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ABSTRACT

In this study, the Kantian schema has been applied to natural language expression. The novelty of the approach concerns the way in which the Kantian schema interrelates the analytic with the synthetic mode in the construction of the presented formalism. The main thesis is based on the premise that the synthetic, in contrast to the analytic, proposition plays the central role in the measurement and representation of consciousness. It is assumed that the discontinuities in natural language production are the only reliable observations and that there is at present no other way in which these observations can be formalized. Despite the enormous number of textual elements and variations, it has been possible to demonstrate perspective and objective structures empirically as the result of a series of non-deterministic bifurcations of a dynamic vector field within euclidean space. By contrasting the captions to the picture series of the original "visual cliff" experiments with a narration produced in an experiment with a single subject, it was possible to show that the formalism can deal with alternative descriptions of the same system (experimental arrangement). On the basis of the given theoretical outline, a totally new comprehension of "text" and the underlying theoretical concepts related to the ecological approach to visual perception has emerged. Five figures illustrate the discussion. There is a 41-item list of references. (Author/SLD)

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Abstract

For the first time in the history of psychological and educational measurement the Kantian schema has been applied to natural language expression in a rigourous and precise way. The crucial novelty of the approach concerns the way in which the Kantian schema interrelates the analytic with the synthetic mode in the construction of the presented formalism. The main thesis advanced is based on the premise that the synthetic in contrast to the analytic proposition plays the central role in the measurement and representation of consciousness. It is assumed that the discontinuities in natural language production are the only reliable observations and that there is at present no other way in which these observations can be formalized. Despite the enormous number of textual elements and great variations, it has been possible to demonstrate empirically perspective and objective structures as the result of a series of nondeterministic bifurcations of a dynamic vector field within Euclidean space. By contrasting the Caption to the picture series of the original Visual Cliff experiments with a narration produced in a single subject experiment, it was possible to show that the formalism has the capacity of dealing with alternative descriptions of one and the same system (experimental arrangement). On the basis of the given theoretical outline, a totally new apprehension of 'text' and of the underlying theoretical concepts related to the ecological approach to visual perception has emerged.

The classical and basic approach to the study of behaviour rests on the proposition that the measurement and representation of sequences of extraordinary or important behavioural events (Y) is possible if a given organism (X) induces a dynamics, i.e. a change of state. If X observes the event Y' after the event Y then X will show a tendency to expect Y' whenever Y appears. Consequently, there is no room for modelling intentionality nor for modelling thinking. "Intentionality is still one of the most elusive of all notions" (Kugler & Turvey, 1987, p. xiv).

The original meaning of this most primitive and clumsy but persistent method is to model the choice of the organism on which of two actions should be carried out. An elaboration of the method into preference or public choice models is simply an extension of a "sense of number" which is characteristic of all higher order nervous systems (Danzig, 1968, pp. 1-12). Thus, every observable behaviour can be regarded as an instant of a mapping from a stable state to a number (one, zero). Because an omen such as "If X does Y and X causes Y then X wants Y" is a special example of the behaviour principle although expressed in language, it can be concluded that the omen, i.e. behavioural semantics, has its origin in animal nature. Behavioural semantics is concerned with a precise attribution of a cause to a behavioural event. With the results obtained from both informal and formal demonstrations it is possible to conclude that (1) conditional judgment (if-then anticipation), (2) classification (generalization) and (3) comparison (combination) are primitive functions pertaining to the logic of behavioural semantics, i.e. the logic of the organism. These elementary processes are, according to Piaget (1978, p. 94) "not intentionally organized and used by an individual subject with a specific new solution in view".

The classical theories of behaviour build on the significance of psychological pain or bereavement in behaviour reinforcement. Reward and punishment are used as the generally accepted steering and control mechanism of human and social development. The construction of appropriate models has been based on the conviction that "believes" are the result of fundamental psychological processes. The following basic assumptions of psychophysics constitute the generalized foundation of all models of behaviour and behavioural semantics:

(1) the individual avoids/wants objects or events
(2) preferences are persistent
(3) stable preferences are generalizable
(4) changes in behaviour cause changes in preferences
(5) preferences and behaviour are independent, i. e. only associatively related.

The traditional basis of investigating choice behaviour is a formal definition. By comparing the elements of a set of attainable alternatives the individual's judgment of intensity in a belief is described with respect to the transitivity, reflexivity, and completeness of the relations holding between the elements of the set. The following four basic parameters are of significance for an operationalization of a person's way of making rational decisions:

(1) experience of intensity in wanting or avoidance
(2) range of variation in the tolerance of risk taking
(3) threshold value of excitability, and
(4) observable differences.

These parameters have also found widespread acceptance as foundation of research on consciousness and cognitive research in general due to the very attractive logic of association. Behaviourally, it implies that pleasure as its momentum is expressed not as product (like the momentum in physics) but as a difference in the maximization of utility. From this argumentation two further assumptions can be derived immediately:

(1) the efficiency of a particular individual defines the success (risk taking and gain) of a certain behaviour strategy, and
(2) hierarchic organizations have to be designed such that they preserve individual growth and distributive justice.

This axiomatic foundation has been developed with the purpose to generate value-free sets of data and to guarantee the generalizability of empirical results. The axiom of number is the foundation of any physical theory of behaviour and knowledge of behaviour is defined as the formal structure of the product of inquiry. In this sense, the knower is an ideal and abstracted individual who cannot know objects with certainty because of their indeterminacy. Though, the world is knowable to the extent that it is itself a formal structure which is computationally accessible within the boundaries of formal-logical calculation. All cognition is computational, mainly on the basis of extensional logics and models of geometry and kinematics. Knowledge is limited but rational, because of its relationship to formal logics.

The Measurement of Change

Complex models have been developed for simulating choice behaviour in complex situations. "Intelligent structuring" and "flexible organization" are two key concepts in the design and implementation of appropriate computer programs. Change is thereby defined as the difference between more or less transparent variables and their interconnections. It seems that "intelligent structuring" gives expression to the designer's ability to construct precise and rigid formalizations of his assumptions of motion perception. On the other hand, "flexible organization" reflects his ability to construct changeable databases. Moreover, the interaction of both concepts allows for a high degree of formal system control in the processing of information. The algorithmic foundation of choice behaviour is justified on the grounds that it has been possible to construct an isomorphic relation between symbolic logic and arithmetics. Through this isomorphism, formal logics based on the analytic proposition could be given the form of arithmetic procedures. As a consequence, a number of syllogisms could be computed through completely automatized procedures. This manipulation of logical formulas has been taken as a pretext for the hypothesis that humans should have computable knowledge about the adequate behavioural response in situations of a certain kind of complexity. For example, Becker (1973) has presented a computer model for the simulation of "experience" as foundation of the avoidance of "Falling-off-places". As argued in Bierschenk (1984), the focus is on an organized complexity implying the collection and conditioning of S-R bonds, techniques which give the impression of a strict environmentalism. To be sure, Becker's simulated behaviour of an organism on a Cliff shows that the organism has the capacity to adapt its action to its environment. But it does so without the inborn ability of spontaneous self-preservation of an infant of only a few weeks of age.

To summarize, a computer simulation or any other simulation of awareness is characterized by:

(1) a great number of state variables
(2) a manifold of state variations
(3) variations in degree of transparency
(4) a high degree of interconnectivity
(5) eigendynamics of some variables
(6) eigendynamics of a complex of variables
(7) a possibility of satisfying contradictory goal variables.

Different high-level computer languages entail partly different variables for the organization of complex problem solving situations. However, the development of an ever greater computing capacity goes hand in hand with the development of ever more powerful high-level languages. Within this development, the mental dimension is conceived as cognitive processes, which have to be explained with reference to "schemas" in Minsky's (1975) sense. They are a means for the representation of world knowledge. However, when a system configuration builds on the imperative of association, "learning" is modelled on the basis of already known information (Bierschenk, 1984). Thus, a cognitive mechanism of this type would be capable of inferring "similarity" and establish "boundary conditions", but would be incapable of judgment, i. e. prospective reference. Informative components can be extracted, if and only if uniqueness can be detected or if known information can be transformed by operations of a schematizing process in the Kantian sense.

