Analogy and Mysticism and the Structure of Culture[1]

by Sheldon Klein

THE CULTURES OF CHINA, AFRICA, TIBET, Japan, and the Navaho provide evidence in support of a model for human cognitive processing which assumes that a major component of the rules for calculating human behavior resides outside the individual, in the inherited, collective phenomena that anthropologists call "culture" (Klein et al. 1981). The model contains rules of behavior encoded as analogical operators that relate situational state descriptions. I have named this kind of operator an Appositional Transformation Operator, or ATO (Klein 1977), and the term refers to the theory, derived from split-brain research, that the division of labor between propositional and appositional models of reasoning is culturally determined (TenHouten and Kaplan 1973, Paredes and Hepburn 1976). My particular interest is in accounting for the the way humans understand language and calculate behavior. That the answers may relate to the results of split-brain re-

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search is likely, but the evidence presented here is independent of any such connection.

If the human brain is a kind of finite-state automaton (that is, a kind of computer) in that it must make its calculations in a finite amount of time, using a finite number of steps to manipulate a finite amount of information in a finite space, then explaining how human beings generate and interpret behavior without using an unreasonable amount of processing time is a major problem. If one posits that the rules of behavior are encoded primarily in a notation equivalent to structures in propositional logic, one is faced with the unpleasant fact that computational processing time could increase combinatorially with the size of the data base. Computations with a data base of sufficient size to account for the rules of a culture would take too long to permit human interaction to proceed at a normal pace (Klein et al. 1980). It follows that the rules of behavior must be encoded in some other way.

The ATOs I have described (Klein 1977) are derived from the two-valued strong-equivalence operator of mathematical logic and from a three-valued variant. They can be used to calculate behavior by analogy, and in a way that evades many of the combinatorial problems associated with computation using propositional forms of rules. ATOs that link serial sequences of behavioral situations may themselves be interpreted as situation descriptions and related to each other by higher-order ATOs, which, in turn, may be treated similarly. Computation with such higher-order systems of ATOs makes it possible to handle goal-related planning in particularly efficient ways.

The interpretation of ATOs as situation descriptions often yields a kind of surrealistic imagery. It has been argued elsewhere (Klein et al. 1981) that many of the ATOs of a given society are encoded in the material and symbolic artifacts of its culture and, furthermore, that "culture" serves as a repository for the ATOs that make computation of behavior a feasible task for human automata. That paper supplies a formal specification of ATO structure and a series of examples of their use in calculating solutions to verbal and visual analogy problems. It then demonstrates that, if a visual analogy problem is given a verbal model interpretation, the analogies calculated through the use of ATOs are valid in both domains. These examples are followed by examples of complex analogies among complex behavioral situations, for example, a love triangle motivated by love, marriage, desire for money, and the willingness to sacrifice any one for the others. The ATOs calculated for these situational descriptions are also given situational verbal and visual interpretations, and the derived

"surrealistic" image appears as an icon representing the concept of bigamy, an element not to be found in the original situation examples.

For this model of collective human cognitive processing to be considered valid, it is essential that illustrative examples be found in real societies in many parts of the world and at different times in human history. It is the purpose of this paper to demonstrate the existence of such a system in Chinese culture, in the form of the *I Ching*, a system that encodes the philosophy of Taoism and Confucianism and has played a significant role in the lives of individuals and governments for millennia. I also note the existence of such an ATO divination system throughout much of Africa and the apparent encoding of ATO structures in the iconic imagery of Buddhism and in that of Navaho sand painting.

Before undertaking an analysis of the *I Ching* as an ATO calculation system, I shall describe ATOs and illustrate their use to calculate behavior by analogy, drawing upon the earlier paper just mentioned.

user to project the elements of a specific problem onto an abstract verbal image or text and to use that image/text as a model or metaphor for the problem. The *I Ching*, however, is part of a system that supplies the rules for quantifying its abstract images and guides the computation of metaphors. These rules consist of equivalence sets of abstract and concrete terms that are markers of classification categories covering the whole range of traditional Chinese world knowledge. The images and their commentaries encode a structuring of the Chinese universe in terms of naturalistic, social, and metaphysical concepts that are derived from very early philosophies as well as from Confucianism and Taoism. (Systems of classificational equivalence sets are to be found in the history of every society in the world; Western readers need only be reminded of the "earth, air, water, and fire" classification of alchemy.)

There are eight trigrams, and they are listed with their names and primary associations (Wilhelm 1967 (1923):725–27):

111
THE CREATIVE, Heaven

010
THE ABYSMAL, Water

100
KEEPING STILL, Mountain

001
THE AROUSING, Thunder

110
THE GENTLE, Wind

101
THE CLINGING, Fire

000
THE RECEPTIVE, Earth

011
THE JOYOUS, Lake

The hexagrams are grouped into "houses" of eight members each:

1. The House of the Creative

1.1	The CREATIVE is Heaven	111 111
1.2	Heaven with Wind is COMING TO MEET	111 110
1.3	Heaven with Mountain is RETREAT	111 100
1.4	Heaven with Earth is STANDSTILL	111 000
1.5	Wind with Earth is CONTEMPLATION	110 000
1.6	Mountain with Earth is SPLITTING APART	100 000
1.7	Fire with Earth is PROGRESS	101 000
1.8	Fire with Heaven is POSSESSION IN GREAT MEASURE	101 111

2. The House of the Abysmal

2.1	The ABYSMAL is Water	010 010
2.2	Water with Lake is LIMITATION	010 011
2.3	Water with Thunder is DIFFICULTY AT BEGINNING	010 001
2.4	Water with Fire is AFTER COMPLETION	010 101
2.5	Lake with Fire is REVOLUTION	011 101
2.6	Thunder with Fire is ABUNDANCE	001 101
2.7	Earth with Fire is DARKENING OF THE LIGHT	000 101
2.8	Earth with Water is THE ARMY	000 010

