About Models and Muddles, Part I: Why Brown's Laws of Form and Pribram's "Hologram Hypothesis" are NOT Relevant to Quantum Physics and Quantum Psychology †

by

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Abstract

As Part I, this paper reviews certain model-theoretic issues pertaining to Brown's *Laws of Form* approach to logic and Pribram's "hologram hypothesis" approach to perception and memory. Separating propositions are proposed which distinguish between Brown's and Pribram's representations and those of Oshins' "quantum psychology". It is shown that the formal structures used by Brown and Pribram are inadequate to represent quantum experience. "Quantum" is used by the present author to mean a non-distributive (von Neumann), coherent (Jauch/Finkelstein), atomic (Dirac/Weyl), lattice (Birkhoff/von Neumann/Mackey) which may be uniquely relatively complemented (Piron)/quasi-implicative (Mittelstaedt) or not uniquely orthocomplemented (Finkelstein). These lattice theoretic definitions and explanations will be elaborated upon in Part II. In the present paper, Brown's "calculus of indications" (CI) characterized as a totally ordered, two chain characteristic function in a universe having distributive lattice structure and lacking metalogical ambiguity and quantal complementarity. On the other hand, Pribram's hologram-based model confuses classical superposition with the quantum superposition of states as rays in projective Hilbert space. Part II will elaborate further upon how the Brown, Brown-Varela-Kauffman, and Pribram models contradict assumptions in my own quantum psychology approach and in quantum physics. In particular, the Brown-Varela-Kauffman "extended calculus of indications" (ECI) will be shown to be a three chain characteristic function in a distributive universe which requires contradictions as primitives (atoms) and forbids ambiguity and complementarity. In addition, a short argument will be presented as to how Pribram's (mis-) identifications lead to a contradiction with the fundamental notion of quantum.

Section I: Introduction

> "It is not the question at present whether this view is true or not, but what arguments we can honestly draw with respect to it from the available information."
>
> — Niels Bohr (Jammer, 1966, p. 176)
>
> "... A certain freedom is left to the creative theoretician which often can be a decisive element in the success of a theory. ... The main problem in the selection of empirical material is the separation of relevant from irrelevant conditions.."
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> — Josef J. Jauch (1965, p. 71)

† This paper is largely a correction and extension of Oshins (1990).

About Models and Muddles, Part I

It seems to the present author, that the function of science is not to find a "the Truth," but to provide improved representations of natural experience. Improved means both to embody a richer representation of experience and to do so in a more parsimonious manner. We come to understand new phenomena better or we come to understand existing phenomena more simply.

The way of physics seems to be to pose empirically meaningful, separating or decidable alternatives[1] — that is to say, empirical questions, the answers to which distinguish between two, or more, competing alternatives. Empirical questions, in turn, are propositions such that one can agree before hand as to how one would distinguish the answers and then empirically ask the questions by in principle performing an experiment.. The answers, as opposed to mathematical questions, are determined by Nature. Indeed, to some extend, physics is the model theoretic formulation of such empirical questions and how they reflect the logic of experience.[2]

Approximately two decades ago, two innovative efforts were put forth proposing formal alternatives to then current, accepted formalisms: Brown's (1973) *Laws of Form* and Pribram's (1971) "Hologram Hypothesis". Brown's *Laws of Form* attempted an alternative to the Whitehead-Russell theory of logical types. In particular, Brown proposed an alternative approach to so-called, self-referential paradoxes.[3]

Pribram proposed an alternative to standard computer modeling of brain/mind functions, such as McCulloch-Pitts-type neural nets (Oshins, 1984, 1989a; Hilgard, 1989). In particular, Pribram attempted an alternative parallel processing model based upon Gabor's holograms that he hoped would reflect spatial frequency profiles found in neuropsychological measurements of memory and perception in terms of a model that expressed distributive[4] memory storage. What it did lead to was a confusion between Gabor's holograms and Bohm's notion of holomovement in his formulation of quantum physics, and, consequently, between classical wave models of coherent waves and quantum states which have projective, linear (and usually unitary) representations and thereby a (fundamentally different) principle of superposition.[5].

My own "quantum psychology"[6] approach to the modeling of experience was originally proposed, in part, as a competing alternative to both Brown's and Pribram's models. Yet, both Brown's model and Pribram's model in different ways laid claim to representing the same phenomena — the universe of experience. Brown's approach, as extended by Varela (op.cit.), Kauffman, (op. cit..), and (Kauffman & Varela, op. cit.), laid claim to finding the final solution to the problem of self-referential paradox and in so doing claimed to be able to represent the logic of any possible universe. In the alternative, I claimed an entirely different resolution to self-referential paradox, compatible with quantum logic, which demonstrates that the Brown-Varela extended calculus is not even capable of representing the actual quantum universe in which we live. Below, I shall show that "L of F logic" assumes the distributive law, which from the quantum logic point of view precludes quantum physics. Some of the differences between such assumptions will be mentioned.

Section II: Overview of Pribram's Hologram Hypothesis

> "... the formation of an image is just what is not relevant in a 'quantum context'; at most a discussion of image formation serves to indicate the limits of applicability of classical modes of description." (Bohm, 1971, p. 443) "... the classical concept of fields ... is ... how the hologram works ... More accurately, these fields obey quantum-mechanical laws. ... (Bohm, 1980, pp. 177-178)

Since there has been some dispute over the years as to *what* Pribram's "hologram hypothesis" refers, in this section I shall briefly present an overview of some actual quotes by Pribram as to the bases for his holographic model in psychology and a summary of my own position as to the historical basis for Pribram's holographic model of psychology. (In Appendix II amplify upon this section with more extended quotes for readers to whom it may be of value). My position is that *contrary to* its current claim of being based upon quantum mechanics, Pribram's model is indeed based upon Gabor's classical model of holography. In particular in the later 1970's, when I was a "guest" with Pribram's laboratory at Stanford while I was developing my own quantum psychology, his model contained only distant and confused associations with some language of quantum physics .

About Models and Muddles, Part I

In the early 1970's, Pribram (1971) introduced his "hologram hypothesis": "The *holographic hypothesis on brain function in perception takes the form of superposition* [p. 142] ... [of] *wavefronts of light* [p. 146]."[7] [my emphasis] "... *holographic description has no peer* [my emphasis.] So why not apply its application to brain processes?" (p. 152) Pribram alleged his model to be formally based upon Gabor's mathematics of holograms (Ibid., 147-166). Since he has more recently lumped this together with Bohm's notion of holomovement in quantum physics, as if they were the same, I reproduce some of Pribram's own statements which demonstrate that he indeed asserted a (classical) hologram model, in contrast to a quantum models (cf also Appendices I & II):

> "*The mathematical descriptions of this holographic process and the brain process* delineated previously *are identical* [my emphasis]. A model of holographic brain processes has been developed (Pribram, 1971; Pribram, Nuwer, & Baron, 1974). " (Pribram, 1981b, p. 144)
>
> "My proposal is ... that the basic function of brain are holographic." (Pribram, 1976, p. 301). "... The mathematical equations ... are *of the same genre as those used by Gabor (1948) when he invented holography* [my emphasis]. ... This resemblance led me to propose that we take seriously the analogy between neural processing and physical holography. ..." (Ibid., pp. 304-305) "... what began as a metaphorical simile has been developed into a precise neurological model. Now based on evidence. There is little remaining doubt (Pribram, 1983b, p. 36)
>
> "... The holonomic model of brain function is therefore mathematically precise, and its assumptions ... and consequences ... are, at least in principle, testable." (Pribram, 1975, pp. 174-5) "... the subquantal domain shows striking similarities to holographic organization. Just as in the case for brain processes presented here, Bohm's theoretical formulations retain classical and quantum processes as well as adding the holographic. The holographic state described by wave equations and the particle state described quantally, are part of a more encompassing whole ... (Ibid, p. 183).
>
> "The essentials of this mathematics ... [show that] each point represents the amount of energy present in a waveform component of the entire array of light reflected from the object. must be linearly superposed. Mathematically, this ... consists of 'adding' the waveforms together. ... the resultant of superposing the energy ... [provides a holographic record] (Pribram, 1982; pp. 276-7):
>
> "... the facts must be explained and the holographic explanation is a powerful one. ... this power comes from its precision. For the first time a wholistic conceptualization ... made as rigorously and mathematically precise as a particularistic one. For psychology such precision is a necessity ..." (Pribram 1981a, p. 231-2)

When in 1977 I went to see Pribram with my own ideas, he was very interested and made me a guest in his laboratory. When I suggested to him the use of quantum Hilbert spaces for psychological modeling (May 5, 1978 letter from Oshins to Pribram), he was excited and thought I may have found "the key" (May 19, 1978 letter from Pribram to Oshins). During 1978 and 1979, when Pribram and I (along with Noyes and McGoveran) were invited to make presentations of our own respective research at Hew Crane's luncheon lecture series at the Electronics & Bio-Engineering Laboratory, SRI, Intl., Pribram began to confuse that there were certain aspects in common to quantum theories and classical wave theories such as holograms, such as the ability to Fourier transform both (cf also Appendices I & II, esp Dirac's quotes) Such common properties seem to have led Pribram to lump holograms and quantum theories as if they were the same, and led me to try to exploit their differences by posing separating alternatives.

