERPs are then averaged separately for the two types of stimuli. The averaged records are dissimilar especially around 300 millisec. after stimulus presentation. We interpreted the change in the ERP for the odd-ball stimulus as indicating that an update in the perception of the stimulus sequence was occurring. But subsequent experimentation showed that another dissimilarity in ERPs could be observed at around 400 millisec. and that updating did not occur unless the 400msec. dissimilarity was present. In short, the dissimilarity at 300 millisec. indicated that an update was necessary and the 400 miliisec. heralded the actual updating. According to all this evidence (Pribram & McGuinness 1992) attention is a two stage process.

At one point William James declares that he is tired of all the confusion surrounding consciousness; that we should stick to trying to understand attention. But of course neither he nor Freud did so. I believe there are several critical elements that contribute to the confusion. One of these is conflating of sensory processing and control of movement with conscious experience. Second, two levels of conscious experience fail to

be distinguished: Freud called them preconscious and conscious; today we use such terms as perception and reflective consciousness (Pribram 1999). These conflations have led philosophers to opt for one of two explanations. One is that all experience directly supervenes on brain processes and the other is that consciousness is an epiphenomenon and irrelevant to living adaptively in the world. I believe both are in error.

The two stages involved in attention provide the key to an alternative explanation. Experience does not immediately supervene on neural processing during a perception or an action. Both are processes that, at any moment, are more like feedforward programs than error sensitive to feedback. We are not aware of the process by which we prehend an object. As noted, this is a good thing – we'd only mess-up. So, does that leave us with conscious experience as an epiphenomenon? Not at all. After I reflexly remove my hand from a hot flame, I contemplate the happening. Our cat is an excellent example: he looks at his paw and licks it – then looks at the offending object and reaches out toward it but this time does not touch it. He repeats this procedure several times over. If I may anthropomorphize, the cat's conscious awareness of the incident, his ERP at 300 millisec. and the later 400 millisec. indicate that awareness of what has happened alter future behavior. In the example given, the cat reinforced the change in subsequent behavior several times – in operant conditioning terms he was shaping the changes in his behavior. And the non-behavioristic claim is that the shaping occurred by way of conscious awareness of what was happening. Conscious experience is not an epiphenomenon. Conscious experience shapes subsequent behavior.

Nor does experience immediately supervene on ongoing neural processing. Consciousness of an experience when attained affects subsequent brain processes by changing the consequent contingencies within which the brain processes now occur. How then does a pattern of thought that characterizes a conscious experience influence an ongoing processing pattern in the nervous system?

Are the patterns that we experience identical with those that characterize brain function? I don't believe so. My view takes computer programming as a metaphor. I address the hardware my computer by using a natural language such as English. But the computer uses BIT language. To communicate an operating system intervenes: A binary code is used to address the hardware. This code is converted into an octal or hexadecimal, the hexadecimal into an alphabetical language using few symbols to make up short words and this language in turn is transformed

into higher and higher order languages such as ASKII, ALGOL, JAVA and so forth. At the top of the hierarchy is the word processing language that can communicate with me. For the output the reverse sequence is put into operation. Each level of processing language converts the prior one which uses fewer symbols over a longer series to a shorter series using a greater range of symbols. A Cartesian dualist, knowing nothing about operating systems might well conclude that natural languages and hardware codes (mind talk and brain talk) have nothing in common.

I have repeatedly reviewed the evidence (Pribram 1991, 1999) for stating that Gabor functions (Gaussian constrained sinusoids) or some similar four dimensional hyperspaces based on Jacoby delta functions or Wigner distributions can serve the mind/brain connection the way the BIT language serves present day computers. Gabor invented his wavelet to determine the maximum compression that one could place on a telephone communication across the Atlantic Cable. (It came out to be approximately half a cycle for each wavelength). Gabor used the same mathematics that Heisenberg had used to characterize subatomic units in physics. Gabor therefore called his unit of communication a quantum of information. This unit shares with Heisenberg's the indeterminacy on measurement at the lower limit. Gabor related this minimum uncertainty in measurement to Shannon's reduction of uncertainty in the bit language domain.

The Gabor function has been found to accurately describe the dendritc receptive fields of sensory neurons in the brain cortex. The Gabor quantum of information can therefore serve the same function for the wetware/experience relationship that the BIT serves for the hardware/software relation.