The Kantian Schema

Basically, the schematizing process merges the empirical with the formal aspect of an evolving system (Hartman, 1967, pp. 101-102). The crystallization of a system means always the discovery of a logic. Consequently, schematization implies that the empirical phenomenon under study needs to be connected with an application of logic. The fundamental assumption underlying classical argumentation in philosophy and science is that natural language is an insufficient instrument for the detection of the "true" nature of the world. For this reason, philosophers, logicians, and mathematicians had to invent pure elements and relations holding between them. By manipulating formulas assumed to correspond to the real world, it would then be possible to determine, within a model world, what is true and what is false. In this way formal logics would be a promising tool in the description of natural phenomena. The unreasonable success of mathematics with respect to physics (Wigner, 1967, p. 171) has been taken as a pretext by logic oriented linguists to give natural language expressions a semantic logical definition and thus, to describe language with reference to sets of analytical propositions.

The Analytical Proposition

The analytical proposition gives a formal structural definition of the clause or part of it. A clause consists of a subject and a predicate associatively connected through a copula, usually 'is'. The connotations of the proposition contain the instructions for the intentional use of a particular term. The way in which a term has to be used is prescribed by the denotations established through syntactic rules. In Kantian terms, this is the foundation of an analytic proposition. The analytical proposition is at hand whenever the predicate is contained (maybe in a covert way) in the subject. The ability to abstract the connotations of an analytic proposition is given through the ability to generate analytical concepts. These are the abstractions of experience, real or conceived. One of Kant's analytic propositions frequently cited is:

A triangle is a three-sided figure (1)

The expression (1) is analytic, since the term 'triangle' can be substit ted with 'a three-sided figure' each time an identity relation is established within a closed system, i. e. the mechanism of symbolic logic. Thus, "analytic concepts are those whose intensions consist of predicates" (Hartman, 1967, p. 31) which may be defined as "a set of words or symbols" (Craik, 1943, p. 29) which by definition must be a closed set. Every analytic concept derived by generating a set is surrounded by a "cloud of intensions" (Hartman, 1967, p. 34) which gives meaning to the concept. Logically, the independence between an analytic concept and its manifold of interpretations constrains its scientific power. Only through a continuously repeated process of abstraction can analytic concepts be redefined and possibly purified. What is lost in this process is meaning. Hartman (1967, p. 34) writes:

"The analytic definition seen in analytic purity is like an iceberg whose larger portion, the process of generalization is submerged."

Kant declared that the connotations of the predicate which are contained in those of the subject must lead to analytical propositions. From the classical behavioural point of view, the subject is the perceiver and the perceiver's language is the medium in which the structure of the subjective world of experience and the structure of the objective world show structural identity. Here, the language of the immaterial and the material describe two complementary aspects of one and the same reality. Though, the relationship between the perceiver and the perceived is not a causal but an identity relation. Therefore, the original studies of consciousness at the turn of the 19th century have focused on the analytical model as the psychological model in which the isomorphism between the predicate (the perceptible world) and the subject (the mental world) appears through an identity relation.

The Synthetic Proposition

In contradistinction, Kant formulated the synthetic proposition and declared that meaning can be comprehended only in synthetic terms. The significance of the synthetic proposition rests on the concept of linkage. Linkage implies that the predicate is linked with the subject. As such the predicate is neither thought to be part of the subject nor to be analysable out of the subject (Kant, 1975, p. 110-112). The concept of linkage signals "predictive ability" (Rosen, 1978, p. 84), and thus novelty. Transformed into a psychological model for the study of consciousness, the synthetic proposition can be given the following expression:

(int(A)) a (ort(O)) (2)

The first bracketed expression denotes that intention operates. Intention signifies a course of action. It implies a stretching out (Latin: *intentio*) or a stretching toward (Latin: intendere) some objective. To incorporate the intentional component into the expression (2) implies that the scope of action within a particular environment is the indispensable part. Intention is necessary for an organism (A) to act purposely. This is indicated by the cooperative actions (a). The second bracketed expression indicates the importance of the ability to orientate (ort) toward some object(ive) (O). Observing behaviour (a) in individuals acting purposely in a meaningful environment is hardly possible without an organism's expression of an 'intended' and 'oriented' schematization. In behavioural science terms, this means that psychological phenomena must be conceived as meaningful actions carried out by an Agent. Acting purposely presupposes not only that structure can be detected but also that intentionality and orientation can be observed. This may be illustrated by the natural language expression:

The researchers observed infants (3)

The variables in the expression (3) may be regarded as describing an observation belonging to a scientific environment. The researchers are the agents who perform a series of actions and the infants are the experimental subjects who function as the object(ive) of observation and study. Given that the relationship holding between researchers and infants has emerged the expression signifies "unity" in Polanyi and Prosch's (1975, pp. 66-81) sense on the basis of differentiated and transformed perception and behaviour. However, a researcher may place himself in the position of the objective:

I observe that I study myself (4)

The transformative process initiated by this expression (4) shows that the relation between Agent and Objective emerges as the smallest common denominator when both reside in the same organism. Further, The reader of such a text may be placed in the observer's position close to the occurring event. The A-component in the expression (4) indicates that intention operating at the observation and action level can be distinguished. At the observation level it gives expression to a distance at the same time as the necessary cooperative action and adaptation to the empirical observation is ensured. What is synthesized are the objects of nature kept together by the logic of affinity which guarantee the necessary synthetic unity of appearance. What Kant calls "lex continui in natura" (Cassirer, 1970, p. 48) is kept together by the transcendental logic of the Schema. For the behaving organism variance in the environment makes possible self-reference through "immediate awareness" (Kant, 1975) or "direct perception" (Gibson, 1979) of the invariance of objects and events.

If, for example, it may be assumed that infants represent the phenomenon of development rather their behaviour or function within events is being studied. The phenomenon, the scientific focus, is being elucidated through the infants acting toward certain specific objectives:

Researchers observed that infants crawled over edges (5)
A a (O) (A a O)

The researchers observations are composed of a series of (AaO) relations manifesting themselves in a hierarchy. When is comes to represent those observations this is continuously done in the form of a process, that is, the observations are packed linguistically coherent. The product is some form of running text. In general, any awareness that can be formalized into the expression

(Aa(AaO)) (6)

is an expression of a purposive act. Kant used the schema notion as device for establishing the scope of action by relating the events stretching over series of instances ("Segmente einer Zeitreihe") (Bierschenk, 1981). The schematizing process is assumed to achieve a synthesis by which variety becomes specified and symbolized. This means that the perceiver-perceived relations are accounted for on the basis of unity signified by symbols. As a consequence, information processing in absence of natural language is inaccessible to consciousness. In the following it will be shown that consciousness can be measured and represented only through natural language production.

General Systems Expression

A fundamental fact of all living systems is that they are self-referential and thus, they contain their own descriptions (Pattee, 1977, 1980). In operation, self-referentiality makes use of the dual steering and control mechanism exerted by the (A) and (O) of the expression (2).

In Kantian terminology the syntax of the expression constitutes a schema, i. e. the empirical independent (AaO) formula. The formula has axiomatic properties in that, it generates a formal system. Modelling and unfolding the formula into a system is carried out by a series of empirical dependent (AaO) relations and indicated by the index i, i = 1, 2, 3, ..., n. The following relations constitute the architectural configuration of the system:

General systems expression: $(AaO)_n = A_n\ a_n\ O_n$, where (7)

a_n = Dictionary identification of textual strings

Component	*Substitution*	*Condition*
A_n	Textual strings	A_n is directly accessible
A_n	X-variable	A_n is covert and unknown
A_n	A_{n-1}	A_n is indirectly accessible
A_n	$A_{n-1} + O_{n-1}$	A_n = 'it' and $(AaO)_{n-1}$ exists
A_n	X-variable	A_n = 'it' and $(AaO)_{n-1}$ does not exist
O_n	Textual strings	O_n is direcly accessible
O_n	Y-variable	O_n is unknown
O_n	$A_{n+1} + O_{n+1}$	O_n is indirectly accessible and $(AaO)_{n+1}$ exists

In general, a set of verbal strings has been defined as a clause if and only if all three constitutive components are present. In principle, an agent dummy (A) is substituted with the immediately preceding agent or clause. If the dummy is language specific (e. g. the string 'it') the immediately clause is the substitute. The object dummy (O) is substituted with the immediately succeeding clause.