Since the early 1980's, Pribram (1980) has been suggesting that hologram models are relevant to a quantum psychology. This claim is apparently (Oshins, 1989a; Pribram & Carlton, 1986; Pribram 1988) due to confusing the classical Hilbert (vector) space of classical fields, such as can be used for holograms, with the quantum Hilbert space (modulo the complex field) of rays. I will discuss later the difference. This seems to have led Pribram to believe that:

About Models and Muddles, Part I

> "... there are trillions of connections between them ['cells operating in the brain']. They operate on the basic principles that have been found to also operate at the quantum level. Actually, it was the other way around. The mathematics that Gabor used, he borrowed from Heisenberg and Hilbert. Hilbert developed them first in mathematics, and then Heisenberg used them in quantum mechanics, and Gabor used them in psychophysics, and we've used it in modeling how brain networks work. ... Analogous isn't quite the right work; they obey the same rules. It is not just an analogy. ..." [my emphasis] (Pribram, 1988)

I hope to illustrate in this paper that Pribram's model is no longer an analogy, indeed, but now a *logical muddle.* (cf also Dirac's quote in Appendix II regarding the misuse of analogy in this context.) Furthermore, in addition to attributing conscious activity to his hologram hypothesis (Appendix I), Pribram (1988) has begun to generalize his concept of a "quantum-type, holographic, implicate-order type idea" to encompass unconscious primary processes, as had been my own original proposal (Oshins and McGoveran, 1980). Attributing Kris' (1950; Arieti, 1976) original idea to Freud[8], Pribram continues to explain the pertinence of his model for creativity and human development (Op.Cit): "You reach into the implicate order. You allow yourself — Freud called it regression in the service of the ego, primary process kinds of things, which are more holonomic, more holographic-like."

I have expressed the opinion on numerous occasions that this "quantum-type, holographic, implicate-order type idea" is not a model of "primary process" thinking but an example of it. It follows the standard von Domarus principle (Arieti 1974, 1976; Oshins 1989a; Oshins and McGoveran 1980; von Domarus 1944) of identifying disparate subjects on the basis of having common predicates.[9] In the above case, as examples, the prefix "holo-" in hologram and in Bohm's holomovement or because both holograms and quantum theory use Fourier transforms or Hilbert spaces. Such arguments have no logical validity. Since the function of science is to refine thought, not to homogenize it, I shall point out in this paper some of the more salient differences, as separating propositions, between holograms and quantum theories.

Section III: Brown-Varela Extended *Laws of Form* [10]

> "I have already stated my view that the calculus of indications is a sound basis for a theory of general systems, insofar as it provides a grounding for every description of any universe." (Varela, 1975)

> "... the algebras here called brownian are formally isomorphic to De Morgan algebras. In Boolean terms it corresponds to dropping the law of the excluded middle. This allows wave-form models; we call such algebras *brownian* algebras. (Kauffman & Varela, 1980, section 1)

> "This proposition suggests that in the waveform arithmetic and the related algebras ... the relevant initials may be occultation [a weakening of the ordinary "absorption" postulate] and transposition [the ordinary distributivity postulate]" (Ibid., proposition 3.3)[11]

This section briefly overviews Brown's *Laws of Form* approach to self-referential paradoxes and how it differs from a quantum psychology or quantum logic approach such as my own, and what differences these differences make. In Paper II (Oshins, in prep.). I will provide a more detailed lattice theoretic discussion. There, I will amplify upon how the Brown-Varela-Kauffman "extended calculus of indications" (ECI)/"calculus for self-reference" (CSR) propose precisely the opposite changes be made to classical, Boolean logic than are made in quantum physics and quantum psychology, how it thereby contradicts quantum physics and quantum psychology, and how it forbids the spinor representations proposed by Oshins (1984d, 1985) for self-referential motion.

As I later did, Brown also tried to modify classical logic in order to accommodate paradoxes such as found in the "This statement is false" example. Brown attempted to identify this statement with the algebraic equation $X = -1/X$, or, alternatively, $X^2 = -1$. His solution was that $X = i = \sqrt{-1}$, whereby he claimed paradoxes to be imaginary. (As Gauss had explained, the imaginary number can be viewed as a transformation in the plane whereby the real axis X is rotated into the imaginary axis i Y and the imaginary axis i Y is rotated into the negative real axis - X). Varela (1975) extended Brown's approach by introducing a third state called the autonomous state in addition to states of true and false, in lieu of Brown's imaginary valuation.

From a more general approach, I made Brown's equation into a two-dimensional, matrix, eigenvalue equation $[X^2_{(2x2)}\Psi_{(2x1)} = -1_{(2x2)}\Psi_{(2x1)}]$ in which X^2 and - 1 became linear, matrix operators acting upon a state Ψ.

The solutions become generalizations of the imaginary number, independently invented by Hamilton in the beginning of the 19th century, called quaternians. The corresponding "Lie algebra" (or local, mathematical group) is order dependent or noncommutative. This is the structure to the Lie algebra of observables in a quantum theory, although not in classical theory[12].

The quaternians operate upon a kind of dichotomy called a spinor — the quantum correspondent to a "bit" for a computer — which is used to represent symmetries, change and invariances of any operationally nondiscriminated, quantum dichotomy. I have suggested that they provide a representational power within psychology akin to that of DNA in biology — the building blocks of internal representations of experience. Since they have an operational ambiguity, I refer to them as "bits of ambiguity."

In addition, Brown proposed two rules to a symbolic arithmetic:

- The law of calling: "The value of a call made again is the value of the call":

- The law of crossing: "The value of a crossing made again is not the value of the crossing":


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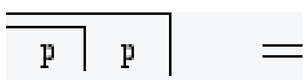
Brown also proposed two rules to a symbolic calculus [13]:

- position axiom: (ordinary complementation axiom)



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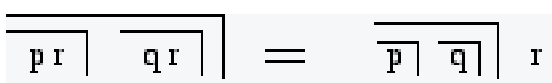
- transposition axiom: (ordinary distributive law)



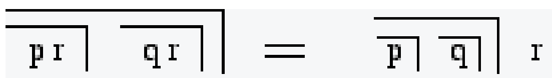
I reinterpreted his law of calling in terms of 2-dim. projection operators $[P_a(2x2)$ such that $P_a^\dagger P_b = \delta(a,b)Pa$, where, specifically, $\delta(a,a) = 1]$; and his law of crossing into an orthocomplementation $[P_a + P_a^\perp = 1_{(2x2)}$, where, specifically, $\delta(a, a^\perp) = 0]$.

Extending this matrix eigenvalue approach to generic observables — ie. the general knowable/measurable aspects of experience — by using standard techniques developed in quantum physics (Schwinger, 1970; Oshins, et.al., 1984) led to my quantization of psychological logic (See Appendix IV). Indeed, as had been shown by von Neumann (Birkhoff & von Neumann, 1936; Oshins, 1984a; 1989), quantum physics can be viewed as a more general logical structure than the Boolean structure of set theory found in classical logic (See Appendix III).

Instead of the relationship between a set and its subsets, quantum physics uses the relationship between a type of (projective Hilbert) space and its subspaces. The fundamental difference is that spaces allow for a type of linear superposition or addition of elements. The quantum process is described as a "non-discriminating measurement" (Schwinger 1970) of "interfering alternatives" (Feynman & Hibbs 1965) realized by an irreducible or "coherent" (Jauch 1968) lattice of propositions. The associated equivocation process provides a type of irreducible, representational ambiguity which does not exist in either standard classical representations, such as in computers, nor in Brown's formulation, in which there is no ambiguity in the distinction (Oshins 1984, 1989a, 1989b; Oshins & McGoveran 1980). Instead of trying to avoid ambiguity, I elevated this specific type of ambiguity into a fundamental principle (Hilgard 1989; Jauch 1968, p. 106; Oshins, Op.Cit.):

> "If one can not (operationally) distinguish/discriminate between two unit predicates A & B, there will always exist a third possible contrary (unit) predicate C such that (A or B) = (B or C) = (C or A), ie. they are equivalent perspectives —– there is no operational way to distinguish/discriminate between A, B, & C."

I was thus led to reinterpret the "liar's paradox" as "This statement is true or false" does not imply that "This statement is true" nor that "This statement is false". This is equivalent to a rejection of the distributive law. Instead the truth valuation induces a transition in truth value within an irreducible proposition. That this nondistributivity can not be accomplished within Brown's formalism follows from his rule "Initial 2. Transposition" (Brown, op.cit., p. 28):



which effectively asserts the distributive law[14]

A final note regarding the Brown-Varela extended *Laws of Form.* In addition to not being able to describe the quantal universe, I claim that it neither provides the realization of double binds (Howe and von Foerster, 1975; Oshins, 1989a, 1989b; Oshins and McGoveran 1980), nor does not provide the metaphysical justification for a presumedly ethical pretension towards autonomy (Howe and von Foerster, Op.Cit.; Varela, Op.Cit.). It seems that the proper response to Howe and von Foerster's claim: "With his calculus of the paradoxical, the self-referential, the autonomous, Varela has opened for the first time the possibility of a Calculus of Responsibility." is that in a universe with entropy, there is no such thing as "autonomy" — just "expensive will". Indeed, one properly conceives of will as a capacity to make and implement choice. Were we "autonomous" with "free will" would not life be much more easy?

Section IV: Oshins' "Ray Hypothesis & What is relevant in a Quantum Context"[15]

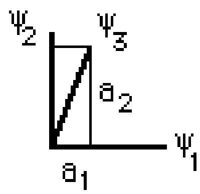
> "Any significant statement about a quantal system is a statement about unit rays" (Biedenharn and Louck, 1981, p. 159)

In this section, I shall overview certain significant differences between classical holograms and genuine quantum representations. (Appendix II contains cites by Gabor and by Bohm which show that they do not appear to share Pribram's belief that holograms are even relevant to a quantum context. It also contains cites by Dirac cautioning against making the very mistake that Pribram seems to have made in identifying classical waves with quantum states.) Here, I shall address some specific issues. In particular, I shall repeat my argument that the projective, quantum Hilbert space of rays, modulo the complex field, is different from the vector Hilbert space of holograms (or for other physical fields such as Gabor's (1946) "logons"). I shall then point out some differences in the observable structure of quantum theories and classical theories such as holograms.

