The Anticipation of Order in Biosocial Collectives[1]

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[1]I extend my gratitude to Karl Pribram who made helpful suggestions on this essay and has graciously allowed me to draw heavily from our collaborative work (Bradley and Pribram, 1995; 1996).

The Anticipation of Order in Biosocial Collectives[1]

ABSTRACT

Written to honor David Loye's work on precognition and prediction, this essay presents a scientific account of the information processing mechanisms by which a social collective anticipates future order. Loye's concept of the ***hololeap*** (Loye, 1983), a metaphorical leap of information, is found to have a number of similarities to Gabor's (1946) concept of information, the ***logon***, used in the physics of signal processing. An energy-based elementary unit of information, Gabor's concept is combined with the concept of least action to develop a theory of information processing in social collectives. The theory shows how two orders of social relations, flux and control, act on the energy of the collective's members to create quantum-like, elementary units of information. Each unit of information enfolds a description of the collective's endogenous organization. The interpenetration between the two orders operates as a communication system that *in-forms* (gives shape to) the moment-by-moment expenditure of energy and results in a stable, effective collective. Because each unit of information overlaps with the unit that succeeds it, each unit enfolds data about the [potential] future order of the collective. In this way, the communicative system anticipates the next moment of the collective's order.

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[1]**Karl Pribram** extends his best wishes to David on the occasion of this publication. He fully supports the statements (wild though they may seem to some) that constitute this essay and shares full responsibility for them. However, the material is fundamentally Ray Bradley's; he has done an overwhelming proportion of the work involved.

1. INTRODUCTION

A psychologist and a futurist, David Loye has long been fascinated by the puzzle of ***precognition***, by the question of how the mind can *foresee* objects and events so remote in space or time that the information-communication processes involved appear to operate outside the causal strictures of space and time (Loye, 1978; 1980a; 1980b; 1983; 1995). Ontologically and epistemologically this has been a perplexing problem for science. For despite what some regard as compelling evidence of the phenomenon with rigorous scientific methods (e.g., Hunt, 1995; Jahn and Dunne, 1989; Puthoff and Targ, 1974; Schmidt, 1974), there is still widespread doubt among most scientists about the very existence of the phenomenon itself (e.g., the scepticism of Hansel, 1980, and Marks and Kamman, 1980). Moreover, even among those who accept precognition as a fact, there is still no satisfactory explanation--aside from that of [pre-]determinism (e.g., Bohm's holomovement of implicate and explicate orders (Bohm, 1980))--that provides an understanding of the information transmission and processing mechanisms by which precognition occurs.

Loye's solution to the puzzle of precognition is presented in his highly acclaimed book, *The Sphinx and the Rainbow* (Loye, 1983), in which he introduces the idea of the ***hololeap***, a mechanism by which precognition occurs as a "leap" of information across the space between organisms. In praising the book as "superb," the pre-eminent neuropsychologist, Karl Pribram, notes that the "idea of a hololeap is well defined and excellent" (Loye, 1983: i).

Loye's notion of the hololeap has a number of similarities to a scientific concept, the ***logon***, used in the physics of signal processing (Kaiser, 1994). Developed by Nobel Laureate Denis Gabor (1946), the logon is an elementary unit of information. A remarkable feature of

Gabor's concept is that because there is an overlap between logons, each logon, each unit of information, contains what Gabor describes as an "overlap with the future" (Gabor, 1946: 437). Loye's hololeap (of information) across organisms is shown to be analogous to Gabor's overlap (in information) between logons.

Beyond this parallelism, I want to show how Gabor's concept, when combined with the concepts of *energy* and *least action*, can be used to develop a scientific account for a *limited* aspect of precognition: to explain the information processing mechanisms by which a collective ***anticipates*** (knows beforehand), moment-by-moment, its future order. To do this, I draw on recent research that Karl Pribram and I have conducted on social collectives (Bradley and Pribram, 1995; 1996). But first, we begin with a review of the hololeap and a discussion of how Loye uses it to provide a metaphorical understanding of precognition.

2. LOYE'S CONCEPT OF THE HOLOLEAP[2]

Loye was motivated by a desire to find an alternative explanation, to that offered by determinism, for the phenomena of precognition (intuition, premonition, remote viewing, foreseeing (prophecy and prediction) and telepathy). To Loye, the view is unacceptable that "we must all be fixed forever in one giant restless hologram" (p.204)--that everything in the universe, as Leibnitz suggested in his *Monadology*, is in predetermined harmony. If one substitutes lens-less for Leibnitz's window-less structures, his monads become holograms--or, more precisely, space-time constrained holograms. Mathematically, these structures are essentially Gabor functions, units which Gabor called *quanta* of information. In quantum

[2]Unless otherwise indicated, the citations in parentheses in this section are to Loye, 1983.

holography "precognition would operate by our becoming aware of what was, is, and will be fixed throughout all eternity" (p. 201). To Loye such determinism is philosophically unacceptable because it runs "completely counter to the thrust [and thought] of the West" (p. 201; my addition); it is morally unacceptable because

> To accept such a view not only pressures us to accept all the obvious imperfections of this world, but to become the blinded or cynical victims of fate--to be able to turn our backs on our fellow beings because ... there is so little that one can do. It can become an excuse for the kinds of social passivity and acceptance of the wrong kinds of higher authority that century after century have accounted for the miserable state of so much of humanity ... . (p. 202)

An alternative view of precognition came to Loye on a seaside walk along the beach and tide pools of Carmel, California:

> There came to me an arresting alternative vision. I saw something that looked like amoebas in pond water. ... They were not ... one interconnected mass, but rather restless, shifting, separate globs with an "eye" ... . And as they moved, alive and jostling one another, they were engulfing smaller bits of substance and also, now and then, one another. ... Could it be ... that this is the pattern of the universe? That we are individually and socially bound within large hologramlike (*sic*) entities that might to a celestial eye look like, as well as act somewhat like, the self-containment of the amoeba? ... Could it be that ... our life can also be visualized as a "horizontal" placement and movement of these

> holographic entities that, rather than existing in a [*predetermined*] hierarchy, operate side by side? So that rather than there being only one giant hologram (or holomovement) in which we are all encased like so many witless toys in motion, what exists is more like the movement of these noumenal amoebas in a celestial pond? (Pp. 202-205; italicized additions in parentheses, mine.)

Loye develops this idea to describe his metaphorical mechanism--the hololeap--by which precognition occurs as the transmission--a "leap"-- of information across the space between organisms.

The concept of the hololeap has four elements. The basic units are bounded, separate, single-celled, self-contained organisms with the capacity for sensing information (like "amoebas," holographic-like "globs" with an "eye"). These units are equivalent (in "horizontal placement" and "operate side by side") and are in a state of constant agitation or movement (are "restless" and "shifting"). This movement results in interaction with the environment (the "celestial pond"), interaction between the units ("jostling") and, occasionally, interpenetration of one unit by another ("engulfing" and "swallowing"). The interaction/interpenetration between the units is the mechanism for information transmission (precognition) (pp. 204-205).

Information transmission can occur in two ways. The first is "*inter*holographically," by the hologram-like units sensing and processing information about the holographic environment in which they are embedded (the "reading of patterns" and "summoning of details" from within the larger "holographic entity" which "encases" the organisms). The second way is "*intra*holographically," either by the interaction between the units in which information is

transmitted across the gap between them, or by the interpenetration of units as a probing ("ranging throughout" and "reading") of each other in which wholistic information about the contents of one unit is enfolded (and thus transmitted) to another (pp. 205-206).

The constant movement of the individual units is the means by which change, novelty and intentionality, enter the system. The restless jostling and shifting produces interaction and interpenetration which, as a hololeap--the "bridging" and "ranging" of information throughout the "junctures" and "chinks" in the system--creates the avenue for free will and intentionality (pp. 205-206). Thus, as Loye sees it, the hololeap provides "opportunity both for the seer to perceive and for the activist to influence the shaping of futures that are *not* predetermined" (p. 206; his emphasis).

3. INFORMATION PROCESSING IN SOCIAL COLLECTIVES

Loye's hololeap is an evocative idea that suggests the kind of information transmission mechanism required for a non-determinist explanation for the phenomenon of precognition. In this section, the main body of this essay, we endeavor to move beyond metaphor by using concepts and explanatory principles from the natural sciences. Our purpose is to demonstrate how Gabor's concept of information can be combined with the concepts of energy and least action to build a scientific account for an aspect of precognition that we will refer to here as ***anticipation.*** By anticipation we mean *a process by which a collective gathers and processes information about operations and events that are spatially and temporally proximate.* To build this account, we draw heavily from Bradley and Pribrams' theory of information processing in social collectives (Bradley and Pribram, 1995; 1996).

By way of overview, the theory shows how two orders of social relations, ***flux*** and ***control*** (defined below), act on the energy of the collective's members to create quantum-like, elementary units of information. Each unit of information enfolds a holographic-like description of the collective's endogenous organization. The interpenetration between the two orders operates as a communication system that *in*-forms (gives shape to) the moment-by-moment expenditure of energy and results in stable, effective collective action. Because there is an overlap between units of information, one of the novel expectations of the theory is the proposition that *information about the future order of the collective is enfolded into the units of information process-communicated in the present.* However, the degree of overlap is determined by the contextual properties of the communication system which require constant adjustment for effective communication. This is effected by the action of the normative order (culture) which breaks the determinacy of such quantum holographic-like information processing.

3.1 Preliminaries

Previous investigations of the 46 social collectives that I studied (Bradley, 1987; Bradley and Roberts, 1989a, 1989b; Carlton-Ford, 1993; Zablocki, 1980) have shown that two patterns of social relations form the communicative structure in stable systems (see Figure 1).[3] One pattern is a dense web of reciprocated affective relations interconnecting virtually all members. This web is organized as a ***field***, a distributed, massively parallel order of symmetrical ties in

[3]The sociograms in Figure 1 were constructed from sociometric enumeration of all possible pair-wise relations (dyads) in which each adult member was asked a set of standardized questions about his/her relationship with each other member. See Bradley, 1987, or Bradley and Roberts, 1989b, for further details.

which individuals are essentially interchangeable. The second pattern is a densely interlocking order of power relations which also extends to connect virtually all individuals. This is organized as a ***hierarchy***, a highly stratified system of asymmetrical, transitively-ordered relations which defines, for each individual, a position that is spatially and temporally localized and, therefore, is unique. In following up on these earlier findings, Pribram and I sought to understand how the interaction between field and hierarchy operates as an information processing system that generates and distributes information about the collective's internal organization.

Figure 1 about here

First, our terms and assumptions. We define *communication* as a process by which information about the collective's internal organization is gathered, processed, and distributed throughout the collective as a whole.[4] A *social collective* is viewed as a durable arrangement of individuals distinguished by shared membership (a boundary) and interaction in relation to a common purpose or goal. We use the term *stability* to mean the degree to which structural integrity and functional viability are sustained by collective organization over time.