The fundamental assumption is that the ecological facts are linguistically packed in such a way that viewpoints can be discovered, differentiated and integrated. By means of an unfolding of the (AaO) formula into a multiple linked ((AaO) a $(AaO)_n$) system, ecologically valid information can be extracted and abstracted. The meaning of this intrasystemic analysis only appears in the Kantian schema as synthesis. The linkage mechanism of expression (7) illustrates how the schema axiom may guide the development of the formula (2) into an algorithmic procedure characterized by functional, structural and dynamic aspects.

Making consciousness the outcome of the cooperative process of the constituent components of the Kantian schema implies that the action component (a) is the umbilicus, i. e the point of reference for the mechanism. The leading idea of the algorithm is that consciousness must be understood in terms of the agent rather than of a physical, symbolic or conceptual entity.

The states of a system of this kind are determined by the mutual dependencies (affinities) of its constitutive components. The affinity relations between the cooperatively operating and interacting components create the absolute terms, i.e. the invariants, which serve as point of departure for synthesis. The Kantian schema implies an interrelation and transformation of analytic concepts resulting in synthetic concepts. This process has to be conceived of as a merge of the empirical with the formal aspect of the evolving system.

In behavioural science terms, this means that the phenomenon of consciousness must be conceived as the synthesis of an active inquiring agent. The agent's ability of self-reference is the fundamental assumption and implies that no master interpretation can be forced upon its verbal expression. When self-reference is concealed or non-detectable, it deprives us of the possibility of knowing what is folded and represented by strings of symbols. Further, if such strings cannot be recognized as intentional verbal behaviour, they cannot serve the purpose of carrying meaningful information either.

The overall importance of the Kantian schema as methodological tool and conceptual framework for a logic of discovery rests on the assumption that an organism, being able to express itself freely, creates information of high validity. This means that the strict dependency of the (AaO) formula relates the perceiver with the perceived or more generally, the knower with the known. Consequently, self-reference need to be incorporated as the integrative component of the schematizing process.

Language as Carrier of Consciousness

The Kantian schema as link in a theory of consciousness is as fundamental as the axiom of number in a theory of physics. This has consequences for the conception of the Space-Time relation. In Kant's transcendental logic it refers not only to the relation existing between independent or associatively related substances and abstraction but refers to the relational order (affinity) that come into existence by a cooperative act. Kant conceives of consciousness as the product of a schematizing process.

Karl von Frisch (1967, Fig. 28-29, 46 and 52) studied "The dance language and orientation of bees" within a natural science context (see Fig. 1). Within his famous research program, he developed a demonstrative definition of the Kantian schema. To speak of schematizing would require the demonstration, that the dance patterns of bees carry a definite meaning. This requirement exactly fits the dance patterns. Frisch's experiments showed that a foraging bee (Fig. 28) performs the "round"

Figure 1.

Dance Language of Bees

From "The dance language and orientation of bees" (pp. 29, 57, 59) by K. Frisch, 1967, Cambridge, MA: The Belknap Press of Harvard University Press. Copyright 1967 by Harvard University Press. Reprinted by permission.

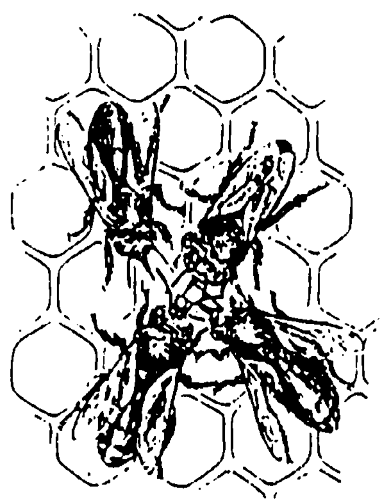

FIGURE 28. A forager (lower left) who has returned home and is giving nectar to three other bees.

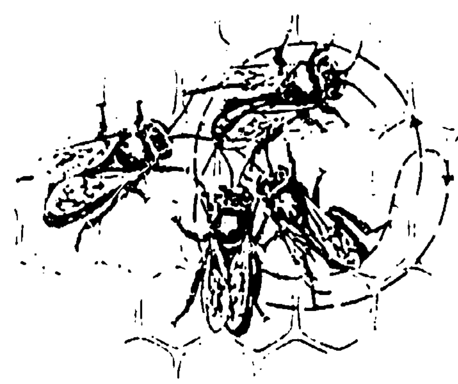

FIGURE 29. The round dance. The dancer is followed by three bees who trip along after her and receive the information

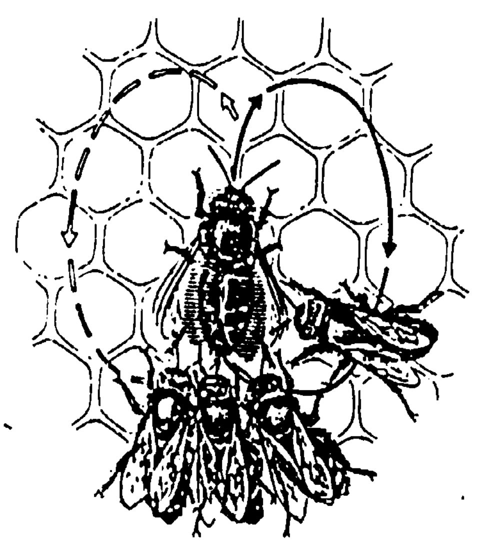

FIGURE 46. The tail-wagging dance. Four followers are receiving the message.

FIGURE 52. Tail-wagging dance with a large number (eight) of followers. In this sketch are shown also the nonparticipating bees in the vicinity. The movements of the dancing group clear a little free space on the thickly populated comb. The positions of the bees are taken from a photograph. Feeding station 2000 m distant.

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(Fig. 29) or "tail-wagging" dance (Fig.46) if and only if the foraging is worthwhile. A "round" dance clearly indicates that the sources of food are nearby. A "tail-wagging" dance is performed when the food sources are at a greater (> 100 m) distance. The "tail-wagging" dance, moreover, announces also the direction of the goal by means of the axis of the dance relative to the position of the sun (Frisch, 1967, p. 142). In addition, the duration (ca 15 sec.) and vigorousness of the dance relate to the amount of either nectar or pollen discovered. The better the source the more energetic and long-lasting is the dance.

The reference factors (int (A) and (ort (O)) will now be used with the purpose to study the specific process of schematizing. By casting the dance language of the bees into the (AaO) formula a radical different procedure for the schematizing of von Frisch's results is intended. The formula (3) may be realized through the action 'to observe'. The nominalization process is initiated in order to test its abstractions for structural affinity and for the self-referential properties of the bee as inquiring agent (A). In the present context it is sufficient to assume finite sets of values (= textual strings) reflecting the case of nominal or linear variables. Thus expression (6) carries the original structural information necessary for the development of a mental processing of textural information. During the processing both structure and process are modified through successive contribution of novel information. The manifestation of the A- and O-components belong to an observation, where the expression becomes:

Bee	A				(8)
observe	a				
that	(O)<---	A	a	O	
		Bee	dance	food place	

The dummy (O) signals that the object linkage has to be solved through reference to the succeeding clause. The dummy (O) symbolizes some observable whose variables include an agent and an object involved into an event. In von Frisch's study it is the dancing event which contains the ecological significant information that becomes available. The dancing bee performs a series of actions. For example, it uses its own body to communicate integrated information within a discontinuous Space-Time system. Any movement, such as wing-strokes without the intention to fly is a ritualized expression by which the bee creates a "language space" for an "analog 'I'" (Jaynes 1967, p. 62-66) to transform its awareness of distance to food places into abstractions. (Note: Consciousness) and to communicate its consciousness to a fellow bee.

By means of a differential analysis von Frisch studied the way in which a bee observes another bee as well as the way in which varied colonies of bees intentionally communicate their awareness. The fundamental idea behind von Frisch's careful and thorough control of intention and orientation is that a symbolic expression has to express self-reference. The consequences of this standpoint are that the medium has to contain species-specific carriers of information and that the organism has to have a device for "lifting the information from its carriers" (Foerster, 1969). Frisch's ambition was to measure whether sounds and movements are carriers of specific information. As Gibson (1979, p. 42) observes, an organism learns to discriminate within a "behavioural loop" what another perceives. With this point of departure, a bee observing another bee picks up information about movements from an "ambient optic area" (Gibson, 1979, p. 203). The optical pattern available to the observing bee is specified by the movements of the dancing bee. Its body generates a particular texture flow with its characteristic invariants. In the sense that the ecologically oriented geometry of awareness is directly determined by the geometry of texture, an unknown objective becomes known for the observing bee through the performance of the dancing bee. Thus, it can be argued that the "knowing together", i. e. con-sciousness has emerged for participating bees (Fig. 52) while others remain uninformed.