The Hilbert space that is relevant to the principle of linear superposition of quantum states (Dirac, 1969, pp. 3-6, Oshins, 1984; 1987, pp. 77-8) uses rays, or directions, not vectors such as physical fields. This distinction is of fundamental importance. For a vector, the components themselves are important; but for a ray, only the ratio of components is relevant. As a consequence one can multiply a ray by any number and obtain the same ray, viz. the identical state of information encodement. In such a projective (or ray) representation space, the projection of one direction upon another provides a measure of the probability that a state of experience represented by the former will lead to a state of experience represented by the latter. Let Ψ = ray encodement of all measurable or observable properties of the system. Representing Ψ_1, Ψ_2, Ψ_3 as unit rays such that none line up and only two are independent, if you add two permissible rays (unit states) you get a third unit ray,

$$\Psi_3 = a1\Psi_1 + a2\Psi_2,$$

which is a coherent, linear superposition of rays Ψ_1 and Ψ_2:



Notice that: (1) that any two vectors, that don't line up, determine a plane (ie. the span which contains any state that can be made up with the other two and which represents the logical "or") & (2) that if we do not distinguish axes then there will always be a third possible axis that lies in the plane and could replace one of the other two in determining the same plane. This is the geometric realization of what we referred to above as the logical principle of complementarity. We can think of a_1 and a_2 as the components of Ψ_3 in Ψ_1 and Ψ_2 , respectively. One computes probabilities of information in one state being evaluated in another state by computing the magnitudes of the projections.

Although Pribram (Pribram, Nuwer, & Baron, 1974, pp. 419-20) correctly states that for a hologram "the film stores the intensity (the square of the amplitude) of the light," he is incorrect (Pribram, 1988) that brain networks, holograms, and quantum states "*obey the same rules ... the same mathematics.*"[my emphasis] Adding a physical field, such as the light field of a hologram, to itself results in twice the field and 4 times the intensity. On the other hand, as mentioned above, adding a quantum state as a ray to itself yields the identical state and thus the same intensity. (Dirac, 1969). In Part II I shall show how the identification of logons with quantal states on the basis of their both employing principles of linear superposition is a syncretic, paralogical conclusion forming process. They have *different* mathematical rules and *different* empirical consequences, and can thereby be shown to contradict the basic quantum postulate.

Additional Confusion between Holograms and Quantum Theory:

1. Observables: Although Pribram (1981a) believes that "... Wigner (1969), a Nobel laureate in physics, has to declare that modern microphysics and macrophysics no longer deal with 'relations among observables but only with relationships among observations'. ..." and has used this as the basis for disallowing my challenge to his theory (February 7, 1986, luncheon seminar in Pribram lab), both classical and quantum theories do indeed have observables. Observables are the injective inverses of measurements, ie. that which we get numbers about. For classical theories, the observables are numerical-valued functions or functionals on classical phase space. The differential structure is governed by Poisson brackets and observables commute within the ordinary algebraic product. The physical observables of a hologram theory are the classical, physical fields. That which is attempted to be represented is the motion of objects, usually rigid objects in physical space of ordinary experience. In other words Pribram is attempting to use the physical fields to carry the representations of eg. rigid objects. This provides a wave theory of waves to realize the motion of

particle theory of particles.

For quantum theories, the observables are projection-valued measures in a projective, Hilbert space. The differential structure is governed by commutator brackets. The observables do not commute within the ordinary algebraic product. The physical observables of a quantum theory depend upon what the actual experimental arrangement is: (eg. position, momentum, energy-momentum tensor for physical variables, and eg electromagnetic 4-potential or electromagnetic field for waves or fields). Quantum psychology provides for wave theories of particles and particle theories of waves. In addition, according to standard physics, the electromagnetic field interacts with matter by making a gauge covariant derivative out of the momentum (ie. $p \to p - e/cA$), whereas Pribram seems to want to use the holographic field to represent the motion of particles. One obvious question is "With a rigid object, what is waving?" In addition, as Weyl learned and Einstein later proved, one can not gauge the electromagnetic field.

The relations between the differential structures are known and can be seen by the following theorem (Wheeler, 1965): For canonical degrees of freedom (Schwinger type I variables/Fock algebra, etc.), ie. for [A , B] - = c I, c being a c-number such that the arguments commute with their commutator, and for G(A,B) and F(A,B) polynomials in their canonical arguments,

$$[G(A,B), F(A,B)] = \sum_{k=1}^{\infty} \frac{1}{k!} C^k \{ \frac{\partial^k F}{\partial B^k} \frac{\partial^k G}{\partial A^k} - \frac{\partial^k G}{\partial B^k} \frac{\partial^k F}{\partial A^k} \}$$

How such a classicalization would psychophysically be accomplished I consider to be one of the most important questions in psychology. Although I have some discoveries and ideas about this, they still need much thought and work.

Furthermore, physical variables such as position, momentum, angular momentum, energy-momentum tensor, etc. transform as finite dimensional non-unitary representations of the Lorentz group. On the other hand, states transform as unitary representations of the Poincar group. (Tung, 1985, esp Section 10.5)

2. Classical vs Quantum Huygens' Principles (Beard, 1963; Feynman,1948; Oshins, 1969, 1984d, 1990): In the late 1970's I proposed the Feynman-Schwinger-Dirac alternative to the Huygens' principle for Pribram's holograms.

For the holographic Huygens' principle, as for any classical theory of light, the number of photons arriving at a point, say C, on a photographic plate or even imageless screen is proportional to the intensity of the light/Pointing vector, represented by complex amplitude $exp\{i(kx - wt)\}$. The phases integrate over all possible intermediate points B thus, (using a *left to right* direction for causal/temporal ordering in order to maintain consistency with Beard's notation in his discussion from which this is directly adapted):

$$P_{AC} = |e^{-i\omega t} \sum_{\text{all possible intermed. B paths}} \int exp(i \int_{\text{path through particular B}} kdx) dB|^2$$

where,

$$i \int_B kdx = \text{ contribution to total wave amplitude of phase of path through B}$$

and the intensities/probabilities add,

$$P_{AC} = \sum_{\text{all B}} P_{AB} P_{BC}$$

On the other hand, for Dirac/Feynman/Schwinger "quantum wavelets", or whatever, as states

$$\Psi_{AC} = \sum_{\text{all possible intermed. B paths}} \int \Psi_{AB}[exp(\frac{i}{\hbar}\{\int_{t_B}^{t_A} Ldt\})]$$

where,

$$\frac{i}{\hbar}\{\int_{t_B}^{t_A} Ldt\} = \frac{i}{\hbar}\{\int_{t_B}^{t_A} (P\dot{x} - E)dt\} = i\{\int_{B}^{A} kxdx - \int_{t_B}^{t_A} wtdt\}$$

and, as usual, the norm squared of $\Psi_A C$ provides the probability density for a quanta to go from A to C.

The differences are that in the quantum case, of course, there is a Planck's constant[16] relating the spatial frequency to the momentum and for the optical Huygens' wavelet, the energy/frequency term is taken outside the integral over space or time in computing the probability. In addition, as pointed out by Feynman (Ibid., p. 377), "Actually Huygens' principle is not correct in optics. It is replaced by Kirchoff's modification which requires that both the amplitude and its derivative must be known on the adjacent surface. This is a consequence of the fact that the wave equation in optics is second order in time. The wave equation of quantum mechanics is first order in the time; therefore, Huygens' principle *is* correct for [quantum] matter waves, action replacing time." Furthermore, a wave theory of waves such as holograms in principle requires a *large enough to be effectively infinite number of quanta* in order bto have the classical coherence needed for a hologram in contrast to the wave theory of quanta as particles of light for which the principle of linear superposition applies to *an individual quantum* as state or ray in projective Hilbert space.(See Sakurai, 1967, Ch. 2, and Dirac quote below).

3. What Commutes: One issue in the confusion between holograms and quantum representations is due to the fact that there are uncertainty relations for holograms or any other Fourier analyzable classical wave. The difference is that for classical waves that which does not commute is the position and the spatial frequency. For quantum particles that which does not commute is the position and the momentum which is related to spatial frequency through the all important Planck's constant. But, for quantum fields, that which does not commute is the field and the field momentum of individual quanta. The road to quantization is to make a Fourier decomposition of the fields and field momenta and to set up commutation (or anticommutation) relations for these fields and field momenta. For classical theories such as holograms, the fields and the field momenta (or alternatively, the different components of the electromagnetic field potential) do commute.

Furthermore, that which interferes in holograms is the entire wave. On the other hand (Dirac, 1958, p. 9): "It would be quite wrong to picture the photon and its associated wave as interacting in the way in which particles and waves can interact in classical mechanics. ... [In order to avoid] contradict[ing] the conservation of energy ... Each photon ... interferes only with itself. Interference between two different photons never occurs."

Section V: Conclusion

"... no amount of experimental evidence can count in favour of a logical muddle." (Bastin, 1971, p. 8)

About Models and Muddles, Part I

The present paper has attempted to point out some of the critical differences between Brown's *Laws of Form* approach to the logic of experience and Pribram's "hologram hypothesis" approach to the logic of experience, on the one hand, and genuine quantum approaches on the other hand. I have pointed out that the *Laws of Form* approach requires distributivity of the lattice thereby precluding quantum physics and that Pribram's hologram approach to quantum physics is a paralogical muddle developing out of confusing the wave structure of the Hilbert space of the holographic field with the projective Hilbert space of quantum states. Part II will elaborate further on the lattice theoretic approach to the Brown-Varela-Kauffman "extended calculus of indications,' showing in particular how it contradicts quantum formalisms and on how Pribram's confusion leads to a contradiction with the basic quantum phenomena.