3. The House of Keeping Still

3.1	KEEPING STILL is Mountain	100 100
3.2	Mountain with Fire is GRACE	100 101
3.3	Mountain with Heaven is TAMING POWER OF THE GREAT	100 111
3.4	Mountain with Lake is DECREASE	100 011
3.5	Fire with Lake is OPPOSITION	101 011
3.6	Heaven with Lake is TREADING	111 011
3.7	Wind with Lake is INNER TRUTH	110 011
3.8	Wind with Mountain is DEVELOPMENT	110 100

4. The House of the Arousing

4.1	THE AROUSING is Thunder	001 001
4.2	Thunder with Earth is ENTHUSIASM	001 000
4.3	Thunder with Water is DELIVERANCE	001 010
4.4	Thunder with Wind is DURATION	001 110
4.5	Earth with Wind is PUSHING UPWARD	000 110
4.6	Water with Wind is THE WELL	010 110
4.7	Lake with Wind is PREPONDERANCE OF THE GREAT	011 110
4.8	Lake with Thunder is FOLLOWING	011 001

5. The House of the Gentle

5.1	THE GENTLE is Wind	110 110
5.2	Wind and Heaven is TAMING POWER OF THE SMALL	110 111
5.3	Wind with Fire is THE FAMILY	110 101
5.4	Wind with Thunder is INCREASE	110 001
5.5	Heaven with Thunder is INNOCENCE	111 001
5.6	Fire with Thunder is BITING THROUGH	101 001
5.7	Mountain with Thunder is CORNERS OF THE MOUTH	100 001
5.8	Mountain with Wind is WORK ON WHAT WAS SPOILED	100 110

6. The House of the Clinging

6.1	The CLINGING is Fire	101 101
6.2	Fire with Mountain is THE WANDERER	101 100
6.3	Fire with Wind is THE CALDRON	101 110
6.4	Fire with Water is BEFORE COMPLETION	101 010
6.5	Mountain with Water is YOUTHFUL FOLLY	100 010
6.6	Wind with Water is DISPERSION	110 010
6.7	Heaven with Water is CONFLICT	111 010
6.8	Heaven with Fire is FELLOWSHIP WITH MEN	111 101

7. The House of the Receptive

7.1	THE RECEPTIVE is Earth	000 000
7.2	Earth with Thunder is RETURN	000 001
7.3	Earth with Lake is APPROACH	000 011
7.4	Earth with Heaven is PEACE	000 111
7.5	Thunder with Heaven is THE POWER OF THE GREAT	001 111
7.6	Lake with Heaven is BREAK-THROUGH	011 111
7.7	Water with Heaven is WAITING	010 111
7.8	Water with Earth is HOLDING TOGETHER	010 000

8. The House of the Joyous

8.1	THE JOYOUS is Lake	011 011
8.2	Lake with Water is OPPRESSION	011 010
8.3	Lake with Earth is GATHERING TOGETHER	011 000
8.4	Lake with Mountain is INFLUENCE	011 100
8.5	Water with Mountain is OBSTRUCTION	010 100
8.6	Earth with Mountain is MODESTY	000 100
8.7	Thunder with Mountain is PREPONDERANCE OF SMALL	001 100
8.8	Thunder with Lake is THE MARRYING MAIDEN	001 011

I have discovered that the arrangement of the hexagrams in houses is completely determined by ATO relations. The structure is a kind of 8 × 8 array in which each element is a hexagram and each column is a house. The term "*product" indicates the result of any computation with ATO logic. Any house may be transformed into each of the others by taking the successive *products of its elements with each of those hexagrams whose upper and lower trigrams are identical. These doublet hexagrams actually function as ATOs. For example, The House of the Abysmal may be transformed into The House of Keeping Still by taking the *product of each of its hexagram elements and the ATO hexagram 001 001:

$$
*\begin{matrix} 010\ 010 \\ 010\ 011 \\ 010\ 001 \\ 010\ 101 \\ 011\ 101 \\ 001\ 101 \\ 000\ 101 \\ 000\ 010 \end{matrix} , \quad 001\ 001 = \begin{matrix} 100\ 100 \\ 100\ 101 \\ 100\ 111 \\ 100\ 011 \\ 101\ 011 \\ 111\ 011 \\ 110\ 011 \\ 110\ 100 \end{matrix}
$$

Again, The House of the Joyous may be transformed into The House of the Arousing by taking the *product of its hexagram elements and the ATO hexagram 101 101:

$$
*\begin{matrix} 011\ 011 \\ 011\ 010 \\ 011\ 000 \\ 011\ 100 \\ 010\ 100 \\ 000\ 100 \\ 001\ 100 \\ 001\ 011 \end{matrix} , \quad 101\ 101 = \begin{matrix} 001\ 001 \\ 001\ 000 \\ 001\ 010 \\ 001\ 110 \\ 000\ 110 \\ 010\ 110 \\ 011\ 110 \\ 011\ 001 \end{matrix}
$$

Furthermore, all hexagrams occupying the same row position in the house classification can be calculated by the method for computing verbal analogies described above. Each trigram component of a hexagram is associated with a verbal image. If we take the *product of the upper and lower trigrams to generate an ATO and then take the *product of this ATO and each of the eight trigrams, we generate eight parallel row entries in the house classification:

$$
4.2 = \frac{\text{Thunder}}{\text{Earth}} = \frac{001}{000},
$$

$$
\begin{aligned}
\text{ATO} &= *(\text{Thunder, Earth}) \\
&= *(001, 000) \\
&= 110
\end{aligned}
$$

$$
\frac{\text{Thunder}}{\text{Earth}} :: \frac{\text{Fire}}{?} = \frac{001}{000} :: \frac{101}{?}
$$

$$
\begin{aligned}
? &= *(\text{Fire}, *(\text{Thunder, Earth})) \\
&= *(\text{Fire}, 110) \\
&= *(101, 110) \\
&= 100
\end{aligned}
$$

But 100 = Mountain.