Making information something that emerges as a result of a cooperative process presupposes the possibility of tying the effect of an experience to a related activity instead of attributing it to some unrelated mechanism. If one with Gibson (1979) may assume that expressive behaviour manifests itself in informative light, this implies that the structure of an object or event can be studied through change. But "regularities" in change can be sensibly measured only with reference to a particular organism. Otherwise an assessment of what is known becomes meaningless. The functioning of the Schema in formalizing knowing can now be summarized:

Bee	A(1)	the knower	(9)
observes	a		
	Aa(O)	the known (integrated experience)	
that			
Bee	A(2)	the experiencer	
dance	a		
food place	O	the environment	

The relation between the two agents is asymmetrical in the sense that Agent(2) is experiencing an unknown environment, while Agent(1) has already integrated this kind of experience. Frisch (1967, p. 43) observed: "Those that have been collecting from the same kind of flower often give attention to one of their fellows from a distance of as much as 2-3 cm hasten to her." The experiencer-environment relation is known to her. Consequently, in his observations the knower is always present in the known. Whenever a knower intuitively knows the unity, it appears as one whole. In this sense, Kant has given a precise definition of intuition in his concept of Schema (Bierschenk, 1981, p. 14). Because the relationship between dance and food place are maintained as a result of Kant's transcendental logic, the topological structure of the ambient visual area transcend both physical and mental realities in which the relationship become realized.

Further evidence for this interpretation comes from the study of Regan, Beverly and Cynader (1979). The results of their experiments with a psychophysical model of stereoscopic motion indicate that ecological invariants exist in the visual-flow pattern. The authors have demonstrated that a variation in object orientation is important for the organism in its pick up of "exterospecific information". After this kind of information has been picked up from its carriers, the organism can extract the ecological invariants and needs not rely on concrete matter or energy. Moreover, a symbolic expression of self-reference allows for the detection of "propriospecific information". By anchoring knowing in these two poles, knowing the world prerequires the extraction of invariants from expressions of mediating experience.

Detection of Ecological Invariants

The ability to pick up information can be measured by covarying organism and environment. Since the variation in perspective is supposed to be dependent on an inquiring agent, it is tempting to study the degree to which this ability is inborn.

Symmetrically expanding shadows specify an approaching object within the ambient optic area. This fact were used by Ball & Tronick (1971) to test whether a newborn infant of only a few weeks of age detects quality of direction and relative depth. An infant sitting in a chair in front of an experimental arrangement was exposed to real objects and shadows on symmetrical and asymmetrical paths towards the infant's face. By simulating variations in perspective through real and virtual objects on the mispath they could make explicit that an inborn mechanism for perceptual information processing exists. The infant's avoidance behaviour implied that this mechanism works with high precision and high sensitivity concerning the direction of motion and the distance of the moving object.

The meaning of the event, in this case the object approaching the "centre of the ego", seemed to be immediately perceived as "danger for life". Thus, schematization implies not only information processing but also prospective reference to a future event, provided it is threatening enough for the survival of the organism. This conclusion is worth a thorough analysis by means of the (AaO) formula:

The researchers	A(1)	(10)
observe	a	
Aa(O)	O	
that		
the infant	A(2)	
discriminates	a	
paths	O	

As in the case of the bees, the dummy symbolizes the environmental variable. In the actual case, it is an event which incorporates an agent and an object on a path. From an ecological point of view the expression (10) manifests the fact that perception of the environment is an activity that twins together the perceiver and the perceived in a cooperative relation, without which the meaning of the perceived cannot be established.

The significance of the asymmetrical relation between the two agents lies partly in the manipulation of the object orientation of A(2), which makes available exterospecific information, partly in the manipulation of A(2) perspective, which allows some inferences about the abstraction of propriospecific information. The result is the observation that an infant of only a few weeks of age acts on the basis of a highly selective perceptual Schema. Lorenz (1950) and Tinbergen (1951) call this same mechanism a Schema in the Kantian sense. But there is neither evidence of a basic structure of language nor of consciousness. In the absence of communication, the meaning of the object is still dependent on correctly drawn inferences based on the geometry of motion.

The Intentional Use of Ecological Invariants

The experimental structure embedded in the design described by formula (2) will be studied further by applying a generalization of the expression (2) on the behavioural discrimination of contours:

(*(A))a and a(*(O)), where * indicates intentions and orientations respectively (11)

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The expression (11) constitutes the basis for transfiguration. By twisting and manipulating the measuring variables "Organism" and "Environment" of the Frisch's study it becomes possible to give a formal expression to the cooperation of both:

(org(A)a) and (a(env(O))) (12)

The organism-environment interactions captured by Gibson and Walk (1960, p. 65) and the environmental structure embedded in their 'Visual Cliff' design (Fig. 2) will be made explicit with expression (12) as instrument. The process anticipated to operate in this structure is dependent on the values (-,+) assigned to the action (a). With organism and environment as experimental factors a new set of four variables becomes available:

(1) A fixation of both (A- O-) represents the event depicted by the top left picture: A child of crawling age is introduced in order to specify the agents place in the environment, i. e. the centre board. Fixating both implies that neither the variation in the viewpoints nor the variations in the shifts of perspective can be measured. This is essentially the zero hypothesis of perception. A stationary environment is sensed by a stationary organism. Many procedures have been developed to create this state with the purpose to calculate the power of sensory stimulation. Stimulation above a certain value causes a response in the organism, so that the environmental information can be sensorily processed. But this does not imply perception.

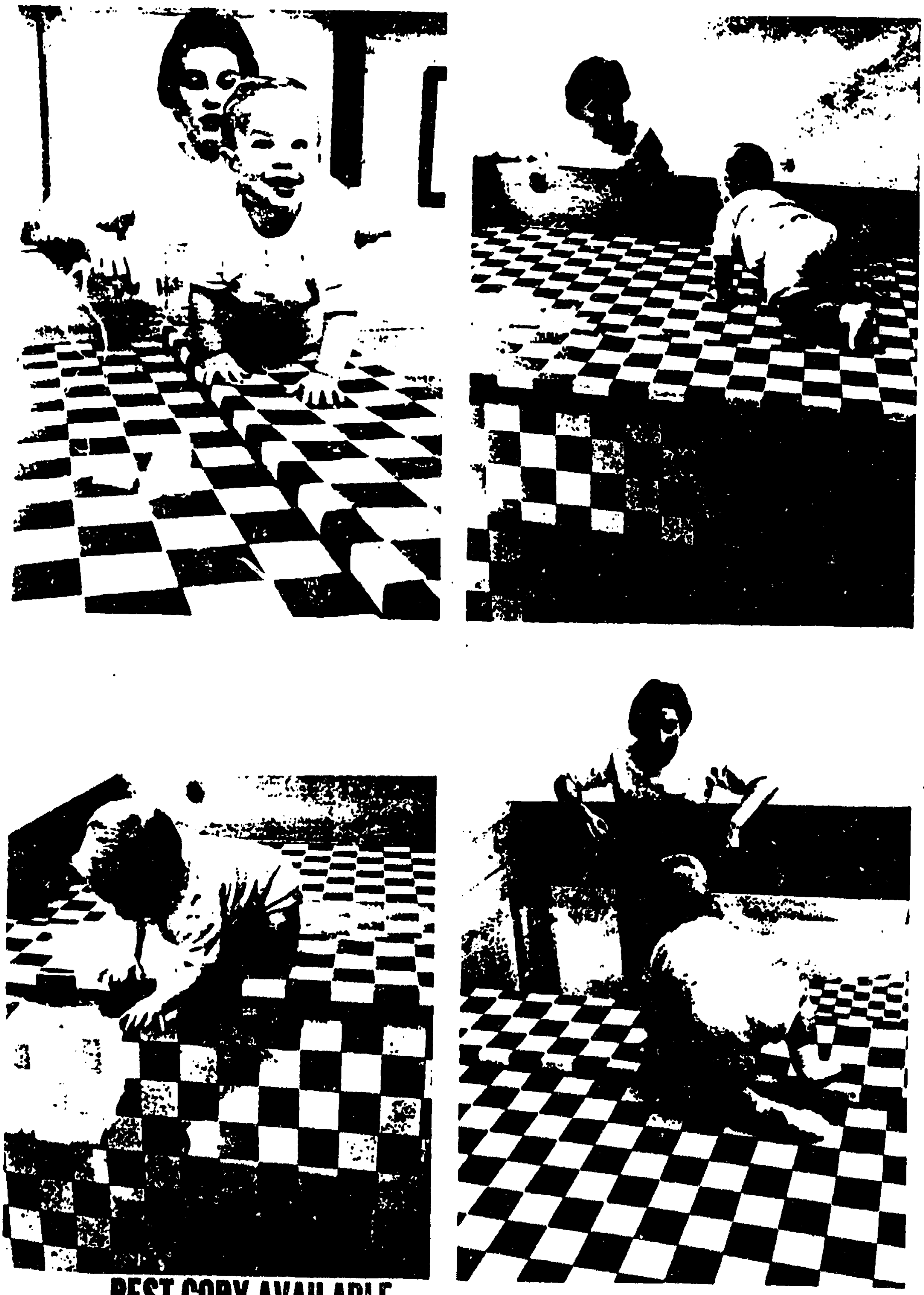
(2) First through a manipulation of the environment by mobilizing the O component (A- O+) variation in viewpoints are introduced and consequently, exterospecific information becomes available. This implies that an object orientation is initiated. At least two viewpoints although of different kind are observable. These are the checker squares of the surface texture and a lure in the form of the mother. The minus sign tied to the A component signals that no variation in perspective is implied. Contrasting of viewpoints of the same type is required. The result is made visible by the top right picture: The child crawls to its mother across the "shallow side" of the cliff.