If science is to progress, it is imperative that it support the proper morphisms as an empirical model. I have sketched several reasons why neither Brown's model nor Pribram's model are adequate for a quantum context. It seems appropriate to end this paper with a lovely quote from Feynman (1963) which points out that for science to work, one's imagination must be properly in focus:

"The whole question of imagination in science is often misunderstood by people in other disciplines. ... whatever we are allowed to imagine in science must be *consistent with everything else we know*; that the electric fields and the waves we talk about are not just some happy thoughts which we are free to make as we wish, but ideas which must be consistent with all the laws of physics we know. We can't allow ourselves to seriously imagine things which are obviously in contradiction to the known laws of nature. ... The problem of creating something which is new, but which is consistent with everything which has been seen before, is one of extreme difficulty."

Appendix I: Pribram on His Holographic Model

> "Why ... would I need to perform experiments and why would they so often come up with results contrary to what I had been thinking? Bohm answered that that was because my thoughts were probably muddled — to which I unfortunately had to agree. ... reality seemed not to reflect my muddled thoughts." (Pribram, 1987)

In the early 1970's, Pribram (1971) introduced his "hologram hypothesis":

"The [hologram] hypothesis is based on the premise that neural representations of input ... have considerable formal resemblance to an optical image reconstruction process devised by mathematicians and engineers. This optical process, called holography, uses interference patterns. It has many fascinating properties. ... These properties are just those needed to resolve the paradox posed ... in the context of demonstrated anatomical constraints in neural input organization.

Before proceeding with the precise formulation, a few paragraphs explaining the general approach taken here may be helpful. Optical information processing by holography is described mathematically in wave mechanical terms. In physical optics, the equations used to describe the behavior of light in experimental situations can be couched either in quantal or in wave form[17]. The physicist is not unduly concerned whether light is quantal or a wave, whether it comes in packets or as electromagnetic waves or both[18]. He is concerned in describing the results of his observations as quantitatively and fully as can be done and chooses his descriptive tools accordingly." (p. 141) "This phenomenon of neighborhood interaction has been studied extensively and given the name *superposition*. The mathematical equations that satisfactorily account for superposition are sets of linear equations called *convolutional integrals* that are ordinarily used to describe interactions among wave forms. The description of one wave form is convoluted with that of another. ... The holographic hypothesis on brain function in perception takes the form of superposition The [p. 142] ... [of] wavefronts of light [p. 146]."[19] [my emphasis] "For the problems of perception, especially those of Image formation and the fantastic capacity of recognition memory, holographic description has no peer [my emphasis.] So why not apply its application to brain processes?" (p. 152) "... the holographic hypothesis enriches psychology by providing a plausible mechanism for understanding phenomenal experience. This permits consideration of components of psychological functions which become lumped together in a restricted behavioristic framework. Pattern recognition is a complex process in which feature analysis and the formation of a central representation of input are steps. In man, given the neural hologram, these steps lead to Image construction.

"Science searches for explanatory principles, and psychological science is no exception." "Superposition, i.e., spatial interactions among phase relationships of neighboring junctional patterns occurs, and such interactions can display Image forming properties akin to those of optical information processing systems — the properties of holograms." (p. 166)

Pribram alleged his model to be formally based upon Gabor's mathematics of holograms (Ibid., 147-166). Since he has more recently lumped this together with Bohm's notion of holomovement in quantum physics, as if they were the same, I shall reproduce some of Pribram's own statements which demonstrate that he indeed asserted a (classical) hologram model, in contrast to a quantum models:

"Holograms are technical instantiations of mechanisms that utilize frequency analysis: image processors (also called optical information processors). Initially, holography was a mathematical invention (Gabor, 1969). Its realization in hardware has been accomplished by storing (on film), the interference patterns of wave forms produced by reflection and diffraction from and through objects. Illumination of the stored interference patterns recreates an image of the objects in a plane removed from the stored patterns. The mathematical descriptions of this holographic process and the brain process delineated previously are identical [my emphasis]. A model of holographic brain processes has been developed (Pribram, 1971; Pribram, Nuwer, & Baron, 1974). This model accounts for many hitherto difficult to explain brain-behavior relationships such as the failure of even very large brain lesions to eradicate specific memory traces (engrams) and the facts of equivalence in both sensory and motor function that were noted earlier." (Pribram, 1981b, p. 144) "In the section on the Neural Hologram, I detail the evidence that items of information become distributed in the brain and stored in holographic fashion." (Ibid, p.150).

"My proposal is therefore that the basic function of brain is to generate the codes by which information becomes communicated. Some of these codes are like those used in optical information processing — they are holographic." (Pribram, 1976, p. 301). "... The mathematical equations ... are sets of reversible transforms that superpose the effects of neighboring stimuli. These mathematical descriptions ... are of the same genre as those used by Gabor (1948) when he invented holography [my emphasis]. ... This resemblance led me to propose that we take seriously the analogy between neural processing and physical holography. ..." (Ibid., pp. 304-305) "Ordinary consciousness is thus achieved by a mechanism (somewhat like a hologram). ... (Ibid., p. 306)

"... what began as a metaphorical simile has been developed into a precise neurological model. [My emphasis] Now based on evidence, this holographic brain model continues to be sharpened as relevant results ... have accrued. There is little remaining doubt that some brain processes are characterized by holonomic transformations that result in algebraic isomorphisms between the image/object domain on the one hand and the holographic transform domain on the other. (Pribram, 1983b, p. 36)

"... The holonomic model of brain function is therefore mathematically precise, and its assumptions (such as overall linearity of component programming systems) and consequences (the distributed nature of the deep structure of the memory store) are, at least in principle, testable." [my emphases] (Pribram, 1975, pp. 174-5) "... the subquantal domain shows striking similarities to holographic organization. Just as in the case for brain processes presented here, Bohm's theoretical formulations retain classical and quantum processes as well as adding the holographic. The holographic state described by wave equations and the particle state described quantally, are part of a more encompassing whole ... *Bohm* relates structural and holographic processes by specifying the differences in their organization. He terms classical and particle organization *explicate* and holographic organization *implicate*."[20] (Ibid, p. 183).

"The essentials of this mathematics can best be summarized by reference to a particular form of holography

— the construction of a Fourier hologram. ... In the Fourier-transformed record, by contrast, each point represents the amount of energy present in a waveform component of the entire array of light reflected from the object. ... To make a (Fourier) hologram, two such Fourier-transformed records must be linearly superposed. Mathematically, this is performed by the transfer function in which one record is convolved with the other and then the resultant complex conjugate stored. In essence, convolving consists of 'adding' the waveforms together. Now each point in the record contains this 'addition' — that is, the resultant of superposing the energy contained in two waveform components derived from the entire array of reflected light. A holographic record can be made by superposing the Fourier transform of the light reflected from two(or more) objects. ... "... these enfolding properties of holograms ... make them so counterintuitive. Within the holographic domain, geometry as we sense it disappears and is replaced by an order in which the whole becomes enfolded and distributed into every part — thus the term *hologram* — but from each part, the whole can again be reconstituted. This is due to another property of the Fourier theorem: Applying the identical transform inverts the waveform domain back into the image. The process (the Fourier transfer function) that converts images into waveforms can therefore also accomplish the inverse and convert waveforms into images."[21] [my emphases] (Pribram, 1982; pp. 276-7):

"Still, the facts must be explained and the holographic explanation is a powerful one. A good deal of this power comes from its precision. For the first time a wholistic conceptualization can be made as rigorously and mathematically precise as a particularistic one. For psychology such precision is a necessity ..." [my emphases] (Pribram 1981a, p. 231-2)

Appendix II: What the Gabor, Bohm, and Dirac actually say about the relationship between classical holograms and quantum states

In this appendix, I shall first begin by citing from Gabor and from Bohm to show that they do not appear to share Pribram's belief that holograms are even relevant to a quantum context. I shall then present some quotes by Dirac cautioning against confusing classical wave theories with quantum states and noting that Fourier transformability is not a separating question. Indeed, in standard quantum field theories, one ordinarily makes a Fourier decomposition of the classical fields and then quantizes them by applying the appropriate commutation or anticommutation relation to the Fourier coefficients. (Sakurai, 1967, esp Ch. 2).

What Gabor really says about holograms and quantum physics.

In their paper, Pribram and Carlton (1986 p. 185) claim to represent a "third force" in modeling the "neuropsychology of imagery", "that being Gabor's usage of the mathematics of quantum theory in creating holography."[22] It is not clear even why these authors are using this article at all since it deals with time-frequency information and hearing and Gabor's hologram work deals with locational-spatial frequency information and since Gabor didn't find it relevant to his actual article on holography (Gabor, 1948). At least he doesn't even cite it.

Furthermore, Gabor is quite clear that he doesn't share Pribram's and Carlton's confusion about this current paper (Gabor 1946) and and being "relevant" to quantum physics. He recognizes that his work only "involves some of the mathematics ..." (p. 429) not that they are able to be identified. He even rejects this: "Perhaps it is not unnecessary to point out that it is not intended to explain the transmission of information by means of quantum theory. ... The foregoing references [to Heisenberg's principle of indeterminacy] are merely an acknowledgment to the theory which has supplied us with an important part of the mathematical methods." (p. 432). And in acknowledgement that he is addressing classical theories, he notes: "Another field of classical physics in which an uncertainty relation is of great importance is Brownian motion." (p. 432); "The mathematical developments up to this point have run rather closely on the lines of quantum mechanics ... But now the ways part ..." (p. 435); and "It will be useful to sketch briefly the difference between the analysis based on elementary signals and the method of wave mechanics ... The question posed by wave mechanics is more general ..." (p. 441).