We make two simplifying assumptions. First, our account does not consider any effects that the characteristics (gender, age, personality etc.) of the collective's members, as individuals, may have on the collective. Second, we restrict the theory's scope to communication involving events that are proximate in social space by limiting it to endogenous

[4]This conception is similar to the notion of communication that underlies the "connectionist" computational models of "brain-style processing" (see, for example, Rumelhart, 1992).

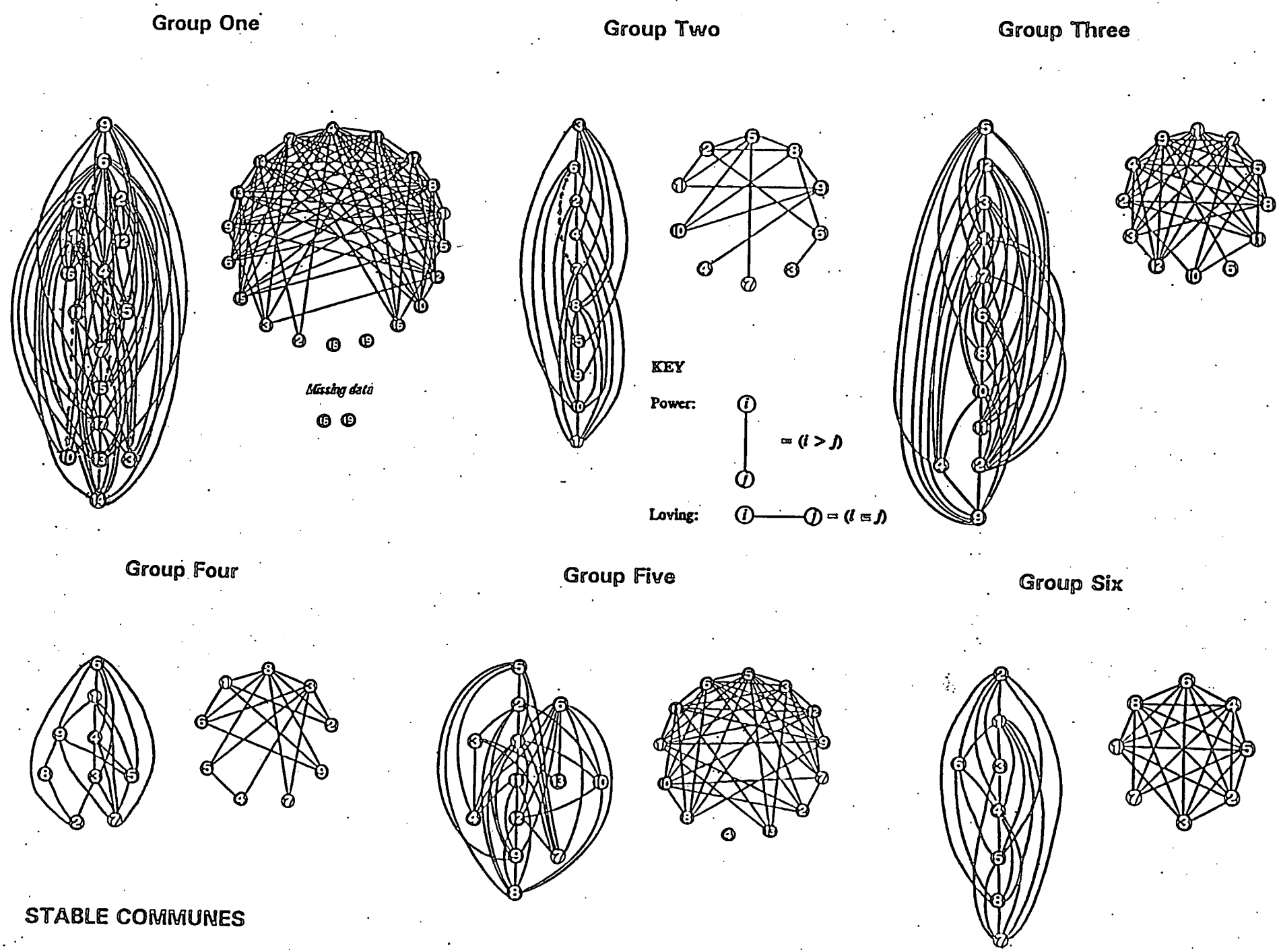
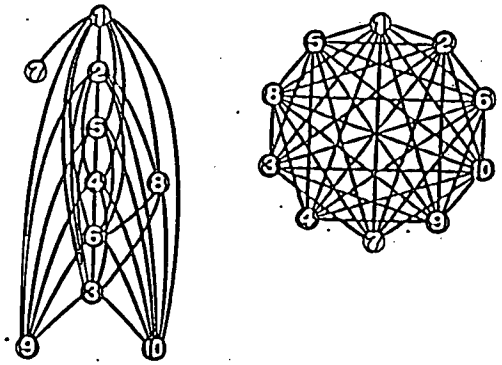


Figure 1. Sociometric Structure of "Power" (Hierarchy) and "Loving" (~~Heterarchy~~ Field) Relations--Selected Stable Communes (continued ...)