The metaphor goes further in that just as hierarchically arranged structures compose the current day hardware so hierarchical structures compose the brain modules and systems. And in a manner similar to programming languages our experience becomes coded hierarchically (as for instance, unconscious, preconscious, and self conscious). But just as the hierarchical hardware structure of the computer has little semblance to the hierarchical structure of programming languages, so the hierarchical structure of brain processing is not that of the hierarchical structure of our experience. There are no pictures in the brain, only quantum holographic (holonomic) processes based on Gabor-like wavelets. To use another metaphor, the processing of an fMRI tomograph uses quantum holography, the pictures we see are reconstructions made possible by the process. In a similar fashion, as already noted, our ac-

tions are controlled by brain processes that, only at the lowest level of a hierarchy, match the patterns of movements and muscle contraction (see Llinas 2001).

A final word: What about the patterns that characterize our thought processes? Do they supervene directly onto patterns of brain activity? Freud as well as many others defined thought as implicit action and based his talk therapy on that principle. According to the view that I have here assembled, implicit action when we become aware of it, that is, when we consciously think about something, we involve the body's effectors, muscles and glands. Watson was not far off in his physiological behaviorism. Evidence continues to accumulate that very slight changes in muscle tone or in breathing or heart rate variability occur during thinking. William James and more recently Antonio Damasio have called attention to the involvement of feelings as bodily responses to what happens and how these feelings influence cognition and decision making (Damasio 1999). What I am making explicit is that the outcome of these body responses to conscious experience is what changes brain patterns so that subsequent experience and intended action become modified.

Conscious experience is not an epiphenomenon nor do its patterns directly supervene onto the patterns of brain processes. Conscious experience must be "taken to heart" and acted upon, albeit even minutely and tentatively, to change the brain process.

Thus Freud in the 21st Century.

REFERENCES

Damasio, A.R. (1999). *The Feeling of What Happens.* New York: Harcourt Brace & Co.

[Freud, S. (1891b). *On Aphasia.* Partly in *S.E* 14: 206–215.]

Freud, S. (1950a [1895]). Project for a scientific psychology. *S.E.* 1: 295–387.

Kaada, B.R., Pribram, K.H., & Epstein, J.A. (1949). Respiratory and vascular responses in monkeys from temporal pole, insula, orbital surface, and cingulate gyrus. *Journal of Neurophysiology* 12: 347–356.

Libet, B. (1966). Brain stimulation and conscious experience. In *Brain and Conscious Experience*, ed. J.C. Eccles. New York: Springer, pp. 165–161.

Llinas, R. (2001). *I of the Vortex. From Neurons to Self.* Cambridge, Mass.: MIT Press.

Malis, L.I., Pribram, K..H. & Kruger, L. (1953). Action potentials in "motor" cortex evoked by peripheral stimulation. *Journal of Neurophysiology* 16: 161–167.

Miller, G. A., Galanter, E.H., & Pribram, K.H. (1960). *Plans and the Structure of Behavior*. New York: Holt, Rhinehart and Winston.

Pribram, K.H. (1961). Limbic System. In *Electrical Stimulation of the Brain*, ed. D.E. Sheer. Austin: University of Texas Press, pp. 311–320.

Pribram, K.H. (1962). The neuropsychology of Sigmund Freud. In *Experimental Foundations of Clinical Psychology*, ed. A.J. Bachrach. New York: Basic Books, pp. 442–468.

Pribram, K.H. (1966). Some dimensions of remembering: steps toward a neuropsychological model of memory. In *Macromolecules and Behavior*, ed. J. Gaito. New York: Academic Press, pp. 165–187.

Pribram, K.H. (1971). *Languages of the Brain*. New York: Lawrence Erlbaum.

Pribram, K.H. (1991). *Brain and Perception. Holonomy and Structure in Figural Processing.* Hillsdale: Lawrence Erlbaum.

Pribram, K.H. (1994). What is mind that the brain may order it? In *Proceedings of Symposia in Applied Mathematics*. *Proceedings of the Norbert Wiener Centenary Congress 1994*. Vol. 2, ed. V. Mandrekar & P.R. Masani. Providence: The American Mathematical Society, pp. 301–329; reprinted (1997). *The Noetic Journal* 1: 2–5.

Pribram, K.H. (1999). Brain and the composition of conscious experience. *Journal of Consciousness Studies* 6: 18–42.

Pribram, K.H. (2004). Consciousness Revisited, in preparation.

Pribram, K.H. & Gill M. (1976). *Freud's Project Re-assessed*. New York: Basic Books.

Pribram, K.H. & McGuinness, D. (1975). Arousal, Activation and Effort in the control of attention. *Psychological Reviews* 82: 116–149.

Pribram, K.H. & McGuinness, D. (1992). Attention and preattentional processing: Event related brain potentials as tests of a model. *Annals of the New York Academy of Sciences* 658: 65–92.

Sherrington, C. (1906). *The Integrative Action of the Nervous System*. New Haven: Yale University Press 1947.