About Models and Muddles, Part I

What Bohm really writes about holograms and quantum physics.

"... the formation of an image is just what is not relevant in a 'quantum context'; [my emphasis] at most a discussion of image formation serves to indicate the limits of applicability of classical modes of description." (Bohm, 1971, p. 443) "... but of course, the hologram is only an instrument whose function is to make a static record (or 'snapshot') [my emphasis] of this order. The actual order itself which has thus been recorded is in the complex movement of electromagnetic fields, in the form of light waves ..." (Bohm, 1980, p. 177) "Whenever the results of an observation are recorded [my emphasis](e.g., on a photograph, a wire tape, a punch card, by pencil marks in a notebook, ...), one has a situation in which the record is decoupled from the system under observation ... This property is, in fact, included in the very definition of what one means by making a record. Although it is not necessary that the results of all observations shall actually be recorded somewhere, it is certainly true that all observational data have the property that they can, in principle, be recorded." (Bohm, 1951, p. 590). "... the very idea of making an observation implies that what is observed is totally distinct from the person observing it." (Bohm, 1951, p. 585). "... Consider, for example, an experiment in which a person obtains information for a photograph. ... [Whenever t]he observer ... [can] obtain his information by looking at the plate ... this process is classically describable, there is a sharp distinction between the observer and the plate that he is looking at." (Bohm, 1951, p. 586)

"... The classical theory [such as a hologram] postulates a continuous distribution of energy throughout space. In the quantum theory, however, one must take into account the fact that energy is possessed by the electromagnetic field in the form of indivisible quanta. ..." (Bohm, 1971, p. 91) "... [the] enfoldment and unfoldment takes place not only in the movement of the electromagnetic field but also in that of other fields ... Moreover, the movement is only approximated by the classical concept of fields (which is generally used for the explanation of how the hologram works). More accurately, these fields obey quantum-mechanical laws implying the properties of discontinuity and non-locality, which we have already mentioned. ..." — (Bohm, 1980, pp. 177-178)

Regarding the issue of non-locality, Bohm is referring to the fact that a quantum state is defined globally, whereas for a classical state such as a hologram: "... the vector potential ... [is] a number that can be specified with arbitrarily high precision at each point in space and time, by means of the classical Maxwell equations. ..." (Bohm, 1971, p. 419)

Dirac's on confusion between classical waves such as holograms and quantal states:

Pribram confuses the concept of superposition of waves with quantum theories. Superposition occurs both classically as in hologram models and quantumly as in Dirac's "fundamental principle of quantum mechanics." The interested reader is advised to read Dirac on this matter, eg. P.A.M. Dirac, (1958):

> "... there will be various possible motions of the particles or bodies consistent with the laws of force. Each such motion is called a *state* of the system. ... A state of a system may be defined as an undisturbed motion that is restricted by as many conditions or data as are theoretically possible without mutual interference or contradiction [ie. "Maximal"] (p. 11) "The procedure of expressing a state as the result of superposition of a number of other states is a mathematical procedure that is always permissible, independent of any reference to physical conditions, like the procedure of resolving a wave into Fourier components. Whether it is useful in any particular case, though, depends on the special physical conditions of the problem under consideration." (p. 12) "The assumption of superposition relationships between the states leads to a mathematical theory in which the equations that define a state are linear in the unknowns. In consequence of this, people have tried to establish analogies with systems in classical mechanics, such as vibrating strings or membranes, which are governed by linear equations and for which, therefore, a superposition principle holds. Such analogies have led to the name 'Wave Mechanics' being sometimes given to quantum mechanics. It is important to remember, however, that *the superposition that occurs in quantum mechanics is of an essentially different nature from any occurring in the classical theory*, as is shown by the fact that the quantum superposition

principle demands indeterminacy in the results of observations in order to be capable of a sensible physical interpretation. The analogies are thus liable to be misleading." (p.14).

And indeed, they have been so in the Pribram model since, eg. holographic electromagnetic potentials have no indeterminacy since all components of the $A_\mu(x)$ fields commute for holographic defining fields but they do not for quantized radiation fields (Sakurai, 1967, esp. Ch. 2; and Bohm quote above)

Appendix III: the Stern-Gerlach Experiment and the Fracture of Classical Logic[23]

In the early part of the century, an experiment was peformed by Stern and Gerlach in which a beam of silver atoms carrying the spin of a single electron is passed through an inhomogeneous magnetic field with gradient. (See Figure A.) This experiment is sufficient to derive the transformation properties of 1/2-integral spin matter, such as electrons and nucleons. The beam is split into precisely two separate beams which are either in the direction of the gradient of the magnetic field or opposed to it. (This is not a statistical effect and can be done one atom at a time.)

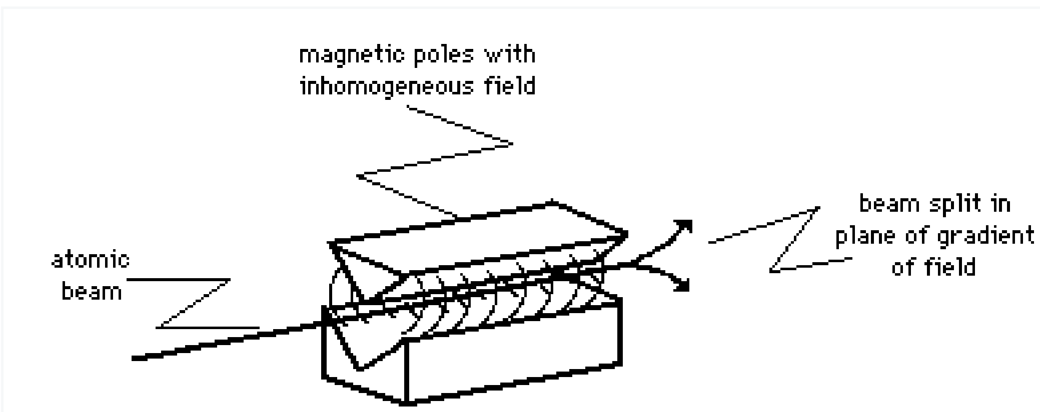


Figure A: Stern-Gerlach magnet separating the beam into two beams.

If the initial magnetic field's gradient was alined, say, vertically we could call the emerging beams Up and Down. This is a dicotomic event. As discussed in Oshins & McGoveran (1980), we can define an operational logic for the Stern-Gerlach experiment. What we mean by empirical truth is quite specific [originally footnote 10]: (1) we agree upon a collection of questions; (2) we agree upon criteria by which observations pass the test of the questions; and (3) we ask the questions of the observation set. Empirical truth is distinguished by whether or not the answers satisfy the agreed upon criteria. In this sense, empirical truth is identified with the occurrence of an event having the properties under consideration — the event has been determined by some measuring apparatus, possibly a human).

The operational meaning to the logic is: (1) that if the single electron atom is "prepared" such that its magnetic moment is pointing Up, as is depicted in Figure B, then it will pass any attempt to "determine" whether it is indeed pointing Up ; (2) that it is true that the single electron atom is determined to have gone Up means that it is always false that it had been "prepared" Down; but (3) that it is false that the single electron atom went Up does not mean that it is true that it was originally Down. It may have been "prepared" with its magnetic moment pointing Right , which means that it would be false that it could be determined Left!

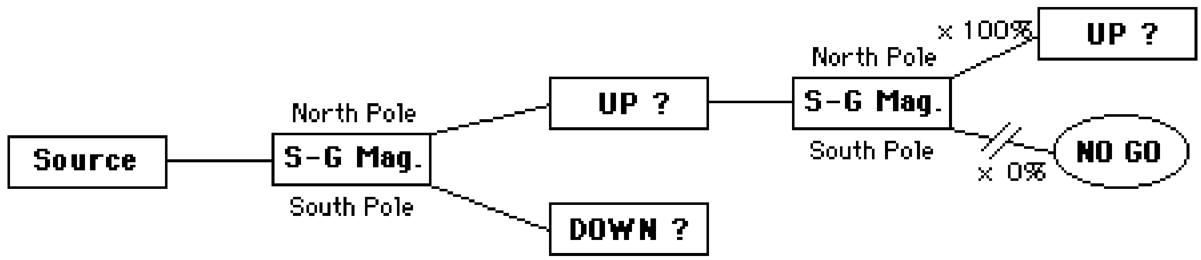


Figure B: Up is true, and Up is true.

This means that if a single electron, silver atom is "prepared" such that its "state" is has orientation Up, and it is tested to "determine" what its orientation is, one will always determine that the single electron atom is oriented Up. The empirical logic can be represented as (Up and Up) = Up.

If we should select out Up and subject this know beam to a second Stern-Gerlach apparatus which has its gradient alined horizontally, thereby allowing only a Right or Left determination, it is empirical truth (always the observed case) that if there is no empirical procedure which could operationally determine whether it was Right or was Left, then it is as if no measurement had taken place, as is depicted in Figure C:

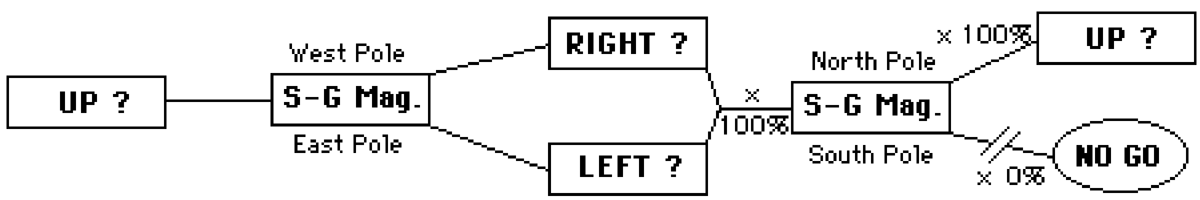


Figure C: Up is true, and (Right or Left) is true.