Therefore, $\dfrac{\text{Thunder}}{\text{Earth}} :: \dfrac{\text{Fire}}{\text{Mountain}} = 4.2 :: 6.2.$

Similarly,
$$\frac{\text{Thunder}}{\text{Earth}} :: \frac{\text{Lake}}{?} = \frac{001}{000} :: \frac{011}{?}$$

$$
\begin{aligned}
? &= *(\text{Lake}, *(\text{Thunder}, \text{Earth})\,) \\
&= *(\text{Lake}, 110) \\
&= *(011, 110) \\
&= 010 \\
&= \text{Water}
\end{aligned}
$$

Therefore,
$$\frac{\text{Thunder}}{\text{Earth}} :: \frac{\text{Lake}}{\text{Water}} = 4.2 :: 8.2.$$

In a similar fashion, one may derive 3.2 by computing *(Mountain, 110) = Fire; 1.2 by computing *(Heaven, 110) = Wind; 2.2 by computing *(Water, 110) = Lake; 5.2 by computing *(Wind, 110) = Heaven; 7.2 by computing *(Earth, 110) = Thunder. The other row equivalences are computed in exactly the same way.

The house classification reflects a system of verbal analogies which are defined by first-level ATO relations. Each of the verbal images is also the marker of one or more classes consisting of such elements as a corresponding color, season, direction, element, kinship term, climate, mountain, planet, sound, musical note, virtue, emotion, animal, viscus, body orifice, flavor, odor, emperor, etc. An *I Ching* commentary explains the motive (Legge 1964 [1899]: appendix 3, sect. 1, chap. 8 [38], 360): "The Sage was able to survey all the complex phenomena under the sky. He then considered in his mind how they could be figured, and (by means of the diagrams) represented their material forms and their character. Hence these (diagrams) are denominated Semblances" and (sect. 2, chap. 6 [48], 396) "the names (of the diagrams and lines) are but small matters, but the classes of things comprehended under them are large."

There are actually several systems merged in the trigram classification, including a two-element (*yin-yang*) system, a five-element system, and the eight-element system. A partial merged listing appears in table 2. The *Po Hu T'ung*, a commentary on the correlations (A.D. 79), explicates the logic (Fung Yu-lan 1953 [1934]:41–42).

What are the five viscera? They are the liver, heart, lungs, kidneys, and spleen. . . . Of these five viscera, the liver corresponds to love, the lungs to righteousness, the heart to propriety, the kidneys to wisdom, and the spleen to good faith. How is it that the liver corresponds to love? The liver is the essence of (the element) wood, and love likes to be actively productive. The east is (the quarter of wood and of the actively productive) *yang*, and is where all things are first born. Therefore the liver resembles wood, being green in color and (shaped as if) having branches and leaves. . . .

How is it that the lungs correspond to righteousness? The lungs are the essence of (the element) metal, and righteousness makes decisions. The west is also (the quarter of) metal, where all things, having reached maturity, are destroyed. Therefore the lungs resemble metal, being white in color. . . .

How is it that the heart corresponds to propriety? The heart is the essence of (the element) fire. (The quarter of fire is) the south, where the exalted *yang* holds a superior position, while the lowly *yin* holds an inferior position. Propriety maintains (social differences between) the exalted and the lowly. Therefore the heart resembles fire, being red in color and pointed. . . .

How is it that the kidneys correspond to wisdom? The kidneys are the essence of (the element) water, and wisdom proceeds unceasingly without any doubt or uncertainty. Water likewise moves forward without uncertainty. The north is (the quarter of) water (and has black as its corresponding color). Therefore the kidneys are black in color. Water is *yin*, and therefore the kidneys are two in number. . . .

How is it that the spleen corresponds to good faith? The spleen is the essence of (the element) earth. The highest function of earth is to nourish all creatures so as to give them form. It produces creatures without partiality, which is the acme of good faith. Therefore the spleen resembles earth, being yellow in color. . . .

If we say
$$\frac{\text{Thunder}}{\text{Earth}} :: \frac{\text{Lake}}{\text{Water}},$$
we also specify that
$$\frac{\text{East}}{\text{Center}} :: \frac{\text{West}}{\text{North}}, \frac{\text{Eldest son}}{\text{Mother}} :: \frac{\text{Youngest daughter}}{\text{Second son}},$$
$$\frac{\text{Dragon}}{\text{Ox}} :: \frac{\text{Sheep}}{\text{Pig}},$$
etc. This basic classification scheme defines an entire universe of analogies; each of these terms is itself a symbol, a metonymic emblem of other classes of elements in the universe.

The house classification provides a reference-base set of analogies. However, the use of the *I Ching* as a divination device usually generates two hexagrams. The first is derived by a semi-random method that may include the additional information that certain of the solid or broken lines (1 or 0) are unstable and in a state of transformation into their opposites. This uniquely determines a second hexagram which is viewed as a transform of the first. This correspondence between the two hexagrams now determines a new system of verbal analogies which may differ from that implied by the basic house

TABLE 2

SOME TRIGRAM CORRESPONDENCES

	001 thunder	110 wind	101 fire	100 mountain	000 earth	111 heaven	011 lake	010 water
Element..............		wood	fire		earth		metal	water
Direction............		East	South		Center		West	North
Color................		blue	red		yellow		white	black
Season...............		spring	summer		*"fang"*		autumn	winter
Climate..............		windy	hot		humid		dry	cold
Planet...............		Jupiter	Mars		Saturn		Venus	Mercury
Sound................		shouting	laughing		singing		weeping	groaning
Musical note.........		*chüeh*	*chih*		*kung*		*shang*	*yü*
Emotion.............		anger	joy		sympathy		grief	fear
Animal...............	dragon	fowl	pheasant	dog	ox	horse	sheep	pig
Family...............	1st son	1st da	2d da	3d son	mother	father	3d da	2d son
Body part............	foot	thigh	eye	hand	belly	head	mouth	ear
Attribute............	movement	penetration	brightness	standstill	docility	strength	pleasure	danger