Group Seven



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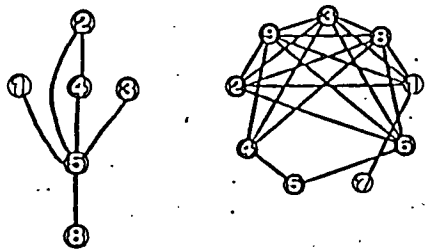

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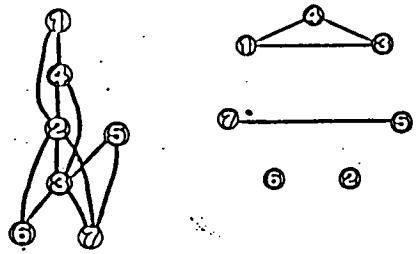
Group Nine



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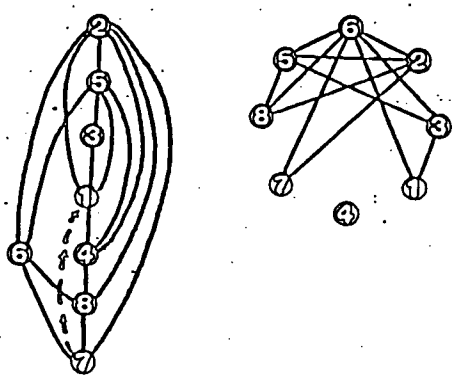
Group Ten



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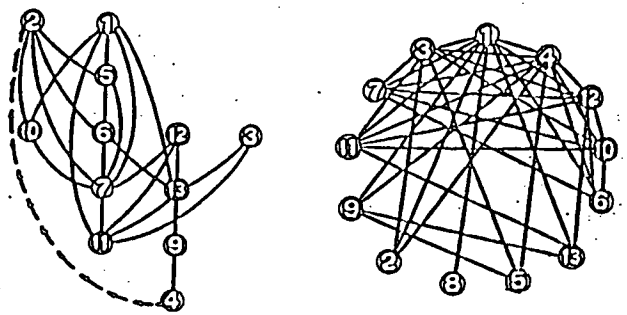

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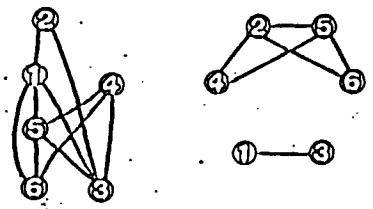
Group Twelve



KEY

Power: $i \rightarrow j = (i > j)$

Loving: $i \leftrightarrow j = (i \equiv j)$

UNSTABLE COMMUNES

Figure 1 (continued). Sociometric Structure of "Power" (Hierarchy) and "Loving" (Heterarchy) Relations—Selected Unstable Communes

operations within bounded collectives.[5]

For our purposes here, we also introduce a third assumption, a temporal restriction, that is implied in the theory. This is to limit the theory's scope to endogenous operations and events that are proximate in the future as well. Thus, as mentioned at the outset, we leave aside the more difficult question of communication involving events that are remote to the collective in [social] space or are remote in [future] time.

In what follows, we start with the concepts of energy and least action and then bring in the concepts of information and communication.

3.2. Energy and Least Action

Ontologically, a rigorous concept of energy, or its equivalent, is fundamental to an understanding of collective organization. This is a point that Loye rightly emphasizes in his "Tenets of the New Psychophysics" (Loye, 1983: 237-249). Energy is a measure of the means--the fuel--for maintaining order in the face of challenge (novelty) or changing an order in the face of inertia. As individual biological organisms, a collective's members possess the potential for work, measured as energy. To exist as an entity, a social collective *must* mobilize and appropriate the members' potential for work, their biological capacity for physical behavior and activity, and direct it toward collective ends. "Energy," so defined, also is the medium for information processing, the medium for encoding and relaying communications as signals back and forth among the elements of a system.

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[5]This means that we exclude information transmission in partially bounded or open social systems like cliques or social networks.

In the physical and biological sciences, ***energy*** is a measure of an amount of [physical] work that can be accomplished (McFarland, 1971). Two types of energy can be distinguished, kinetic and potential. When work is actually being done in maintaining order or in producing change, it is defined as *kinetic energy*; the measure is directly proportional to the amount of kinesis, that is, to the amount of physical activity required to maintain order or to produce change. *Potential energy* is inferred from an estimate of the amount of possible work that a situation provides. It is an inference based on similarity to conditions which, previously, have been observed to transform potential energy into actual work.

In most physical and biological systems, there is a tendency to minimize work in order to conserve energy. This is known as the ***least action principle***, or the system's Hamiltonian function. In its general formulation, the principle holds that a system is at equilibrium under conditions which maintain potential energy at a minimum (Considine, 1976: 1,454). This means that any departure from equilibrium--any disequiliberating change in the system's structure--creates potential energy. In order to return to equilibrium, the system must expend the potential energy by performing work to use it up. Such changes in levels of potential energy have been studied in the natural sciences and have resulted in dynamic systems models--so-called "chaos theory" (Morrison, 1991; Nicolis and Prigogine, 1997; Strogatz, 1994). These models have enjoyed wide success in accounting for the behavior of complex (far-from-physical-equilibrium) systems in the natural sciences (Prigogine and Stengers, 1984) and have sparked a growing interest in the social sciences (e.g., Abraham and Gilgen, 1995; Arthur, 1989; Dendrinos and Sonis, 1990).

In applying these concepts, we assume that the members of the social collective are biologically capable of work, and that this capability is measurable as potential energy. When activated by the collective, the members' potential energy becomes engaged in social interaction. To realize collective action, entails work; work is measured as kinetic energy. The tendency to energy conservation leads the collective to strive towards an efficient use of energy. This requires effort to explore alternative ***paths*** towards order, patterns of actualization that allow collective work to proceed efficiently, that is, with the least amount of dissipation.