(3) By mobilizing the A component (A+ O-) it is presumed that the Agent's perspective varies, i. e. it gets a different angle of inclination. This implies a shift in perspective. A state change is the result and documented by the body-floor relation in the bottom left picture: The child has turned around its body and tests the solidity of the glass surface by patting it at the "deep side" of the cliff.

(4) The complementary relationship between the variations in exteroception and proprioception can be observed by mobilizing both components (A+ O+). This implies that the affordance of the cliff can be detected. The result is pictured at the bottom right. The mother calls the child from the "deep side" of the cliff. The child has the deep side in front of it.

Figure 2.

The Child's Depth Perception
From "The 'Visual Cliff'" by E. J. Gibson, R. D. Walk, 1960. Scientific American, 202, p. 65. Copyright 1960 by Scientific American, W. H. . Freeman and Company. Reprinted by permission.



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- The Visual Cliff experiment has been set up primarily for studying:

(1) the detection of tranformational invariants, which specify the nature of change, and
(2) the detection of structural invariants, which specify the identity of the structure that undergoes change.

Gibson, Kaplan, Reynolds and Wheeler (1969) have argued that humans can directly perceive going or coming out of view as opposed to going or coming out of existence. Their argument has further consequences, namely, (1) any point in the environment is a possible point of observation, and (2) the organism's perceptual mechanism analyzes what is "offered" to it, i. e. what comes into view. Since such an analysis is fundamental for the survival of the species, the organism or individual makes intentional use of the information. It is therefore assumed that "egomotion" is encompassed in perception.

Because the ecological approach to visual awareness required an experimental setting in which perception of what is offered could be tested behaviourally, it was necessary to find a method for measuring optical information processing. The problem was solved in such a way that Eleanor Gibson's behavioural interest was built into the perceptual design carrying the ecological invariant. It was assumed that fear of hight is the negative emotional reaction that most significantly shows the intention of survival among the species. Consequently, the behavioural study of the sensitivity to hight was made the key for inferring meaningful behaviour toward the Cliff as a natural clue to danger.

In the picture series it is demonstrated that a cooperation of the organism with its environment requires locomotion As the pictures document, the infant is required to locomote (by crawling) and to orient itself across the Visual Cliff. This task could be performed by the researchers placing a lure, such as the child's mother, at the other side of the arrangement. If the infant refuses to crawl over the deep side, this is taken as evidence of fear of hight and depth perception is concluded. Moreover, it is demonstrated that awareness of an edge is a function of changes in both perspective and viewpoints. Changes in the infant's perspective increase with increasing locomotion. The ability of abstracting transformational invariance is thus a function of this locomotion and the differentiation of the objectives. The general result of the Visual Cliff experiments will now be presented with reference to expression (6):

The researchers	A(1)	(13)
observed	a	
Aa(O)	O	
that		
the infants	A(2)	
avoid	a	
the deep side	O	

Schematization synthesizes and preserves the origin of a developmental process. Therefore, progression implies a behavioural development in which every new phase is characterized by distinctive aspects. These increase the organism's autonomy in relation to its environment, and thus it chance to survive. At this stage in development, novel differentiations and integrations change the characterizing function of the Schema manifested in a corresponding change in the nature of information. The observed regularities in the infant's behaviour make possible an inference about an observed fact, namely avoidance behaviour as indication of a "negative affordance". But consciousness cannot be measured by this design. The meaning of the cliff has to be communicated by means of a text that captures the affordance of the experimental set-up.

Textual Transformation

Tinbergen (1951) showed by means of contour coding experiments that the structural transformation of a surface is necessary if it shall carry information that the individual of a certain species can use. Independent of its position on the evolutionary scale, it does not simply react to external influences. It selects, transforms and organizes information. This observation implies that a pictorial or graphical display has to depict crucial structural qualities in such a way that the individual can capture its significance by extracting higher order functions, which are assumed to be shapeless, formless and transcendental. "Direct perception" does, according to Gibson, extract and abstract the ecological significant invariants of the surrounding world. Of fundamental importance in the individual's perception of its environment is the affordance of an object or event. Affordances are defined as "invariant combinations of properties at the ecological level" (Gibson, 1979, pp. 127-140).

What can be observed in the experiments presented thus far is a systemic thinking, in which the (AaO) formula has governed the layout of the experiments. It is due to Lorenz's (1941) transformation of the Kantian schema into a natural science context that the Schema as hypothesis has become attractive in psychobiological research. Sperry (1952) for example developed his theory of "chemoaffinity", which established the basis for his split-brain experiments. As a result, Sperry (1969, p. 533) comes to the conclusion that "consciousness is an integral part of the brain process itself and an essential constituent of the action".

By applying the (AaO) formula to the analysis of behavioural outcomes it was possible to show that the synthetic proposition is the necessary instrument for the establishment of consciousness and that consciousness is closely tied to a linguistic mechanism. The essential key concepts for establishing conceptual invariance are "perspective" and "viewpoint".

For a conceptual coding of language the empirical context has to be known and the Agent function (perspective) be determined. Perspective control lies in the definition of a agent, which in turn, determines what viewpoints are chosen and how they change throughout a text. It is assumed that a pictorial and symbolic expression of the organism-environment interaction entwines perspective and viewpoints in the same way as intention and orientation have entwined organism and environment at the preceding level of behavioural analysis. It follows that the experimenters' consciousness of the organizational layout of the cliff must be studied by applying the (AaO) formula to the Caption text of the picture series namely:

"CHILD'S DEPTH PERCEPTION is tested on the Visual Cliff. The apparatus consists of a board laid across a sheet of heavy glass, with a patterned material directly beneath the glass on one side and several feet below it on the other. Placed on the centre board (top left), the child crawls to its mother across 'the shallow' side (top right). Called from the 'deep' side, he pats the glass (bottom left), but despite this tactual evidence that the 'cliff' is in fact a solid surface, he refuses to cross over to the mother (bottom right)."

The Caption text produced by the researchers is an expression of their degree of consciousness which becomes materialized through the textual flow. But transformations in the text are of a multivariate kind and therefore far too complex to be comprehended without a topological analysis and topographical representation.

Algorithmic Text Processing

Whenever observational events structure the language of an observer, this language contains information belonging to these events. Events are basically, the discontinuities in the textual flow. When it comes to present observations as a series, this is continuously done in the form of a process linearizing the phenomenon to be expressed. Thus the observations are given a syntactically coherent form.