That (Right or Left) is true means that all preparations will either go Right or will go Left if determined by a horizontal (ie. right/left) apparatus. That there does not exist an operational procedure which could determine if Right had occured or if Left had occured is the same as no empirical distinction having taken place. Eg. "I need a person.", not "I need a 'boy or girl'."

It is empirically false that:

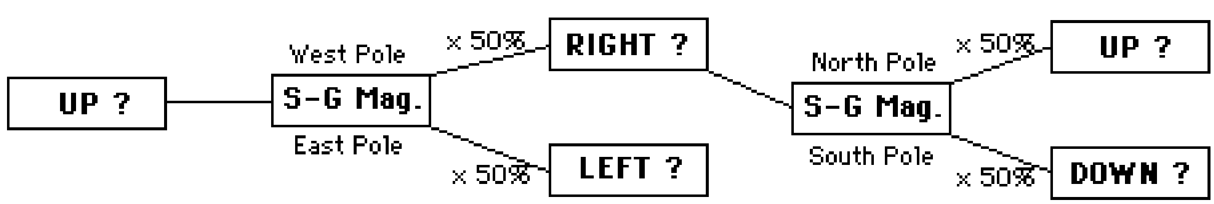


Figure D: Up is true and Right is true.

This is so because if Right were true, then Left would be false. The analogy here is that I might be looking for a "boy or a girl", ie. a person, yet the context is not one of gender but of race. Specificly, a "black" is a "boy or a girl" but a black (as an abstractia) is neither a boy nor a girl (cf. also, Oshins, 1989, footnote #8), since if a black were a boy then a black could not be a girl. Thereby, it is claimed that introducing the context of race (eg. "black") would presumably allow for transitions between boy-labeling and girl-labeling which would not take place given a strictly gender context. This might occur for our example with a contextual issue dealing with empathy and discrimination.

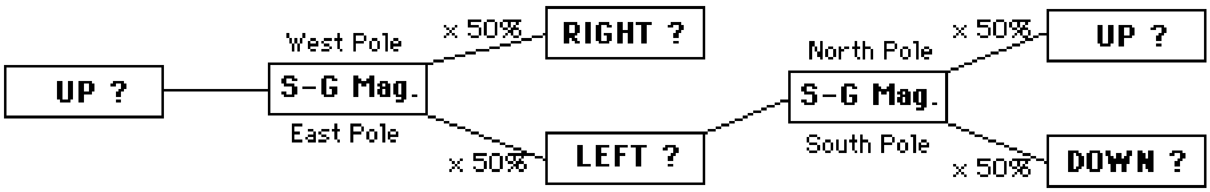


Figure E : Up is true and Left is true.

Likewise, if Left were true, then Right would have to be false.

The distributive law of classical logic asserts that it is always true that: [A and (B or C)] = [(A and B) or (A and C)]. Upon substituting the empirical data we find (with obvious abbreviations)

$$U \quad and \quad (R \quad or \quad L) =?= (U \quad and \quad R) \quad or \quad (\quad U \quad and \quad L)$$

$$T \quad and \quad T =?= F \quad or \quad F$$

$$True \neq False$$

$$False$$

We are forced to conclude from this "non-classical two-valuedness" that the distributive law of classical logic is empirically violated. It is replaced by the principle of complementarity: If two constructs are not-discriminated, there will always be a third within the span (or plane generated by the two) such that non-distinguished aggregates of any pair will be equal to the span.

Appendix IV: Schwinger Quantization for Incompatible Discriminations

Operationally, quantum physics has shown that there is an empirical difference in coding between (Oshins 1984a, 1989a,b, 1990; Schwinger, 1970, esp. pp. 27-28): (1) forming a class (ensemble) of possible states (subensembles) which are discriminated according to some specific attribute (eg. subensembles having either predicate-A or incompatible/complementary predicate-B) and (2) forming a class (ensemble) of possible states (subensembles) which are not empirically distinguishable according to such a predicate — ie., there is no empirical procedure that discriminates between the alternative, possibly incompatible/complementary predicates). This is true even if no member of the class is distinguished or separated out, as long as, operationally, one could be.

Schwinger (Ibid.) introduces the following "measurement symbol" notation for a "selective measurement": $M(b')$. This represents a projection operator that accepts systems possessing the value b of the property B and rejects all others. As a projector $M(b')$ satisfies the properties: $M(b')^\dagger M(b') = M(b')M(b')^\dagger = M(b')$ and $M(b')^\dagger = M(b')$, ie. they are normal, idempotent and Hermetian. In addition, he introduces the following "measurement symbol" for a "non-selecting measurement" that does not even discriminate between the b' alternatives:

$$I = \sum_{b'} M(b')$$

Non-discriminating Measurement:

Here we have no operationally meaningful way of saying that a measurement had even taken place. Thus the non-discriminating measurement acts as if no measurement had even taken place. Within the Hilbert space, one would apply Dirac's principle of linear superposition of states and take their span which corresponds to the projection operator of the entire space, ie. the identity operator I. On the other hand, for an alternative that could in principle be discriminated, even though one is not selected, Schwinger introduces a different measurement symbol:

$$M_b = \sum_{b'} e^{i\phi_{b'}} M(b')$$

Discriminating, but Non-selecting Measurement:

The random phases ϕ_b' separate the previously coherent sectors into superselected sectors. It is easy to show that the elementary selective measurement symbols (projectors) obtain from the non-selective measurement symbols by replacing all but one of the phases by positively infinite, imaginary numbers, thereby rejecting all but one of the subensembles.

The road to quantization is easy: As Schwinger shows (1970) the for compatible projection operators M_b' and M_b'' the product of the projectors yields a delta function $\delta(b', b'')$ times a projector. Without getting to caught up in the formalism, for noncompatible measurement symbols dealing with *complementary* attributes one obtains a Dirac bracket $< b'|c'' >$. One can then show Schwinger's "Action Principle" that the variation of a bracket connecting two space-like surfaces σ_1 and σ_2 is proportional to the expectation value of the variation of the Action (or integrated Lagrangian density) between these two space-like surfaces:

$$\delta < \sigma_1|\sigma_2 > = < \sigma_1 \{ \frac{2\pi i}{h} \int_{\sigma_2}^{\sigma_1} (dx) L[\chi(x)] \} |\sigma_2 >$$

Oshins (1989a,b) has suggested a possible psychological example which might carry this same type of representational alternatives. Consider the difference between saying a person (= a "male or female", if distinguished) came into the room and saying that a "male" or a "female" came into the room (distinguishing gender as opposed to a different, competing context). Of course, the existence of complementary, competing construct attributes is an empirical issue. Other possible complementary alternatives might involve a meta-choice between, say, the good/bad-attribute-dichotomy and the love/hate-attribute-dichotomy. See also, Bohr (1987/1954, p. 81) regarding "justice and charity" and Heisenberg (1958, p. 179) regarding "enjoying music and analyzing its structure." The existence of two operational ways to code "nonselecting measurements" became a foundation for Oshins' "quantum psychology" approach (Op.Cit.).

NOTES

1 We are specific as to what we mean by separating alternatives (Jauch 1965, pp. 94-96; Oshins, et.al., 1991, to appear; Von Weizsacker, 1971, pp. 244-245): Such an alternative provides a complete set of mutually exclusive, empirically decidable propositions, the determination of which prepares a state with a specified property: "If x $\neq$ 0 is a proposition representing a separating alternative, then there exists a state s such that s(x) $\neq$ 0; and if x $\neq$ y, which is any alternative proposition, then there exists a state s such that s(x) $\neq$ s(y)" On the other hand, it is not clear what science might mean were there not in principle a state that in principle could provide a measurably different outcome for two alternative proposition that are allegedly different!

2 Since it has been alleged that I confuse the domain of discourse of "formal language"/mathematics considered by the *Laws of Form* camp with the domain of discourse considered in physics or psychology, I note the following facts:

About Models and Muddles, Part I

1. The *Laws of Form* camp does indeed claim to be describing the domains of physics and psychology. As examples:

1a. "Even at the level of scrutiny we have achieved so far, there is great beauty in the harmony of shapes and the vibrational quality of indicational expressions. So far, the music of these spheres seemed to have escaped our notice, except some more special forms (such as the *wave/particle duality in quantum mechanics* [my emphasis]), ... all of these periodic phenomena in matter, nature, an art seem to be fundamentally the same. They stem from the basic *act* of [forming a Brownian or Brown-Varela-Kauffmanian] distinction, of creating a duality of this and that. This primordial act is pregnant with time, space, pattern and their dance." (Kauffman and Varela, 1980, pp. 205-206; cf. also Comfort, 1984, 1990).

1b. "For instance, in psychiatry the significance of the relationship paradox — self-reference [as put forth by Brown and Varela], which in one context may have destructive, but in another context constructive consequences has been pointed out again and again by George [sic. Gregory] Bateson. In the destructive (pathological) case, a paradoxical interpersonal (e.g., mother-daughter) relation exists, the "double bind", in which autonomy of one partner (daughter) is encouraged by the other (mother) on one level of discourse, but denied on another (say, the interpretive) level; the (controlled) breakdown of the "metalogue" causes the victim to withdraw affectively, and other schizophrenic symptoms develop" (Howe & von Foerster, 1975, p. 2)

My claim has been that quantum discriminations that realize physics and psychology are of a fundamentally different form, as will be discussed in this article, using Schwinger discriminations. In addition, I have claimed that there are psychological experiences which require similar generalization to nondistributive (quantal) lattices for their realization such as the unconscious, primary process mechanism of von Domarus' principle of identification (equivocation) by predicate, in Batesonian "double-binds" and in the MRI use of metalogical ambiguity as complementarity in brief (paradoxical) therapy techniques (Hilgard 1989; Oshins, 1989 a,b,c; Oshins McGoveran 1980).