SOURCES: Blofeld (1978:190–91), Wilhelm (1967 [1923]:1–11, 310), Legge (1964 [1899]:xliv–v), Legeza (1975:11), Fung Yu-lan (1953 [1934]:40–42, 86–132).

classification. If, for example, a divination attempt yields the hexagram 001 000 (4.2) and the transform partner 101 111 (1.8), the ATO that relates these is *(4.2, 1.8) = *(001 000, 101 111) = 011 000. The implied verbal analogy is

$$\frac{\text{Thunder}}{\text{Earth}} :: \frac{\text{Fire}}{\text{Heaven}}$$

$$\begin{aligned} \text{ATO} &= *(\text{Thunder Earth, Fire Heaven}) \\ &= *(\ 001 \quad 000\ , 101 \quad 111\ ) \\ &= 011\ 000 \end{aligned}$$

But this ATO may be used, systematically, to obtain transforms of the houses in the original scheme. The result is a new house classification scheme that is related to the original by the analogy,

$$4.2 :: 1.8, \text{ or } \frac{\text{Thunder}}{\text{Earth}} :: \frac{\text{Fire}}{\text{Heaven}}$$

The *products of this ATO and the second hexagram of each of the original houses are as follows:

*(1.2) 111 110	(4.8) 011 001
(2.2) 010 011	(3.8) 110 100
(3.2) 100 101	(2.8) 000 010
(4.2) 001 000 , 011 000 =	(1.8) 101 111
(5.2) 110 111	(7.8) 010 000
(6.2) 101 100	(8.8) 001 001
(7.2) 000 001	(5.8) 100 110
(8.2) 011 010	(6.8) 111 101

Doing the same for the seventh hexagram of each of the original houses yields:

*(1.7) 101 000	(7.5) 001 111
(2.7) 000 101	(6.5) 100 010
(3.7) 110 011	(8.5) 010 100
(4.7) 011 110 , 011 000 =	(5.5) 111 001
(5.7) 100 001	(4.5) 000 110
(6.7) 111 010	(2.5) 011 101
(7.7) 010 111	(1.5) 110 000
(8.7) 001 100	(3.5) 101 011

etc. Thus, the original hexagram transformation, 4.2 (001 000) to 1.8 (101 111), with its implied verbal analogy,

$$\frac{\text{Thunder}}{\text{Earth}} :: \frac{\text{Fire}}{\text{Heaven}},$$

can actually generate a whole new system of verbal analogies quite different from that implied by the *I Ching*'s original classification into houses, e.g.,

$$\frac{\text{East}}{\text{Center}} :: \frac{\text{South}}{\text{West}}, \quad \frac{\text{Eldest son}}{\text{Mother}} :: \frac{\text{Second daughter}}{\text{Father}},$$

$$\frac{\text{Dragon}}{\text{Ox}} :: \frac{\text{Pheasant}}{\text{Horse}},$$

etc. Each divination, i.e., the determination of a hexagram and its transform, actually defines a total realignment of the categories and their analogical relations. The net effect is that the implications of a divination for all facets of the conceptual universe can be calculated directly.

The *Po Hu T'ung* (Fung Yu-lan 1953 [1934]:44–45) describes the manner in which the five elements and their associated seasons provide models for all social institutions:

What is the model for the succession of the son upon the death of his father? This is modeled upon the fact that when (the element) wood reaches its end, fire becomes king (in its place). What is the model for a younger brother to carry on after the death of his elder brother? It is the succession of summer after spring. What is the model whereby approbation of goodness is to be extended even unto sons and grandsons (of the person whose goodness is thus approved)? It is that the productive forces of spring wait for summer to bring about further growth. And what is the model whereby hatred of evil stops with the person (who is thus hated)? This is modeled on the fact that autumn acts as the executioner without waiting for winter.

What is the model for the ministers to take over the administration during the minority of a ruler? This is modeled on the fact that (the element) earth exercises jurisdiction over affairs during the time from the last (month of summer) to the first (month of autumn). What is the model for a son avenging (a crime committed against his father)? This is modeled on the overcoming of (the element) water by earth, and of fire by water. What is the model for the obedience of son to father, wife to husband, and subject to ruler? This is modeled on the obedience of Earth to Heaven. What is the model for the fact that a man (who gets married) does not leave (the home of) his parents? This is modeled on the fact that (the element) fire does not separate from (the element) wood. What is the model for the fact that a woman (who gets married) leaves (the home of) her parents? This is modeled on the fact that (the element) water flows away from (the element) metal. What is the model whereby (a man), when he takes a wife in marriage, goes in person (to her home) to receive her? This is modeled on the fact that when the sun sets, the *yang* descends into the *yin*. . . .

The association of the eight trigrams with the five elements links the models to the *I Ching* divination system.

I have demonstrated that the original arrangement of the hexagrams in houses described in the *I Ching* is based on an ATO logic. It is my personal extrapolation that the determination of a hexagram and its transform, as part of a divination process, actually implies a new classification of hexagrams, with a new system of verbal image analogies. Yet this extrapolation seems quite justified by commentaries on the role and function of the *I Ching* (Wilhelm 1967 [1923]:263):

The hexagrams, consisting of six lines each, are, so to speak, representations of actual conditions in the world, and of the combinations of the light-giving, heavenly power and the dark, earthly power that occur in these situations. Within the hexagrams, however, it is always possible for the individual lines to change and regroup themselves; just as world situations continually change and reconstitute themselves, so out of each hexagram there arises a new one. . . .

The hexagrams give complete images of conditions and relationships existing in the world; the individual lines treat particular situations as they change within these general conditions.