The developed algorithm takes the production of natural language in the form of speech or text as an expression of an Agent's (A) cooperation (a) with some environment (O) with the aim of finding its absolutely simple constituents and its mechanism of transference. A strict dependency between these constituents creates the synthetic concepts. In the moment of text production, an observation is put into perspective. The experience of the Agent builds on actions implying that intention and orientation are incorporated into the perspective underlying the verbal flow. The perspective is defined through two points. One is the point of observation and the other the point of view, e. g., the horizon. Within these boundaries, processing of information comprises variable measurement of viewpoints which are focused to varying degrees of perspective inclination. The textual expression of the degree of variation is the distance between the point of departure (= beginning of running text) and the folded and serially ordered viewpoints of the text. There is a general topological correspondence between the events and the information presented through language. While maintaining its topological coherence, the nature of the information contained in a particular text changes as the process of textual production progresses from one terminal state to the next.

The graphical reproduction of an observer's perspectivation is essentially a pattern of strings of symbols and spaces in between, demarcated by a point at the beginning and end of each pattern. Note: That these strings carry the symbolic information commonly associated with words is of no relevance in a systemic determination of information. On the other hand language has to contain specific information that can be picked up from these carriers. In expression (16) the algorithmic functioning and the lexical notions of some sentence markers are shown.

The algorithm also has to work with clause openers which have the function of demarcating the boundaries of a clause except for the end of running text. Clause openers may be word grapheme as well as junctional graphemes. A graphical clause is part of a sentence. As illustrated in expression (16) a clause opener succeeded by another one defines the boundary as the end of a sentence in the technical sense. Thus, any first clause opener of a series is redefined as sentence marker. By this measure, the algorithm brings out implicit sentence markers. The algorithm defines on purely formal grounds the organizational frame of a sentence. But this frame is insufficient for processing the perspective in the verbal flow. What is required for a final analysis is a structural approach.

The Schema marks the structural aspect of a string of symbols. Schematizing incorporates the assumption that higher order functions are underlying the verbal flow, though not directly apparent from the analysis of syntactic categories. In the generative process, the analysis starts on the basis of the component represented by the verb. Without the identification of a verb, it is impossible for the algorithm to disclose a mental process. If the algorithm identifies two or more verbs, this will result in a recursive cyclic processing as many times as there are verbs. A procedure keeps track of the number of verbs within a particular clause and inserts immediately before any of two verbs the technical clause opener (that).

The verb

As verbs are recognized all finite and inflected verbal forms and participles inflected in concord with the grammatical subject. The following form categories related to the Visual Cliff Caption may be illustrative:

Form Category	Visual Cliff Examples	(15)
imperative	test	
present tense	consists, pats, crawls, refuses	
preterite indicative	patterned, placed	
preterite conjunctive sat		
infinite	to cross	
present participle	crossing	
perfect participle	laid, called	
supine	looked	

The definition is based on the assumption that the verb as predicative category and word class has to carry the controlling function in the final decision as to whether a clause is present or not. A consequence of this definition is that in Swedish language the particle-verb compounds and reflexives are not included, except the passive 's'. This implies that deponent verbs are considered to be part of the passive construction expressing an unknown Agent. Furthermore, the definition circumvents all problems associated with auxiliary verbs. Such verbs are treated as autonomous verb forms, that cause the algorithm to initiate a recursive cycle whenever an auxiliary and a main verb coincide. From a structural point of view, it has turned out to be an advantage to treat the auxiliary verbs as basic verbs. Basic verbs such as 'shall' and 'have' seem to be associated with fundamental life conditions (Jaynes, 1976, p. 51) and are for action as imperative as 'go' and 'stop' are for a mechanically functioning system.

At some stages of development, human perspective was very shallow and only could absorb a language based frame of action (I. Bierschenk, 1989). It is worth noting that a few basic verbs are immediately accessible in critical situations under time pressure, or when freedom of action is constraint and choice of strategy unclear (Bierschenk & Bierschenk, 1986). Moreover, the indicated algorithmic use of basic verbs results in clarity and precision of the analysis process. Finally, the copula 'is' has traditionally the task to connect a main word with an attribute in a symmetrical relation. The algorithm recognizes 'is' in the same way as any other verb in a directed, i. e. asymmetrical relation.

The algorithm has been operationalized by Helmersson (1987, 1991) in the form of a computer program which takes its departure in natural produced text. The details of the algorithmic processing and the approximately 50 rules of the system have been presented in Bierschenk and Bierschenk (1986). Consequently, the Caption text to the picture series has been subjected to the following procedure:

(1) (AaO) encoding
(2) Supplementation of A- and O-dummies
(3) Generation of A/O matrices
(4) Cluster analysis
(5) Topological analysis and topographical representation.

The procedure has led to the following outcome, for substitution of A-dummies (A)aO and O-dummies Aa(O) see (7):

(16)

Block	*Code*	*Block*	*Code*	*Block*	*Code*	*Block*	*Code*
(.)	00	with	70	(top	60	,	01 00
01 (that)	01	a	70	left)	60	09 but	01
(A)aO	30	Aa(O)	70	06,	01	despite	30
Child's	50	04 that)	01	the	30	this	30
depth	50	(A)aO	30	child	30	tactual	30
perception	50	patterned	40p	crawls	40	evidence	30
is	40p	material	50	to	60	that	01 30
tested	40p	directly	50	its	60	the	30
on	60	beneath	60	mother	60	cliff	30
the	60	the	60	across	60	is	40a
visual	60	glass	60	the	60	in	60
cliff	60	on	60	shallow	60	fact	60
.	00	one	60	side	60	a	60
02 (that)	01	side	60	(top	60	solid	60
The	30	and	01 60	right)	60	surface	60
apparatus	30	several	60	.	00	10,	01
consists	40a	feet	60	07 (that)	01	he	30
of	60	below	60	(A)aO	30	refuses	40a
a	60	it	60	Called	40p	Aa(O)	50
board	60	on	60	from	60	11 to	01
03 (that)	01	the	60	the	60	(A)aO	30
(A)aO	30	other	60	'deep'	60	cross	40a
laid	40p	.	00	side	60	over	60
across	60	05 (that)	01	08,	01	to	60
a	60	(A)aO	30	he	30	the	60
sheet	60	placed	40p	pats	40a	mother	60
of	60	on	60	the	50	(bottom	60
heavy	60	the	60	glass	50	right)	60
glass	60	centre	60	(bottom	50	.	00 90
,	01 60	board	60	left)	50		

In the case of a passive voice expression (p) the dummy (A)aO is supplemented with the a priori defined Agent (X) which is always activated. This may be exemplified by the first block of the Caption to the picture series which contains the passive voice as cue to the Agent. The two-figure code system carries the complementary dimensions intention (first figure) and orientation (second figure) according to the following scheme:

Component	Code	Component	Code	(17)
Sentence opener	00	Figure	50	
Clause opener	01	Ground	60	
Context	10	Means	70	
Experience	20	Setpoint	80	
Agent	30	End of text	90	
Action	40			

The scope of action

Conceptual components require a systemic arrangement of the (AaO) relations such that intentionality and directiveness can manifest themselves through linguistic variables. Linguistic variables may get different functions depending on perspective. Syntactic cues to conceptual description are the prepositions, which functions as pointers to the viewpoints of the subcomponents of the Objective (50, 60, 70, 80). Thus, the scope of action is precisely defined by number and kind of the prepositions. The scope of action and prepositions may be exemplified by some verbs from the Visual Cliff Caption:

A	a	O	Code	(18)
X	is tested	*without prep.*	50	
The apparatus	consists	of	60	
X	laid	with	70	

The component assigned help to illustrate their positional change and, as already indicated, change of function is an expression of perspective. The conceptualizations depicted in expression (18) follow closely a pure linguistic approach. But all viewpoints involved in every action are lifted up onto the observational level in case they have been left out by the observer. To be complete each observation must express an (AaO). On the observational level, however, this relation does not always get its manifestation in language. With the help of context the observer may chose not to make explicit the full relationship and still be understood. On the other hand, the scope is decided upon by the empirical context and has sometimes to be supplemented into the verbal expression for making its algorithmic processing possible. The algorithmic processing of an observation only can be carried out if the complete conceptualization of the observation is made explicit. This explicitness has to be obtained with reference to the scope of action and the empirical context.

Applied to the observations on the Visual Cliff, it denotes the determination of the point of departure, i. e. the Agent (X). The perspective of an observation may be wide. In this case it addresses the actions of both the observer and the observed. A narrow scope encompasses only the event on the cliff. Which scope is to hand can only be decided upon, if and only if the Agent is under control (I. Bierschenk 1987), because it has the steering and control function. It follows that the Agent must always be unequivocally identifiable, if any action shall be processed.