2. As it is true that the *Laws of Form* camp claimed to have found a *more general logic of experience* than classical Boolean logic, it is also the case that quantum logic proports to provide a *more general logic of experience*. Consider for example Jauch (1968):

"The prime source of scientific knowledge about the physical world is the experience gained by systematic observation of physical systems. Purely mathematical knowledge, although very useful for the organization of empirical raw material into a body of interrelated facts, it useless as a *source* of knowledge about the physical world. The reason for this is that mathematical truth is analytical truth; this means that it contains nothing more than what is already contained in the premises or the axioms. It is always certain [ly true or it is certainly false], but just because of this certainty, essentially tautological. Empirical truth, on the other hand, is *synthetic* truth. The general physical laws are arrived at by *induction* from observed facts, and therefore are never *certain* but only *verifiable for a finite number of instances.*

These general laws are formulated as axioms in a mathematical language. Conclusions are then drawn from these axioms by rigorous mathematical methods which lead to the prediction of other observable facts. These facts may be verified or not by observations. ."(p. 70)

"... A certain freedom is left to the creative theoretician which often can be a decisive element in the success of a theory. ... The main problem in the selection of empirical material is the separation of relevant from irrelevant conditions. (p. 71)

"The calculus introduced here has an entirely different meaning from the analogous calculus used in formal logic. Our calculus is the formalization of a set of *empirical* relations which are obtained by making measurements on a physical system. It expresses an objectively given property of the physical world. It is thus the formalization of empirical facts, inductively arrived at and subject to the uncertainty of any such fact.

About Models and Muddles, Part I

The calculus of formal logic ... is obtained by making a n analysis of the meaning of propositions. It is true under all circumstances and even tautologically so. Thus, ordinary logic is used even in quantum mechanics of systems with a propositional calculus vastly different from that of formal logic. The two need have nothing in common. [I disagree with the latter. I believe that classical/formal *must* be physically compatible with and a contraction of quantum since there is one world which as well as we know *is quantum* at a more general and more fundamental level. Thereby the one of description can not be in contradiction with that which is and remain valid. . Indeed, it is my understanding the the whole *origin* of the *Laws of Form* approach was to demonstrate that formal logic/language between people is *not* able to be realized using Boolean logic due to so-called self-referential paradoxes in language.] It turns out, however, that, if viewed as abstract structures, they have a great deal in common without being identical. Their most important difference is that the calculus of formal logic is Boolean, while that of physical propositions is Boolean only for classical systems ... The distinction between a formal logic and an empirical proposition system is exhibited most clearly in reference 16 [Middlestaedt, P. 1966. *Philosophische probleme der modernen physik*, Mannheim, esp Ch. VI]"

My own foray into using quantum logic was in part due to the insight that in addition to being able to realize certain linguistic phenomena that was allegedly not Boolean, such as *Laws of Form* and "fuzzy logic," It quantum-type equivocation seemed to carry common representations with certain *intrapsychic* and *unconscious* processes such as Vigotsky's "complexes" (Oshins, 1984; Vigotsky, 1934) and von Domarus' process (Arieti, 1974, 1976; Hilgard 1989; Oshins 1984, 1989 a,b,c; Vigotsky, op.cit.). In particular, it seemed to me that a nondistributive lattice obeying a Dirac principle of linear superposition of rays (as atoms) in projective Hilbert space might realize the sought after language of Sullivan (1944):

> "Language operations as thought are profoundly different, quite fundamentally different, from language operations as communication and as pure mechanisms used in dealing with others." (p. 9)

and of Pitts and McCulloch (1947):

> "That Language in which information is communicated to the homunculus who sits always beyond any incomplete analysis of sensory mechanisms and before any analysis of motor ones neither needs to be nor is apt to be built on the plan of those languages men use toward one another." (McCulloch, p. 56).

Finally, it is pertinent to point out that this latter quote seems to have also inspired Pribram (1971, p. 1) to use *Languages of the brain: experimental paradoxes and principles in neuropsychology* for the *title* of *his* treatise proposing *Gabor's classical holographic model* as an alternative to the McCulloch-Pitts "black box"/Turing equivalent/neural net model (Oshins, 1984). I *just* challenged Pribram's claim that "holographic description has no peer" as an alternative to McCulloch-Pitts in 1977-78 when we both lectured together during an SRI luncheon lecture series (Hilgard, 1989; Oshins, 1984. 1989 a,b)

3 As will be elaborated further in Part II (Oshins, in prep), these have been "extended" by Varela (1975, 1976) and Kauffman (1978a,b, 1980, 1982, 1987, 1989/87, 1990; Kauffman & Solzman, 1981; Kauffman & Varela, 1980) into imaginary-valued, 3-valued logics, and interpreted, peculiarly, as linearly ordered 3-chains (Varela 1975, 10. *Rule of Dominance*; Oshins, in prep; Oshins 1991) This is claimed to be the natural generalization of Brown's Cannon 6. *Rule of Dominance*, which stipulates that Brown's "primary" calculus of indications is a 2-Chain. In any case, the so-called third autonomous state precludes complementation and thereby complementarity (Bohr), violates the law of the excluded middle (Kauffman, 1978a, 1989/87; Kauffman and Varela , op.cit, p 173). Both the primary calculus of indications (CI) and the extended calculus of indications (ECI) are axiomicly distributive (Brown, 1973, Algebraic Initial [axiom] J2. transposition, p. 23; Varela 1975, Theorem 5)., from a lattice point of view, thereby have only superselected states that forbid Dirac's fundamental principle of linear superposition of states and quantum physics.

4 This use of distributive refers to spatially spread out instead of the logical or lattice theoretic axiom of

distributiveness referred to in the present article Pribram's usage of distributive refers to the fact that in certain circumstances when part of the brain is destroyed, the individual does not lose a "chunk" of memory but does lose a more global resolution. In order to explain such observed phenomena, popularized by K. Lasley, Pribram and others suggested an holographic type of distributive memory and perception model. The interpretation by Pribram is that the information is encoded in a Fourier transform mode [suggested by myself to be a square-root of an unitary inversion (Oshins, 1984c, ft. nt. 6)] whereby a truncated transformed distribution would display such "graininess" upon retransformation.

5 A more sympathetic advocacy of the Pribram position can be found in Comfort (1984), and Marcer (1988a, 1988b) in addition to my bibliographic references to Pribram's own statements. It is an interesting juxtaposition with the present article that Marcer has claimed: (a) that "... Oshins is right, the brain is almost certainly a universal quantum computer. ..." (open letter of October 23, 1985) and (b) that his own (Marcer's) "... model by holochory, is in agreement with the conclusions of the Stanford neurophysiologist, Dr. Karl Pribram (24) that only a 'holographic' model could satisfactorily account for the experimental evidence. ..." Marcer (1988a, esp. ft.nt. 10).

Although these authors are all directly aware of my own challenges to Pribram's holographic model, none has confronted the challenges nor acknowledged them in their writings so that readers can form their own judgements. The closest effort to refute my challenges seems to have occurred at ANPA 12, which I unfortunately was unable to attend. In his "Report on ANPA 12," Manthey (1991) states "Peter Marcer brought us up to date on his collaboration ... regarding universal 'holographic' theories, which derive from Huygens' principle. Keith Bowden, working from the same principle, showed how ... These two branches of thought seem to be formally compatible and to admit to quantum mechanical interpretation in spite of their origins in continuum mathematics. Hence there is no conflict with Oshins' contribution on 'Why Brown's Laws of Form and Pribram's Hologram Hypothesis are just what is not relevant in a quantum context' [present[ed] by McGoveran and Noyes]"

It had been my impression based upon feed-back from the American wing of ANPA who were present (McGoveran, Noyes, and Young) that Marcer's position had been directly refuted by a number of attendees, and rightfully so. Clearly, calling two disparate physical theories not in conflict by claiming them to both be related to "universal 'holographic' theories, which derive from Huygens' principle" does not make them any less in conflict, as the present paper illustrates. In addition, "continuum mathematics" is not the issue here. The issues devolve around differences between classical holograms and quantum physics, classical lie products vs. quantum lie products, my proposal in the late 1970's for a Dirac-Feynman-Schwinger action principle instead of Pribram's classical holographic Huygens' principle, etc.. My position is that such lumping of fundamentally different subjects is neither sound, as it relies on "primary process" paralogic, nor a service to science.

6 Originally referred to as "genuine stupidity logic" (Oshins and McGoveran, 1980) Historically, my model was <u>not</u> developed as an adaptation of nor application of quantum physics. It began (Oshins, 1989 a,b,c; Hilgard, 1989) by trying to resolve conflict within the psychological literature as to the nature of schizophrenia as a logical phenomena. The method involved resynthesizing various properties of Brown's *Laws of Form* and Zadeh's (1965) "fuzzy logic".

The extension to a quantum theory occurred in the late 1970's and early 1980's, in part, as a competing, physically meaningful, parallel processing, alternative to Pribram's "hologram hypothesis". Additionally, I had hoped to draw attention among physicist to the plight of Yuri Orlov (eg. Oshins, 1983c). Orlov's related approach, called "wave logic" (Orlov, 1975, 1981, 1982; Oshins 1983a), was initially a mathematical attempt to apply group theory to logic. Orlov insisted that "WAVE LOGIC IS NOT A LOGIC OF QUANTUM MECHANICS. Noncommuting operators of the wave logic relate to the same object and have a sense of equivalent propositions expressed in different languages. Noncommuting operators of quantum mechanics relate to different objects" (1975).