A justification for considering the original grouping of hexagrams in houses basic and for viewing the semi-randomly determined divination hexagram as an index into this structure can be found in the following (Wilhelm 1967 [1923]:280–81):

Nonchange is the background, as it were, against which change is made possible. For in regard to any change there must be some fixed point to which the change can be referred; otherwise there can be no definite order and everything is dissolved in chaotic movement. This point of reference must be established, and this always requires a choice and a decision. It makes possible a system of co-ordinates into which everything else can be fitted. Consequently at the beginning of the world, as at the beginning of thought, there is the decision, the fixing of the point of reference. Theoretically any point of reference is possible, but experience teaches that at the dawn of consciousness one stands already enclosed within definite, prepotent systems of relationships. The problem then is to choose one's point of reference so that it coincides with the point of reference for cosmic events. For only then can the world created by one's decision escape being dashed to pieces against prepotent systems of relationships with which it would otherwise come into conflict. Obviously the premise for such a decision is the belief that in the last analysis the world is a system of homogeneous relationships—that it is a cosmos, not a chaos. This belief is the foundation of Chinese philosophy, as of all philosophy. The ultimate reference for all that changes is the nonchanging.

The role of ATOs in the *I Ching* is clear: they function both as high-level state descriptions and as operators. It is for the human user to quantify particular, abstractly described world-states. But the *I Ching*, with the systems of classification of world phenomena contained in Chinese philosophy, actually provides a guide for quantifying the state descriptions.

The *I Ching* is a consciously developed product of millennia of the functioning of Chinese social life. Similar systems for

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categorizing the universe and for calculating relationships exist, or once did, in virtually all human societies. The fundamental contemporary work describing their nature and function is Lévi-Strauss's *La pensée sauvage* (1962). His totemic operator is equivalent to a specification of the ATO concept; the *I Ching* appears to be a highly developed example. Articulated divination schemes are found in many societies; Western civilization is not exempt. Consciously articulated, analogical calculating systems can be found in a line of history that includes Pythagoras, Hermes Trismegistus, alchemy, Kabbala, and the *Ars Magna* of Ramon Lull. The influence of such work persisted through the Renaissance, and the latter is part of the acknowledged intellectual background of Descartes and Leibniz.

I have posited that ATO systems are *unconscious* means by which humans in social groups calculate behavior by analogy. If the *I Ching* is part of a cognitive system that is driven not by the stimulus of a randomly calculated hexagram, but by a sample of reality in the form of a situation description, then, given such an input, the system will automatically redefine its analogical relations globally. This is the basis for the calculation of behavior by analogy and for the perception and use of metaphor.

If the ATO model is valid, one would expect evidence from brain research psychology and functional computer modeling and, in particular, cross-cultural evidence, both contemporary and historical. I hope that the analyses presented here, representing the last category, will serve to stimulate the search for evidence in all of these areas.

ATO LOGIC IN AFRICAN DIVINATION SYSTEMS

ATO logic plays a major, overt role in the related, widely diffused divination systems of Africa (the Ifa of the Yoruba, the Sikily of Madagascar, etc.). In general, they resemble the *I Ching* in that they utilize sets of units consisting of elements that are interpreted as odd or even. These sets are, in part, generated by a semi-random method and then subjected to ATO logic manipulations. The systems are well known and well described (Maupoil 1943, Jaulin 1966, Gleason 1973). For example, in the generated set of 16 figures (Jaulin 1966:22) in figure 11, the odd and even elements may be interpreted as 0's and 1's. Columns 5, 6, 7, and 8 are obtained from Columns 1, 2, 3, and 4 by column-to-row transposition, but Column 9 is the ATO operator for Columns 1 and 2, i.e., *1, 2. Similarly, Column 10 is the result of *3, 4, and Columns 11 and 12 are the ATO operators for Columns 5 and 6 and 7 and 8, respectively. The middle row appears as a set of first-order ATOs for the top row. The third row contains Column 13, which is equal to *9, 10, and Column 14, which is equal to *11, 12. Column 15 is the ATO for 13 and 14, and Column 16, appended to the right of the top row, is the ATO or *product for Columns 15 and 1.

As in the *I Ching* system of houses, there is a base set of 16 figures that serves as a reference point for actively cast, derived sets. Each of the figures is correlated with the elements earth, air, fire, and water, with signs of the Zodiac, with night and day, with the nights and days of the week, with the months of the year, with numbers, with letters of the alphabet, with body parts, with planets and constellations, with colors, with parts of the house, with flavors, with shapes, with prophets and caliphs, and with metals (Maupoil 1945: 61–75). Each of the figure positions in a divination construction correlates with a different domain of social life, and each of the possible 256 signs is associated with cases in common law (Gleason 1973:17):

For each of 256 signs-in-combination there are, in principle, 16 "rows" of discourse—each of which contains a case in the common law of Ifa. These cases, although presented as real precedents, are intentionally paradigmatic and involve an animal, a divinity, an
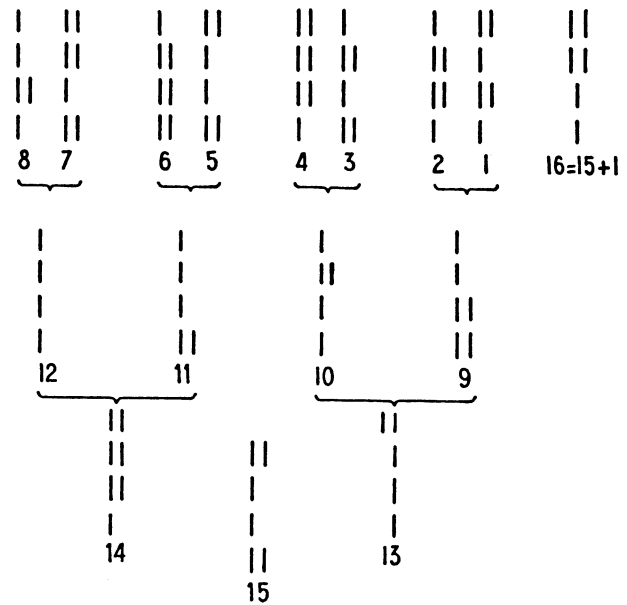

FIG. 11. ATO structure in an African divination system (from Jaulin 1966:22; reprinted by permission of Robert Jaulin). If the odd and even elements are interpreted as 0's and 1's, then, by ATO logic, on the first level, *1, 2 = 9; *3, 4 = 10; *5, 6 = 11; *7, 8 = 12; on the second level, *9, 10 = 13; *11, 12 = 14; on the third level, *13, 14 = 15; and on the fourth level, *15, 1 = 16.

exemplary king, or other special being as "client" whose situation runs parallel to that of any living person who identifies with it.