3.3. Flux and Control

Within this framework, Pribram and I identify two processes which act to generate descriptions of the collective's internal organization. The first is ***flux***, the constant transformation of energy throughout the collective. It occurs in the distributed, massively parallel field of *equi-valent* relations as a dense web of symmetrical affective ties interconnecting all individuals to everyone else (see Figure 1); this concept is analogous to Hunt's (1995) idea of a "vibrating" field of emotions that interconnects individuals. The field operates to activate and unify affective attachments among individuals, thereby mobilizing their potential energy. The energy transforms continuously *throughout* the field as the collective adjusts and readjusts continuously to internal and external changes.

In the absence of other factors, initial conditions such as negative feelings like fear, hatred, or jealousy, will block the efficient conversion of potential energy to kinetic energy; in non-linear dynamics such systems are characterized by negative Liapunov exponents leading to

stasis, ossification (complete [physical] equilibrium), or to regular fluctuations described by relaxation oscillators (Abraham, 1991). On the other hand, as elaborated below, initial conditions such as admiration, awe, or love create a kind of harmonic resonance (due to a positive Liapunov exponent) in the relations among members, which will enhance the conversion of potential to kinetic energy--a phenomenon Zablocki (1971 and 1980) observed in his studies of communes and called the "cathexis effect." The danger here, if this enhanced kinetic energy is unconstrained, is that undue dissipation of energy will ensue: in the language of non-linear dynamics, chaos will result (for examples, see Zablocki, 1980, Figure 4-5: 165).

The second process is ***control***, the construction of a landscape of social constraints which efficiently directs the transformation of energy into collective action. This operation is achieved by the hierarchical order which is a densely interlocking stratified system of asymmetrical relations connecting all individuals (Figure 1). By differentially constraining the paths by which individuals expend their energy, both with respect to specific locations in space and with respect to particular moments in time, the controls render an *in*-formed pattern of collective organization.[6]

3.4. Information and Communication

Whereas Loye's hololeap is a novel descriptive metaphor rich in evocative imagery and nuance of meaning, Gabor's logon is a rigorous scientific concept with formal mathematical properties. To appreciate the relationship between the hololeap and Gabor's concept it is first

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[6]This conception is similar to Bohm and Hileys' notion of "active information" (see Bohm and Hiley, 1993: 35-42, 59-71).

necessary to contrast the logon with the more commonly used measure of information developed by Claude Shannon (1949).[7]

Shannon's measure is that of information as *a reduction of uncertainty through choice among alternatives*. His smallest unit of information is the **BIT**, the **BI**nary digi**T**--nowadays corresponding to the smallest standard unit of information in computational information systems. In such systems each unit of information in a sequence contributes to resolution of the signal's message by reducing the probability of alternative meanings.

Virtually unknown in the social and psychological sciences, Gabor's (1946) concept of information is radically different than, though related to, Shannon's. This is the concept of the *minimum* uncertainty with which a signal can be encoded as a *pattern of energy oscillations across a waveband of frequencies,* as in the encoding and transmission of vocal utterances for telephonic communication.

In his classic "Theory of Communication," Gabor (1946) shows that there is a restriction to the efficiency with which a set of telephone signals can be processed and communicated. The restriction is due to the limit on the precision to which concurrent measurements of spectral components (frequency, amplitude, and phase) and the (space)time epoch of the signal can be made. (This restriction is illustrated in Figure 2a in which time and frequency are treated as orthogonal coordinates.) So that although accurate measurement of the signal can be made in time **or** in frequency, *it **cannot** be simultaneously made in both beyond a certain limit* (Gabor, 1946: 431-432).

Figures 2a - 2c about here

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[7]See Cherry (1966) for an excellent review of these ideas.

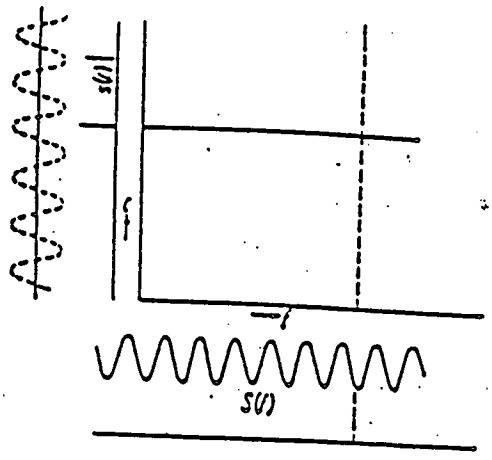

Fig. 2a. Limits of Concurrent Measurement of Time (t) and Frequency (f) of a Signal