About Models and Muddles, Part I

Although his wave logic approach may have not considered relating the operators to different objects, it seemed to me that this was an unnecessarily restrictive requirement. I was interested in the types of non-commuting interactions between observing and observed systems, ie the individual and his or her environment and the boundary forming processes between them (Bohr 1961/29, p. 99; DeWitt, 1971, p. 220; Kubie, 1953; Oshins 1989b, footnotes 7 and 10; Rotter 1966. I adapted some of Orlov's ideas into my own and introduced his ideas into psychology. I introduced the term an "Orlov Direction of Meaning" as the direction reflected by the diagonalizable matrices which I suggested could realize fuzzy logic (Adelson, D. 1984; Oshins & McGoveran, 1980; Oshins, et. al. 1984; Oshins, et. al. 1991, to appear).

When Orlov himself began to apply his ideas to psychology (Orlov 1981, 1982; Oshins 1983a), he still insisted that "Our hypothesis is that the experience of doubt is not of a quantum mechanical nature, and stems from those signals which the logical system sends when it discovers both the impossibility and the necessity of making a decision in a state with insufficient resolving power." (Orlov, 1981, p. 88). Since Orlov had not presented a reason for rejecting a quantum approach to psychology and since I had been able to resolve certain conflicts within the psychological literature while integrating for the first time several disparate areas of psychology — such as spatial frequency data which Pribram had been interested in with Shepard's (1981, Shepard and Metzler, 1971) theory of "mental rotations" — in a formally simple manner, I became more convinced that if I could show a basis for using quantum physics in psychology, I could provide a tool for physicists in fighting for Orlov's freedom from the Soviet prison camp. Since Professor Sidney Drell had urged me to find an empirical basis for my ideas, if I hoped to get the attention of physicists, and since I had already provided a basis to believe in spinor representations in the brain, I turned my attention to possible magnetic effects, ultimately proposing several ideas for experimental inquiries using SQUID (Superconducting Quantum Interference Device) technology (Oshins, 1984a).

7 As I will discuss later, Pribram confuses the concept of superposition of waves with quantum theories.

8 I would like to thank E.R. Hilgard for drawing my attention to the origin of this concept.

9 A prototype of von Domarus' principle is the following paralogical/paleological "syllogism": "I am a virgin. The Virgin Mary was a virgin. Thus, I am the Virgin Mary."(Arieti, 1974; Oshins & McGoveran, 1980)

10 Much in this section is adapted from (Oshins, 1989b; Oshins and McGoveran 1980).

11 That Kauffman & Varela acknowledge the distributive law is that which is relevant to their approach and that Birkhoff and Von Neumann (1936) insist that it is the violation of the distributive law is that which is relevant to a quantum approach seems to render Comfort's proposal that "quantum logic [is a] Non-Boolean non-distributive logic developed originally by Von Neumann and Birkhoff in which a $\leftrightarrow$ $\sim$ a ? 0." (Comfort, 1984, 259) ridiculous.

In addition, since I have already pointed out to Comfort directly that he is confusing the law of the excluded middle with quantum's failure of the distributive law (8/12/88 letter from E. Oshins to A. Comfort, cc. to L. Kauffman), I am at a loss as to why he insists that by paying reverence to Kauffman (Comfort, 1990, p. 5) these facts are any different. At least von Neumann agrees with my position on both of these matters (Birkhoff & Von Neumann, 1936).

Furthermore, Comfort's position that this is related to "Hamlet"'s "doubt state" "To be or not to be?" referred to by Comfort as "both X and ∼X" is further bewildering. The original identification of of Hamlet's "To be or not to be?" with "doubt states" was made by Orlov (1981, 1982; Oshins 1983a,c) . Indeed, the Hamlet state was Orlov's prototype for quantum-like [although to Orlov *not* quantum] doubt. This was originally contrasted with *contradiction* requiring theories such as fuzzy logic and the Brown-Varela-Kauffman extended laws of form by Oshins (1981). A contradiction embracing rendition such as advocated by Comfort would thereby yield "I am and I am not."

12 Marcer (1988a, p. 3) offers a peculiar proposal that the “Lie product [a,b] = ab - ba ... may ... be interpreted ... analogous to the NAND gate of digital control theory, which takes the form of the secondary Huygens’ sources of some physical field. ...” In addition to confusing classical and quantum Huygens’ principles and physical fields with states as will be discussed later in this current paper, Marcer is proposing that the NAND of any proposition with itself equals zero since the commutator of any variable with itself is equal to zero. Here he is confusing the group structure of the algebra of observables with the lattice structure of their logic. Furthermore, the Lie product results in a closed sum of elements in the Lie algebra whereas a NAND can be converted into an OR relationship, the quantum interpretation of which is the SPAN of the subspaces projected upon by the projection operators of the relevant observables. This is generally of a greater dimensionality than the projectors under consideration.

13 As I shall elaborate upon in Part II, Brown-Varela-Kauffman and their followers reject the position axiom and the law of the excluded middle, making complementarity impossible, while insisting that the distributivity axiom still holds. On the other hand, quantum logic models enlarge the complementation axiom and violate the distributivity law.

14 Appendix III uses the Stern-Gerlach experiment to demonstrate that the distributive law fails for quantum logic. Oshins, et.al, (1991, to appear) discusses the original Birkhoff & von Neumann (1936) argument that the distributive law fails due to the complementarity of Even and Odd with Left and Right. I also note thereby that the Brown calculus of indications can not realize the logic of the Stern-Gerlach apparatus since it is distributive and that the Brown-Varela-Kauffman extended calculus of indications can not even further since it forbids complements of atomic states such as Up, Down, Right, Left, etc..

15 Part of this section is taken from Oshins (1989a,b).

16 Formally, from a group theoretic perspective, Planck’s constant enters the formalism through imposing (Galilean or Einsteinian) inertial invariance upon an isotropic and homogeneous system which admits classicalization for expectation values. It appears as an absolute mass scale and as a minimal unit of energy transfer. I have suggested elsewhere that Planck’s constant might act as a “contraction” parameter allowing for the classicalization of psychological experience, as it does for physical experience. (Oshins, 1984c, ft.nt.#9, p. 76-7; 1989a,b ft.nt. #3; Bargmann, 1954; Jauch, 1964, 1968; Mackey, 1968).

17 I point out that “in quantal or in wave form” is not a parallel structure; they are different levels of abstractia. More precisely, quanta have particle-like aspects and have wave-like aspects depending upon the empirical determination under consideration. This does reflect Pribram’s constant confusion between particles and waves, between lumps and quanta, and between wave and quanta. Elsewhere, he expresses his point of view that Fourier transforms take one back and forth (in an invertible manner) between Bohm’s quantum, implicate holomovement which Pribram confuses with a hologram and classical sensory experience. As I shall cite later, Bohm does not share this point of view. Indeed, he is quite clear both that holograms are classical entities and that according to quantum theory, any measurement requires a noninvertible, irreversible act of amplification, decoupling the observer from that which is observed.

18 Ibid. In addition, any modeler should be concerned whether or not their conceptual structures are appropriate. In this case, they are being confused. I note that when I put a “quantum” [sic. “packet” or “lump”] of sugar in my coffee, this has no bearing on “quantum theory” as a physical model. To further clarify this issue, one might say that although quanta “are” particles or waves [sic. “have particle-like or wave-like”] , quanta are not particles and quanta are not waves, ie. in this regard, they obey a nondistributive logic.

19 As I will discuss later, Pribram confuses the concept of superposition of waves with quantum theories.

20 Again Pribram has lost parallel structure and has confused particles with quanta and somehow put this into opposition with holographic.

21 Pribram is noting that the mathematics involved consists of superposition of energy waves of light and that the relevant holographic-related transformations are invertible between the waves and images.

22 Actually Pribram and Carlton temporize their commitment to Gabor's thinking in this regard. They even quote Gabor "'The foregoing references are merely an acknowledgement to the [quantum] theory which has supplied us with an important part of the mathematical methods' (1946: 432). It is not implied that events at the quantum level are necessarily responsible for the process, although this remains a possibility." Yet, at the end of their paper (p. 204) they still conclude: "What has occurred between retina and primary visual cortex is a transformation into Hilbert space, not a filtering operation. The transformation is akin to that which characterizes the quantum domain in physics, and is thus in keeping with the suggestion by Gabor and Licklider in the quotation which introduced this paper."

But, the quote which introduces the paper: "'... The analogy ... [to] the position-momentum and energy-time problems that led Heisenberg in 1927 to state his uncertainty principle ... has led Gabor to suggest that we may find the solution [to the problems of sensory processing] in quantum mechanics' (Licklider 1951: 993)" is neither an accurate quote nor an accurate rendition of Licklider, nor Gabor. The actual quote from Licklider is "... find the solution to the time-frequency problem in quantum mechanics. ..." Clearly, "the time-frequency problem" is not quite the same as "the problems of sensory processing". In addition, although I have searched for such a statement in the reference to Gabor, I can not even find what Licklider is referring to. Furthermore, Pribram and Carlton omit the facts that (1) in the indeterminacy relations being analogized by Licklider, the ones that are pertinent to quantum physics, specifically include Planck's constant; and (2) he continues on pointing out that for the classical indeterminacy relations being described "It should be noted, however, that there is no uncertainty ... The only sense in which there is uncertainty is that a short wave has many frequency components." Clearly, this is a different uncertainty than that of Heisenberg!

23 From Oshins & McGoveran (1980, appendix).

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