Unlike the *I Ching*, which is part of popular cultural knowledge, Ifa is the intellectual property of a limited group (Gleason 1973:9): "Ifa can only be revealed through its initiates, who themselves have acquired the secret teaching bit by bit, who alone may manipulate the sacred counters." It is impossible to rule out a historical connection with the *I Ching*. Caslant (1935:169, quoted in Maupoil 1943:51, translation mine)[3] states:

We may ... suppose ... that knowledge of geomancy continued in Persia approximately to the 8th and 9th centuries, to that epoch in high Iranian culture during which the universities of Gondeshapur and Baghdad flourished.

The intellectual elite of all countries converged on these centers, and Arab and Jewish savants, molded in these universities, carried their knowledge of geomancy to Damascus, Alexandria, and Cairo along with their learning in philosophy and medicine. From these centers, the knowledge spread, via Upper Egypt, as far as the Sudan and Darfur and, via the Mediterranean, to Northwest Africa and Spain. ...

An apparent connection between the philosophy of the *I Ching* and that of the Pythagoreans suggests a historical link to later developments; the *I Ching* may have been known in Persia at the time of the Alexandrian conquest (Fung Yu-lan 1953 [1934]:95):

Striking similarities emerge when we compare the doctrines of the Pythagoreans with the Chinese "study of emblems and numbers."

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[3] "Nous pouvons ... supposer ... qu'elle (la Géomancie) était connue depuis fort longtemps en Perse aux VIIIᵉ et IXᵉ siècles tout au moins, c'est-à-dire à cette époque de haute culture iranienne où fleurissaient les Universités célèbres de Gondé-Shapour et de Bagdad, vers lesquelles convergeait alors l'élite intellectuelle de tous le pays.

Ce sont les savants arabes et juifs, formés dans ces universités, qui, en même temps que la science philosophique et médicale acquise, emportèrent la science géomantique à Damas, à Alexandrie et au Caire, d'où, d'une part, elle s'enfonça en Afrique par la Haute-Égypte jusqu'au Soudan et au Darfour, et, d'autre part, par la voie méditerranéenne gagna le Maghreb et l'Espagne. ..."

Appendix III of the *Book of Changes*, for example, contains the famous passage: "In the *Changes* there is the Supreme Ultimate, which produced the two Forms. . . ." This is similar to the Pythagorean theorem that "from the monad proceeds the indefinite duad." Likewise, if we examine the series of ten pairs of antinomies enunciated by the Pythagoreans, such as Limit and the Unlimited, it is evident that what they call Limit corresponds fairly closely to what the exponents of the *Book of Changes* call *yang*, while the Pythagorean Unlimited similarly corresponds to the Chinese *yin*. In Greek philosophy it has been generally maintained that the Unlimited constitutes matter, Limit constitutes form, and that physical things are the result of the imprint of form upon matter. In China, likewise, the exponents of the *Book of Changes* maintained that the *yang* is active and hence gives forth, whereas the *yin* is passive and hence receives. Indeed, among the ten above-mentioned pairs of antinomies, there are only two that differ markedly from the theories of the exponents of the *Changes*. . . .

But what is it that may have been transmitted to Africa? First, the use of geomancy based on a binary number system; second, the use of ATO logic in the arithmetic calculations; third, the use of analogy and projection of particular details of problems into the forms of canonical texts. What has changed in the transmission is the content. Either the new system was adopted as a calculating machine to be used with an already existing conceptual framework, or it arrived in a syncretic synthesis of more than one world framework, reconciled in the mathematics and referentia of the divination system.

BUDDHIST ICONOGRAPHY AND NAVAHO SAND PAINTING

There are strong indications that the structure of Buddhist iconography, and also that of Navaho sand painting, are based on ATO logic. If this is so, then questions of invention and diffusion versus brain physiology are thrust tens of thousands of years into the past. As a preliminary to the discussion, I offer an example of my own creation, a visual, iconographic interpretation of the house classification scheme of the *I Ching*. I do this to illustrate the ease of conversion between notational modes and to provide the reader with an intuitive example of fundamental ATO identity behind apparent profound surface diversity. Figure 12 contains an arbitrary visual interpretation of the first four houses of the *I Ching*. The visual features are in binary opposition, and a 0 indicates the upper element, a 1 the lower element. The reader may verify that the pictures are arranged in an order that follows the analogic relations of the hexagrams in the original classification. In creating the example, my intent was to demonstrate that the *I Ching* ATO system may be linked to an arbitrary visual domain, yet function with the same logic. I argue, accordingly, that whatever the source of ATO logic, it is a calculating device that is neutral to the content of the classification systems to which it is applied. ATO logic is not limited to binary features, but will also work for any number of choices that are powers of 2. For example, ATO analogical reasoning may be performed with a set of four colors by assigning each a two-digit binary number (00, 01, 10, 11) and treating them as if they represented pairs of binary features.

The Buddhism that was brought into Tibet in the 7th century was Mahāyāna combined with the 5th-century yoga doctrine of ecstatic union, the Mantrayāna doctrine of spells and charms, and the 6th-century Tantric doctrine of the worship of female energies in conjunction with male energy. Lamaism developed as an 8th-century fusion with Pön, the native religion of Tibet (Gordon 1959[1939]:5.