Supplementation

When the Agent is covert syntactic cues need to be employed to identify the Agent. Consequently, supplementation is strongly connected to the definition of the scope of action. The textual description of the Visual Cliff is done on the assumption that the experimenters govern the scope of action. They have set up the device and staged the observations. The analysis of the steering function of the Agent has been worked out by I. Bierschenk (1987) on the basis of the sample text: 'I should observe infants.' The difference between a positional (S v O) and a perspective (AaO) approach is exemplified:

String	Control (S v O)	(AaO)	(19)
(.)		00	
Why	Q_{adv}	01	
(A)aO		30 (X)	
should	v	40	
I	S	50	
(that)		01	
(A)aO		30 (X)	
observe	v	40	
infants	O	50	
(.)		0090	

I. Bierschenk (1987) observes: "The obligatory insertion of the Agent that is made by perspective analysis does not imply a complementary addition of a surface structure." The example shows that classical linguistic analysis is position bound, but it is not a question of filling a position. The challenge lies in taking the question marker as signal for initiating transformational processes. The (X) is the controller of the point of reference of what is being said of "I" It follows that "I" can be discovered as a viewpoint.

Intentionality and orientation

Both concepts imply a need for the indication of direction. This is achieved through the distinction of the Agent as centre or starting-point of an action from its viewpoints. The verb string is the umbilicus for the processing and must be identified by means of a supplied dictionary. The mechanism executes its work by searching for the viewpoints marking the orientation. Any string following immediately after an active verb is a materialization of one or more concrete or abstract viewpoints. The complementary move is carried out to mark any string preceding an active verb as the manifestation of the textual agent or agency in the expression. In the passive case, the Agent is marked with the variable X.

The Objective Component

The differentiation of the Objective component within a perspective clause is made on the basis of prepositions. In principle, this concerns the prepositions 'on', 'with', and 'for'. These have the function of representing three kinds of pointers toward structural variability. The perspective order between them is the presented one and refers to the distance from the verb. Viewpoints that are not preceded by a preposition are next to the verb and in direct focus. The preposition 'for' points toward something very distant beyond the visual field, i. e. toward the setpoint. With respect to the algorithmic approach, 'for' has priority over the other two and 'with' has priority over 'on'. This principle governs the relative position of the viewpoints. But perspective differentiation is possible only within the Objective component. If prepositions appear in the Agent component, they are treated as integrated in the Agent variable.

Figure and Ground. Both are subcomponents of the Objective component:
The Figure component denotes the absolute point of reference. This circumstance is syntactically identified through the absence of prepositions. A text consists of a number of perceived or conceived viewpoints presented in a certain determined order. A particular observation may refer to the immaterial existence of an event (e. g. 'depth perception') toward which the action is directed (Block 1).
The Ground component represents the absolute axis of reference and marks distance as an extension along the ground. In principle, the component does not rely on the abstract notions of Space and Time. Instead, the axis is empirically based and comes into existence through the Agent's cooperation with and exploration on the floor. In principle this concerns a spatial orientation which is syntactically identified by prepositions of the following type: 'in', 'on, 'under'. The operating strategies 'on the Visual Cliff' have all their viewpoints linguistically expressed.

Means and Setpoint. Both are optional subcomponents of the objective component:
The Means component. When a means is present it is regarded as an explication of the action which, however, does not effect its scope, but the number of viewpoints in the observation. A means gives expression to an optional aid or instrument by which the action is performed. Syntactically, the viewpoints associated with the Means component are identified by the prepositions 'with', 'through' and 'by'. In the Caption to the picture series only one instance is present (Block 3). The concrete action of the agent (X) is directed toward the glass in order to give 'one side' the appearance of substance.
Setpoint. What can be perceived or conceived beyond the limiting horizon of the experimental environment has not been realized in the Caption. This means that the experimenter's intention with the experimental arrangement is implicit. Syntactically, the viewpoints associated with the Setpoint component are identified with the preposition 'for'. From the perspective of the experimenter, the picture series has been composed with the intention to represent the simulation of the experience of falling for a child. This intention lies beyond the horizon of the experiment. The absence of this subcomponent indicates that the idea of the experiment has not been expressed verbally. The reason may be that the experimental description is well anchored in the design. Consequently, an explanation of intention beyond the experimental frame seemed superfluous. However, a present Setpoint does not denote the fulfilment of the intention.

Concentration of the Viewpoints

In general, the algorithm identifies four different kinds of viewpoints. It is capable of transference and functional redefinition of Agents and Objectives as illustrated by the Blocks 4 and 8. The results of this processing will now be presented in a blockwise fashion:

30: X (20)
50: CHILD'S DEPTH PERCEPTION
60: on the visual cliff

30: The apparatus
60: of a board

30: X
60: across a sheet of heavy glass
70: with X+material directly beneath the glass

30: X
50: material directly
60: beneath the glass on one side and several feet below
it on the other

30: X
60: on the centre board (top left)

30: the child
60: to its mother across the 'shallow' side (top right)

30: X
60: from the 'deep' side

30: he
50: the glass (bottom left)

30: despite this tactual evidence that the 'cliff'
60: in fact a solid surface

30: he
50: he+over to the mother (bottom right)

30: he
60: over to the mother (bottom right)

It is essential to realize at this point that the developed algorithm is based on observable properties of the Caption text being recognized. Block 1 illustrates that the intention and orientation of the text producers is integrated into the verbal description. The block (1) incorporates the assumption that the ecological significant information embedded in the textual structure becomes accessible only in relation to the activated variables (30, 50, 60). The crucial novelty of the algorithmic processing lies in the manner in which the variables apply to the text. They are named variables, because they interrelate the behavioural or qualitative character of any text. By means of the variables it is possible to perceive directly the variability of textual behaviour on the phenomenological level, but this variability is only virtually identical with the variability of the underlying textual flow.

Variables are not to be understood as names referring to something. The decisive step is the transition from Agent or Objective as constituents of a system comprising the object of study to agents or objectives as variables of the system to be observed. The block (1) gives expression to the intention carried by an unknown agent. Consequently, the agent as variable takes the string (X) as its value. The information of the viewpoints of the block (1) is carried by the variable codes for figure and ground (50, 60) expressing imagination and orientation. Thus, a variable of the system is some characteristic which, in principle, can be measured directly. The Caption begins with 'Child's depth perception' which is a specification of the state of the system at a particular point in time. Algorithmic processing implies that the string is taken as the 'value' of the variable (code 50). It is the code of the Figure component and marks the absolute point of reference. The algorithmic coding procedure does not instantiate some logical definition of the variable, but provides a starting point for observation and measurement. Here, the orientation is toward something more abstract than the environment itself. Intention is something inherent in the Agent which gets expression through the Figure. What is expressed is more abstract and more integrated information compared to the information carried by the Ground component. This is easily seen by the textual string of the Ground component: 'on the Visual Cliff'. The syntactic cue to the Ground is the preposition 'on'. In the Caption, the instances manifesting the Ground are numerous and concrete. This is due to the fact that the Ground represents the instrument of the explanation of the experimental cause. The importance of the algorithmic procedure lies in its capacity to evaluate a variable on a state of the system which eventually will result in the measurement and representation of its dynamics and structure.

Matching

Abstracting structural and organizational aspects of natural text implies that all strings are processed and tested for their distinctiveness. This process is initiated by a routine that tests the completeness of a block. During the coding process a block is procedurally defined whenever a 01-code precedes and succeeds some textual strings which include a verb string together with a string taken as value of the variables (code 30, 40, 50/ 60/ 70/ 80). When all codes are adequately represented all strings are further processed by a routine that generates unique strings. The comparison of strings depends only on intrastring criteria.

Unique strings are the basis for setting up a series of binary matrices of the (Nxp) type, where (N) represents the textual agents and (p) represents the textual viewpoints (v_i). The function of the agents is to guarantee the coordinative structuring.

Thus, the agent as variable is the makeshift instrument for change of position and transference. Its logical content is nothing else but a point in a pattern of relations produced by the matrix generation process.

Table 1.