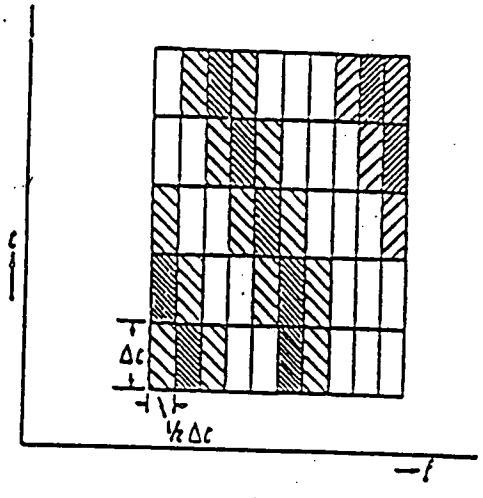

Fig. 2b. Representation of a Signal by Logons

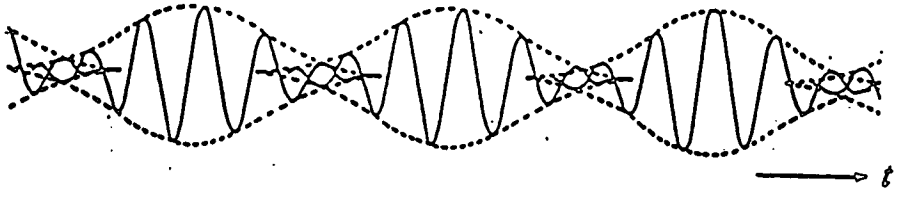

Fig. 2c. Representation of the Overlap of Logons

Figure 2. Representations of Limits of Measurement, Elementary Units of Information (Logons), and the Overlap of Logons
Adapted (From Gabor. 1946: Fig. 1.3 and Fig. 1.7)

Gabor was able to show, mathematically, that this limit could be given formal expression by Heisenberg's uncertainty principle.[8] In its rigorous form the uncertainty relation is given as

$$Dt\ Df \geq \tfrac{1}{2}$$

(where D = *delta*), which states that *t* (time) and *f* (frequency) cannot be simultaneously defined in exact terms, but only with a latitude of greater than or equal to one-half in the product of the uncertainties. Since certainty can be obtained only by minimizing uncertainty on both coordinates, the *minimum measurement* of the signal in time **and** frequency is

$$Dt\ Df = \tfrac{1}{2},$$

which defines an ***elementary unit of information*** (Gabor, 1946: 431-437).

This unit of information both minimizes uncertainty and provides the maximally efficient compression of communication: the minimum space or time of transmission occupied by the signal which still maintains the fidelity of [telephonic] communication. Gabor called his unit of optimal efficiency a ***logon***, or a *quantum of information* (illustrated in Figure 2b), and showed that the signal that occupies this minimum area "is the modulation product of a harmonic oscillation of any frequency with a pulse in the form of a probability function" (Gabor, 1946: 435). This fundamental unit of information is a sinusoid variably constrained by space-time coordinates; it differs from Shannon's unit of information, the binary digit, which is the Boolean choice between alternatives (Pribram, 1991: 28).

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[8]Heisenberg had developed his mathematical formulation of uncertainty to define the discrete units of energy, *quanta*, emitted by subatomic radiation.

Musical notation is an example of a logon-like system of communication that operates to inform the action of a musical [social] collective such as an orchestra, a band, or a choir. An individual "note" can be viewed as an analogue of a logon. It is composed of data "plotted" in a (written) musical score on the same two orthogonally-related dimensions as a logon: one dimension is *frequency*, varying oscillations of sound waves (energy vibrations) produced by the operation of a musical instrument; the second dimension is *time*, how long the note is to be played--its duration. The pattern of energy expenditure by which the music is actualized is prescribed on a musical score as a moment-by-moment sequence of operations on the musical instrument, for each musician, specified **both** in frequency and in time. Moreover, the score for all musicians contains a *spatial* component as well: it also specifies which subset of musicians, in relation to the whole orchestra, is to play at each moment. Thus a composer's written musical score represents a description of how the potential energy of a collective of musicians is translated into expenditures of energy, differentiated for each individual on the dimensions of frequency and time-space, to actualize a given composition as "music."

With regard to Loye's hololeap, of particular relevance here, is an important implication of Gabor's mathematically defined elementary units of information for the role of causality in communication. As noted, logons are not discrete units but occur as probabilistically constrained sinusoids, a series of overlapping units in which the "heads" and "tails" of adjacent units interpenetrate one another (illustrated in Figure 2c). Thus the overlap among logons produces an order in which the data in each logon are enfolded, probabilistically, into the data contained in adjacent logons. In Gabor's words this means,

therefore, that *each logon contains an* ***"overlap (with) the future"*** (Gabor, 1946: 437; emphasis added).[9] This overlap between logons is analogous to the "probing" and "engulfing" interaction among organisms in Loye's hololeap.

What is of special interest is the degree to which the enfoldment among logons yields a communicative system in which the data in succeeding logons are contained, in a nontrivial way, in the logons that preceded them: in other words, the extent to which information about the "future" (potential) order is probabilistically enfolded into the elementary units of information being processed in the "present."

However, the overlap among logons is not the only feature of communication that enhances indeterminacy. The degree of overlap itself is a function of the contextual properties of the communicative system which affect the frequency and time(space) components of the signal (Xie, 1995). In complex dynamical systems, like biological and social collectives, the establishment and maintenance of an optimal overlap among logons for efficient information processing entails constant adjustments to the communicative structure to regulate the energy frequency and space-time aspects of signal processing. This is a primary function of the cultural order in [human] social systems (Bateson, 1979). In addition to defining social objectives and proscribing the means for achieving them, the normative order sets and regulates the social parameters that affect the energetic and space-time aspects of communication.

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[9]This overlap is a result of using a probabilistic measure of time as one of the (measurement) dimensions. "The principle of causality requires that any quantity at an epoch *t* can depend *only* on data belonging to epochs earlier than *t*. .... In fact, *strict causality exists only in the 'time language'*" (Gabor, 1946: 437). Thus, in the non-constrained spectral domain, since time is totally enfolded, causality (in the sense of Aristotle's efficient causation) becomes meaningless.