The iconography of Tibetan Buddhism appears to follow ATO combinatorial logic of the sort seen in the *I Ching* and African divination systems. I have not verified this with overt calculations—this is a vast task, and the literature is in several languages—but the attempt should be made. Whitney (1959

[1939]:vi) likens the identification of Tibetan Buddhist iconic imagery to botanical analysis. As one might determine the division, family, and species of a flower, one can determine the class of image from its pose, expression, and dress. More detailed identification of the individual and its particular form are determined by the number of arms, legs, and faces, by hand gestures, by symbols carried in the hands, and by color (Bhattacharyya 1968[1924], Lauf 1972, Gordon 1959[1939]). Each of these elements is associated with other conceptual domains. Table 3 contains a listing of the five Dhyāni Buddhas and some of their correspondences. Bhattacharyya (1968[1924]: 47) states:

The five Dhyāni Buddhas who are the embodiments of the five Skandhas or primordial elements are the progenitors of the five families of deities constituting the whole of the Buddhist pantheon. The emanated deities of these Dhyāni Buddhas, as a rule . . . are usually of the same colour as that of the Dhyāni Buddha and are placed in the same direction as assigned to their sires. This very plan is followed most scrupulously in almost all the maṇḍalas or magic circles as described in the remarkable work Niṣpannayogāvalī of Mahāpaṇḍita Abhayākara Gupta [12th century A.D.; see Abhayākara Gupta 1949].

Mandalas are special forms of Thang-kas (paintings of divinities or groups of divinities used to invoke deities) and are used for spiritual meditation (Gordon 1959[1939]:27; Lauf 1972:50–51). Gordon (1959[1939]:27) suggests that they originated from the yoga doctrine of the union of the world of ideas and the world of forms. Other forms of mandalas found their way to Japan (Ishida 1975, vol. 1:i):

The T'ang priest Hui-kuo (A.D. 746–805) presented the Japanese priest Kūkai (alias Kōbō Daishi) with a set of Ryōkai Mandara (Maṇḍala of the Two Circles). This set, consisting of a pair of hanging scrolls representing the Taizōkai (Garbhadhātu) and Kongōkai (Vajradhātu) respectively, is known in Japan as the Genzu Mandara. . . .
    Concerning Maṇḍalas earlier than the Genzu type transmitted from Hui-kuo to Kūkai we can cite, as an example of the Vajradhātu group, the *Gobu Shinkan* (Wu-pu Hsin-kuan) brought back from China by the priest Enchin, the study of which has seen some progress. On the other hand, however, detailed study of Maṇḍalas of the Garbhadhātu group has almost never been made, due probably to its complicated composition consisting of innumerable divinities. This statement applies not only to researches by Japanese scholars, but to those by experts in other parts of the world. Their study of the Esoteric Buddhism of India and Tibet, for example, is mostly concentrated on Vajrayāna (Later Esotericism) in which many-armed deities are recurrent, researches on Mantrayāna (Earlier Esotericism) prior to the Genzu Mandara being next to nothing.
    Mantrayāna which thrived at Nālanda has left nearly no relic even in India, so that it is hard to know what it was like. Fortunately, however, it was transmitted to China in quite early times, and many of its scriptures were translated from Sanskrit into Chinese; about a century later, it was introduced also to Tibet, where Tibetan translations of the sutras were established. In order to fill up the blank pages left by Early Esoteric Buddhism, therefore, our only available recourse is Chinese or Tibetan translation. In this respect Japan, where Chinese sutras older than Tibetan ones have been known and where associated objects have been imported and preserved, holds a favorable situation for the study of Mantrayāna. Herein lies the purpose of this book. The present writer wishes to help in filling up the above-mentioned blank pages by casting light on Garbhadhātu and Vajradhātu Maṇḍalas earlier than the times of Hui-kuo and Kūkai.

Figure 13 contains a portion of a mandala from Ishida's work (1975, vol. 2:120). The reader might compare it with the "mandala" of my figure 12, produced in a mechanical fashion from the house classification of the *I Ching* hexagrams. Figure 14 (Chandra 1971:249) contains an extract from another mandala.

Navaho sand-painting techniques appear to follow an ATO logic and to involve the creation of mandala structures. (I am indebted to Reichard 1950 and 1973 [1939], Newcomb, Fishler, and Wheelwright 1956, Newcomb and Reichard 1937, McAl-

1.1 111 111	2.1 010 010	3.1 100 100	4.1 001 001
1.2 111 110	2.2 010 011	3.2 100 101	4.2 001 000
1.3 111 100	2.3 010 001	3.3 100 111	4.3 001 010
1.4 111 000	2.4 010 101	3.4 100 011	4.4 001 110
1.5 110 000	2.5 001 101	3.5 101 011	4.5 000 110
1.6 100 000	2.6 001 101	3.6 111 011	4.6 010 110
1.7 101 000	2.7 000 101	3.7 110 011	4.7 011 110
1.8 101 111	2.8 000 010	3.8 110 100	4.8 011 001
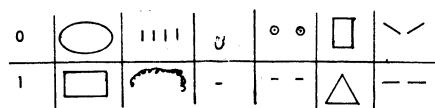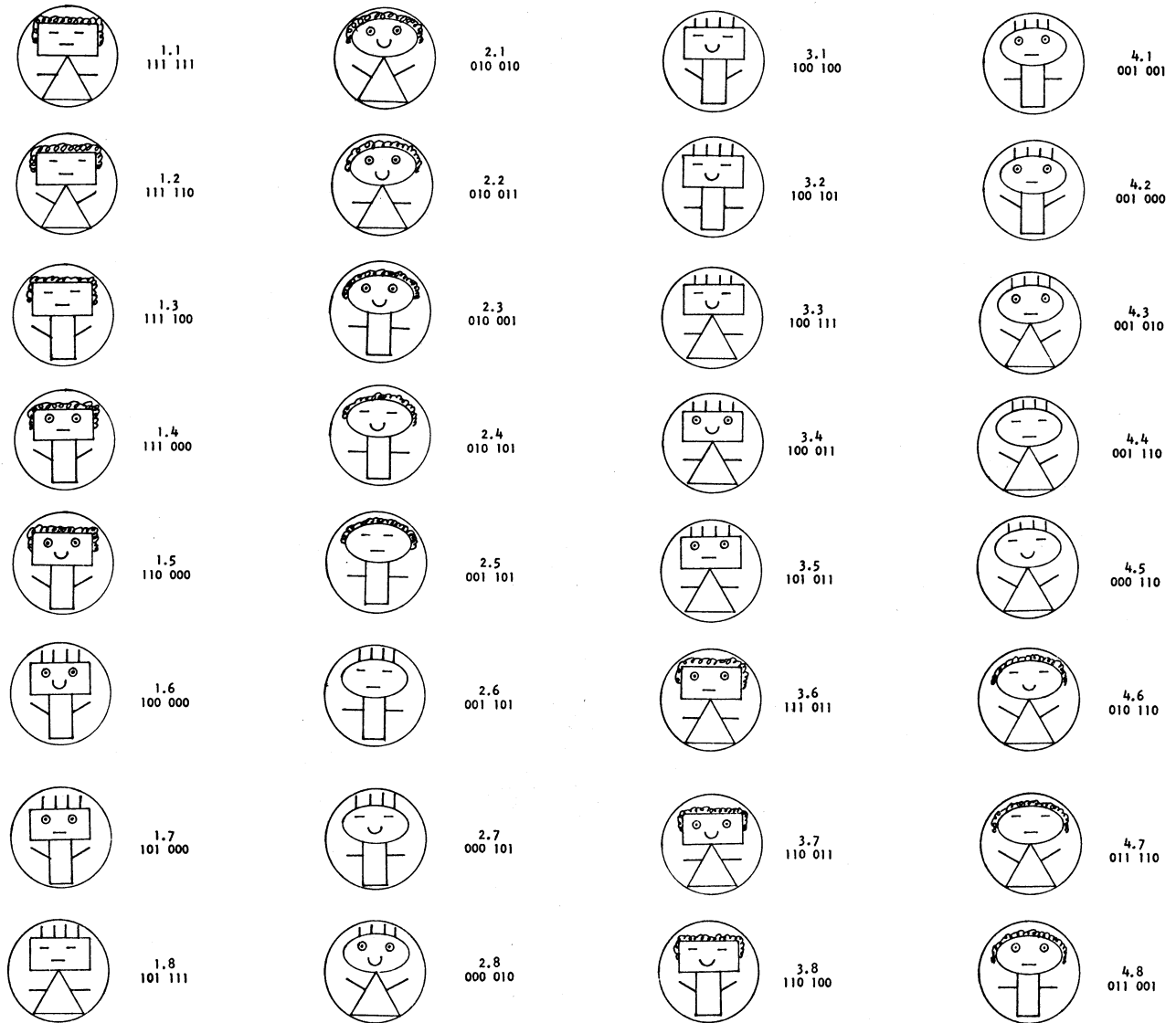
FIG. 12. An arbitrary visual interpretation of the first four houses of the *I Ching*.

TABLE 3

SOME CORRESPONDENCES OF THE FIVE DHYĀNI BUDDHAS

	VAIROCANA	AKSOBHYA	RATNASAMBHAVA	AMITĀBHA	AMOGHASIDDHI
Location	Center	East	South	West	North
Hand position (mudrā)	Teaching (Dharma-cakra)	Witness (Bhūsparsa)	Bestowing (Vara)	Meditative (Dhyāna)	Blessing of Fearlessness (Abhaya)
Throne animal	Lion	Elephant	Horse	Peacock	Winged Dwarf or Garuḍa
Element	Ether	Air	Earth	Fire	Water
Color	White	Blue	Yellow	Red	Green
Symbol	Wheel (Cakra)	Thunderbolt (Vajra)	Jewel (Ratna)	Red Lotus (Raktapadma)	Cross Thunderbolt (Visvavajra)
Sense	Sight	Sound	Smell	Taste	Touch
World	First	Second	Third	Present	Future
Bodhisattva	Samantabhadra	Vajrapāni	Ratnapāni	Avalokita	Viśvapāni
Earthly Buddha	Krakucchanda	Kanaka Muni	Kāśyapa	Śākya Muni	Maitreya
Skandha	Consciousness (Vijñāna)	Form (Rūpa)	Sensation (Vedanā)	Name (Samjnā)	Conformation (Samskara)

SOURCES: Waddell (1895:350–51); Lauf (1972:130); Gordon (1959 [1939]:31).

四 摂　　　　　　　　　　　　　　　外 四 供

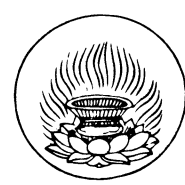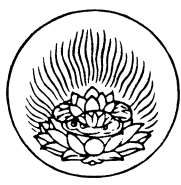| 35 金剛索	34 金剛鉤	33 金剛塗香	32 金剛燈	31 金剛華
Vajrapāśa	Vajrāṅkuśa	Vajragandhā	Vajradīpā	Vajrapuṣpā
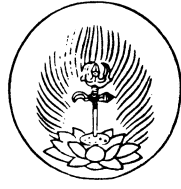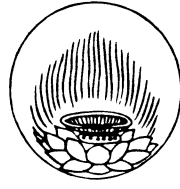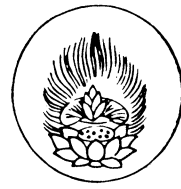
FIG. 13. A portion of a mandala illustrated in Ishida (1975, vol. 2:120; reprinted by permission of the publisher). Each column contains variant representations of the deity whose name appears at the top.