Our example of musical collectives suggests that there are limits to normative regulation of this kind of information processing. At one extreme is the written musical score--the composer's moment-by-moment prescription for each action by every musician on the two dimensions of frequency and time-space--a formalized embodiment of the ultimate level of normative regulation. Sociologically, this is equivalent to *formal* [social] organization. At the other extreme, it is clear that certain minimum normative specifications on the two dimensions are also necessary for communication within more *informal* social collectives, such as jazz groups. At minimum, the jazz group must specify--normatively define--the "key" (the progression of harmonic frequencies to be used) and specify the "time signature" (the number of beats per measure of time) in order to improvise effectively in their construction of "music."

The Gabor elementary function, as it is often referred to, which has been found to characterize perceptual processing in the cerebral cortex (see Pribram, 1991, Lectures 1-5, for a review of the evidence)[10] is, therefore, the unit for biological information processing which allows for indeterminacy. Moreover, two previous findings from my study of urban communes (Bradley, 1987), document an order of social communication that does not seem describable within the terms of Shannon's concept but appears more readily understood within Gabor's terms. The first finding is of a non-localized order in which information about the collective's global organization appears to be enfolded and distributed to all individuals; the

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[10]For example, in a series of recent studies on the barrel cortex of the rat (involving the stimulation of the rat's whiskers in terms of the spectral and spatial components of neural response activity), Pribram and his collaborators (King et al., 1994; Santa Maria et al., 1995) have shown that the response activity of receptive fields could be described in terms of spectral and spatial manifolds, and that each of these manifolds could be derived from Gabor-like functions.

second is that this holographic-like order was found to be constrained by a system of hierarchical relations (see Bradley, 1987, Chapters 8 and 9, respectively).

3.5. Communication and Order

We should now be in position to apply Gabor's concept of information and show how the interaction between flux (frequency) and control (hierarchy) operates as a communication system within the social collective. The symmetric bonds of the distribution of flux indicate that individuals are essentially interchangeable so that there is a more or less equivalent patterning of flux throughout this endogenous field. As this field is an energy field, it lies within the spectral domain[11] and is related to space and time by way of a transformation (the Fourier transform). By contrast, because individuals are asymmetrically connected in the hierarchical order, the system of controls operates differentially on the collective's members, both with respect to their energy expenditure in a particular location in space as well as with respect to the actualization of their energy in particular moments of time.

Drawing on Gabor's concept of information, it is expected, therefore, that the operation of hierarchical controls on the distribution of flux generates a moment-by-moment--*quantized*--description of the collective in terms of both structure (spatial-temporal position) and flux (distribution of energy). By providing a succession of descriptions within space-time and spectral coordinates, elementary (logon-like) units of information are constructed and communicated, via a holographic-like process, throughout the social collective. Because each quantum of information overlaps with the unit that succeeds it, each unit contains information

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[11]Recall that in physics, energy is measured in terms of frequency times Planck's constant.

about the future potential order of the collective. In this way, the communicative system anticipates the next moment of the collective's order.

However, whenever there is an imbalance between the amount of distribution of flux and the amount of control, quantization breaks down, resulting in a loss of information transmission. The reduction in information transmission impairs the operation of the collective which, in turn, increases the likelihood of instability. Thus, because an optimal relationship between flux and control is *not* given--not a *pre-determined* aspect of information processing, but one affected by the contextual properties of the communication system--constant adjustment of the system is required for efficient and, therefore, effective communication. This is effected by the cultural order in [human] social collectives.[12]

In a test of the theory using endogenous sociometric measures of flux (networks of positive affect) and control (networks of power relations) from data collected in a longitudinal study of 60 urban communes (see Bradley, 1987, and Zablocki, 1980), Pribram and I found a strong pattern of results consistent with the theory (see Bradley and Pribram, 1995 and 1996, for further details). Of particular interest here, is our finding that flux and control are predictive of stability: that the relationship between flux and control at a given point in time

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[12]The influence the cultural order has in setting the contextual parameters for an optimal communicative structure can be illustrated from the research on neurobiological development in infants which shows what happens when the normative order does not operate effectively. In an impressive review of the multi-disciplinary research involved, Schore (1994) shows how the affective context of the relationship between an infant and the primary caregiver has important consequences for neurobiological development and subsequent psycho-social function. At a societal level, the affective context for the interaction between infant and parent is normatively proscribed to be positive, i.e., one of love and nurturing devotion. However, in situations where this has broken down and is replaced by a prolonged exposure to heightened negative affect, the growth and organization of the infant's developing neocortex suffers enduring pathological consequences. Intense emotionally stressful experiences are biochemically imprinted into the cortical circuits of the brain's frontolimbic system. This results in structurally defective neurobiological organization which, in turn, produces insecurity in social attachments. These functional impairments of the cortical circuitries result in a persisting susceptibility to further patterns of pathophysiological growth which are associated with later forming psychiatric disorders.

was found to predict survival status twenty-four months in the future. This is shown in the scatterplot of communes in Figure 3, with control on the vertical ordinate and flux on the horizontal ordinate; unstable groups are shown as hollow dots. It is clearly evident that the communes tend to cluster in the mid-region of the field formed by flux and control, the area theoretically expected to be associated with efficient information processing; this is a result that also is consistent with the region of efficient pattern matching in thermo-dynamically inspired connectionist models of neural networks (e.g., Hopfield, 1982, and Hinton and Sejnowski, 1986). Moreover, it can be seen that location in the mid-region[13] is associated with a high probability of survival in the future.[14]

Figure 3 about here

This finding, however, should *not* be taken to mean that the data generated by flux and control, at a given moment, necessarily enfold long-term information about collective order many months in the future. Rather, it is more likely that the efficiency of information processing in the mid region acts as an attractor. To the degree that groups maintain a position at this location, they avail themselves to a constant succession of logon-like units of information which enfold moment-by-moment anticipations of the immediate future order.

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[13]The apparent anomaly of the three survivors located in the high flux-high control quadrant are communes with charismatic leaders in residence. While there is not space to explain it here, their stability is consistent with the expectations of the theory (for a full account, see Bradley and Pribram, 1996).

[14]The lines marking the lower and upper boundaries to the mid-region in Figure 3 were established by dividing the full sample of communes into stable and unstable sets such that the probability of survival was maximized for the former while being minimized for the latter. Discriminant analysis, comparing the grouping of communes within the lines (those in the mid-region) to the two groupings outside (i.e., those above and those below the two partitions), provided a statistical confirmation of these results (see Bradley and Pribram, 1996).

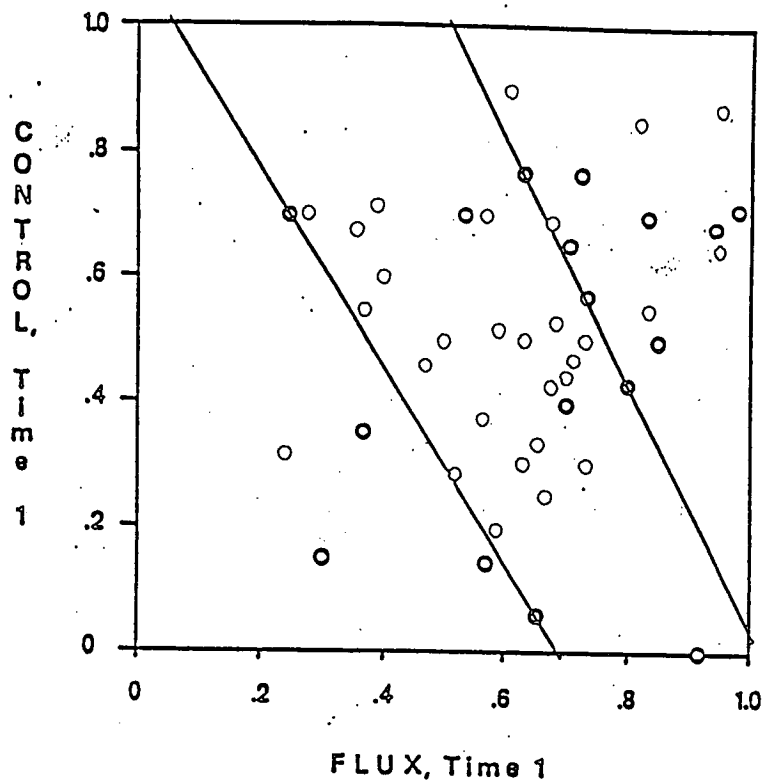

Figure 3. Scatterplot of Communes on Flux and Control at Time 1 by Stability (Survival Status) at Time 3 ~~and Showing Transformational Communes (Charismatic Leader in Residence)~~ (24 months later)

4. CONCLUSION

Our efforts here have aimed at furthering one aspect of a lifetime of remarkable work that David Loye has contributed in his desire to foster a social future that is based on human equality and partnership and also is in harmony with the natural world. To Loye, therefore, the solution to present social and ecological disorder lies not only in a heightened "moral sensitivity" and stewardship for the human worlds we construct, but also in an increased understanding of how we can foresee, to a limited extent at least, their implications and estimate, as well, the potentials for alternative futures. Hence his interest in the twin phenomena of precognition and prediction (Loye, 1978; 1983; 1995).

Loye developed the concept of the hololeap as a non-determinist solution to the enigma of precognition. The hololeap is a metaphorical description of a process required for an organism to have some limited prior knowledge of objects and events remote in space and time.

In this contribution, we (that is, Pribram and I) have endeavored to make the problem scientifically tractible by narrowing the focus to information about events that are spatially and temporally proximate to an organism. By restricting our focus to bounded social collectives, and by combining Gabor's energy-based concept of information with the concept of least action, we have developed a theory that shows how a social collective gathers and processes information about its potential future order.

Our theory of information processing concerns the internal structure of the collective. This internal structure is conceived to be based on the biological potential of the individuals composing the collective to engage in physical work, measured as energy. When activated by

the collective, this energy is made available for social interaction as a field of potential energy. We have labeled this dimension of the endogenous order, flux.

In the other dimension, individuals are connected hierarchically. We have labeled this dimension control because it appears to direct and regulate the activation of the collective's energy. Controls over the activation and distribution of flux result in social communication by way of quantum-like units of information (logons)--moment-by-moment descriptions in terms of space-time constraints on spectral (energetic) processes--of the collective's endogenous organization. Since these elementary units of information overlap as a series, the collective's order at a given moment is informed by the order probabilistically implicit (as "expectations") in the units of succeeding moments. In this way, the communicative structure formed by the conjugate orders of flux and control anticipates, to a limited extent, the future order of the collective. Because optimal operation of the communicative structure is *not* pre-determined, constant regulation by the normative order is required to maintain efficient information processing and, therefore, minimum uncertainty in communication.

A final word. Although our concern has been confined to human social collectives, it is likely that similar information processing mechanisms are involved in the moment-by-moment hololeaps--anticipations of order--in rapidly moving animal collectives such as shoals of fish and flocks of birds. It is evident that Loye has tapped into one of the fundamental processes of communication in nature.

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