Matrix k_1: Viewpoints of the Figure Component

	1	2	3	4
X	1	1	0	0
He	0	0	1	1

1. Child's depth perception
2. Material directly
3. the glass (bottom left).
4. He+over to the mother (bottom right)

With reference to the Caption text all matrix elements (a_{ijk}) are initially assigned the value zero (0). Thereafter, the matrix generation routine marks all relational affinities between the A's and O's with the value one (1). The blockwise unique string combinations are registered by the following matrices:

k_1: 30/50	k_2: 50/30	k_3: 30/60	k_4: 60/30
1100	10	101110100	10000
0011	10	010000000	01000
	01	000001000	10000
	01	000000010	10000
		000000001	10000
			00100
			10000
			00010
			00001

Basically, the textual transformations are conceived of as a series of equivalent relations to be established by some linkage procedure. The resulting state variables would then establish the link between the original text and the prototypical naming of the groupings of the viewpoints. In general, a binary matrix and its transpose represent different kinds of agent-related viewpoints. Concentrating the viewpoints means a division of the viewpoints of a particular matrix into natural groups. This implies that the distance between one viewpoint (v_i) and another (v_j) in the specified matrix is expressed as the distance of these two viewpoints only.

Dynamics and Linkage

The dynamics of a text gives expression to the intention of its producer. Dynamics generates, modifies or breaks the linkage relations existing between the variables established through expression (7). Textual dynamics defines also the constraints operating in a text. Such constraints can always be expressed in the form of linkage relations.

Single linkage as a method for grouping of units was developed by Sneath (Sneath & Sokal, 1963). His method builds on the simplest procedure of all the agglomerative methods developed for estimating the losses of information in the attempt of finding natural groupings and structural relations in a set of data. Single linkage is defined by the shortest link existing between two units or variables. Other linkage procedures are "complete linkage", "average linkage within the group to be formed", and "average linkage between agglomerated groups" (Anderberg, 1973, pp. 137-140). A method which comprises all three procedures has been developed by Ward (1963). Ward's goal was to find an agglomerative procedure which could minimize the degree of disturbance during the process of agglomeration. His method is based on the following fundamental ANOVA equation:

$$\mathbf{T} = \mathbf{W} + \mathbf{B} \qquad (21)$$

where **T** is the total dispersion matrix, **W** is the matrix of 'within' groups dispersion and **B** is the 'between' groups dispersion. For any given set of data the matrix **T** is fixed. This means that **T** is a constant and thus independent of the chosen partitioning of a given sample. The grouping criterion, therefore, depends on the functions of **W** and **B**.

The first and most important decision concerns the choice of a suitable measurement procedure. When observations are independent of size the computation of a distance value seems to be the most meaningful procedure for grouping a set of measuring objects into natural groups (Sokal & Sneath, 1963, p. 156). Distance as the measure has been applied, because the a_{ijk} element gives expression to the presence or absence (1,0) of an affinity relation. Ward's grouping procedure is based on the calculation of an objective function that minimizes 'within group variance' (**W**). The **W** function builds on the calculation of Euclidean distance which is a special case of the Minkowski metrics. A relocation of an individual element of a group is achieved by an updating procedure that saves the squared Euclidean distances between group centroids. The procedure starts with the total set and defines each element as its own group. The one-element group has as its consequence that the Error Sum of Squares (ESS):

$$ESS = \text{Sum } x_i^2 - 1/n\ (\text{Sum } x_i)^2 \qquad (22)$$

where x_i is the distance score of the *i*th element, equals zero (.000).

ESS = .000 is due to the fact that the numerator equals the squared sum of all elements in the group and that the denominator equals the number of observations in the group (Ward, 1963, p. 237; Anderberg, 1973, p. 143). At each step Ward's procedure considers all possible unions of pairs of groups. The two groups are fused that result in the minimum rise of ESS. Initially, the move of an observation from one group to another depends on the move of only one border at every iteration and thus, effects only a rise in B. By this measure ESS becomes proportional to the squared Euclidean distance between the centroids for the agglomerated groups. The recurrence formula for the calculation of the distance measure between groups can be found in Everitt (1974, p. 17) and is also available in Wishart's (1982) CLUSTAN program. Finally, Ward's method differs from common centroid methods in that the procedure weights the distance between the centroids during its calculation of the distances. The solution of the grouping results in a hierarchical organization of bifurcations.

The process of concentrating the viewpoints associated with the Figure component was carried out with Wishart's program and builds on the amalgamation of four textual strings according to the following tree information from the computer output:

```
Cycle    I    J    Coeff.   Items grouped
                             1 2 3 4
                             | | | |
  1      1    2    0.000     -   | |
                             |   | |
  2      3    4    0.000     |    -
                             |    |
  3      1    4    2.000      ---

Mean = 0.667       Predicted Clusters = 2
Dev. = 1.155       Realised Deviates  = 1.15
                   (t.80 < 1.63 < t.90)
```

Many hierarchic grouping procedure produces dendrogram data. These can be represented in the form of a tree. It is easily constructed on the basis of the presented tree-data. But these data as well as other relevant information is usually too extensive to be reproduced. However, in the actual analysis this information about the groupings can be reproduced together with the values of the t-distributions and their confidence intervals. The rule used is the "Upper Tail Rule", which is reported in Wishart (1982, pp 14-16). The t-statistics with (K = Cluster - 1) number of degrees of freedom is computed by a multiplication of the deviates with the square root of (K). Wishart uses square root of(n) where n = number of values on the optimizing function, i. e. the number of ESS values, which are three in the present case. A K-based instead of a n-based test value minimizes the problem of non-normality of the Error Sum of Squares. Except for statistical significance, when ever possible the Dendrogram may be examined for a natural shred in the hierarchy, which is a classical procedure in all multivariate analysis (Cattell, 1966). Thus the empirical definition of a group founded on the Caption text is based on the premise that an obvious break is identifiable such that the resulting collinear groups can be given a meaningful name. Moreover, the significance criterion P(t>T) for the t-test has a value of >.20.

Naming

The process of concentrating the viewpoints into groups starts from an agglomeration of the four textual strings represented in Table 1. Its cluster analytic treatment shows that the $v_{(1,2)}$ and $v_{(3,4)}$ are closest to each other. The prototypical naming of these groups abstracts the experience and imagination from the set of strings of symbols conglomerated within the respective group. This grouping may not immediately be comprehended. One may reason that $v_{(1,4)}$ would be closer. Though, the manifested relations are the result of the researchers operations, namely testing depth perception by preparing the glass surface on one hand and the child's behavioural objectives, namely exploring the glass on the other hand. The two elements linked to the respective group reflect an immediate connection to the upper and lower part of the picture series. The upper part represents the object of study, namely the experimentally modified floor (strings 1,2). The lower part depicts the phenomenon, the scientific focus, which is elucidated through the child acting toward the specified objects (strings 3,4). The elements in the groups cohere with Gibson's (1979, pp. 156-158) theory of affordance. Naming the two aspects (1) 'The Glass Floor' and (2) 'The Danger' respectively, reflects the theme of the Caption.

The process of abstraction and naming has generated analytical concepts originating from argumentation about the subject matter. The process of categorizing (from Greek *kata-*, against + *agorein* = to speak public, from *agora* = assembly) the Caption text has resulted in variables with practically no deviation in import. Crystallizing the strings representing the viewpoints, means that a minimally sufficient number of groups can be determined. The groups represent analytical concepts which have to be understood as an integration of the viewpoints. The result of the integration process is indicated by the prototypical names given to the clusters. It follows, naming the concepts is synonymous with naming the variables that represent the terminal states of the system. With an experimental orientation, it can be argued that the variables determine the conditions which allow the abstractions to substitute the original text.

Coordinative Structuring

The development of a network is dependent on the observed discontinuities which are the only reliable observations in the analysis of language as a dynamic system. This makes topology especially appropriate for the study of complex cognitive processes assumed to govern the morphogenesis that creates the "figure" of a text. Thus, the textual figure exists only as the result of cognitive processes and/or an mathematical abstraction of its viewpoints. This figure is free and independent of the surface features of text, but dependent on the language specific cues that carry the ecological information. Only through the cooperation of the viewpoints, carried by strings of symbols, and their schematizing can the mechanism inherent in natural language execute the relationship between observing and symbolizing in a meaningful way. This fact underpins the basic assumption of innate structural formation reflected through language. The dynamics of the transformational process involved and the constraints enforced by the terminal states create the topological order and consequently the synthetic concepts in correspondence with the given material. The way in which the different states are linked give rise to a course which characterizes the dynamics and structure of the original text.

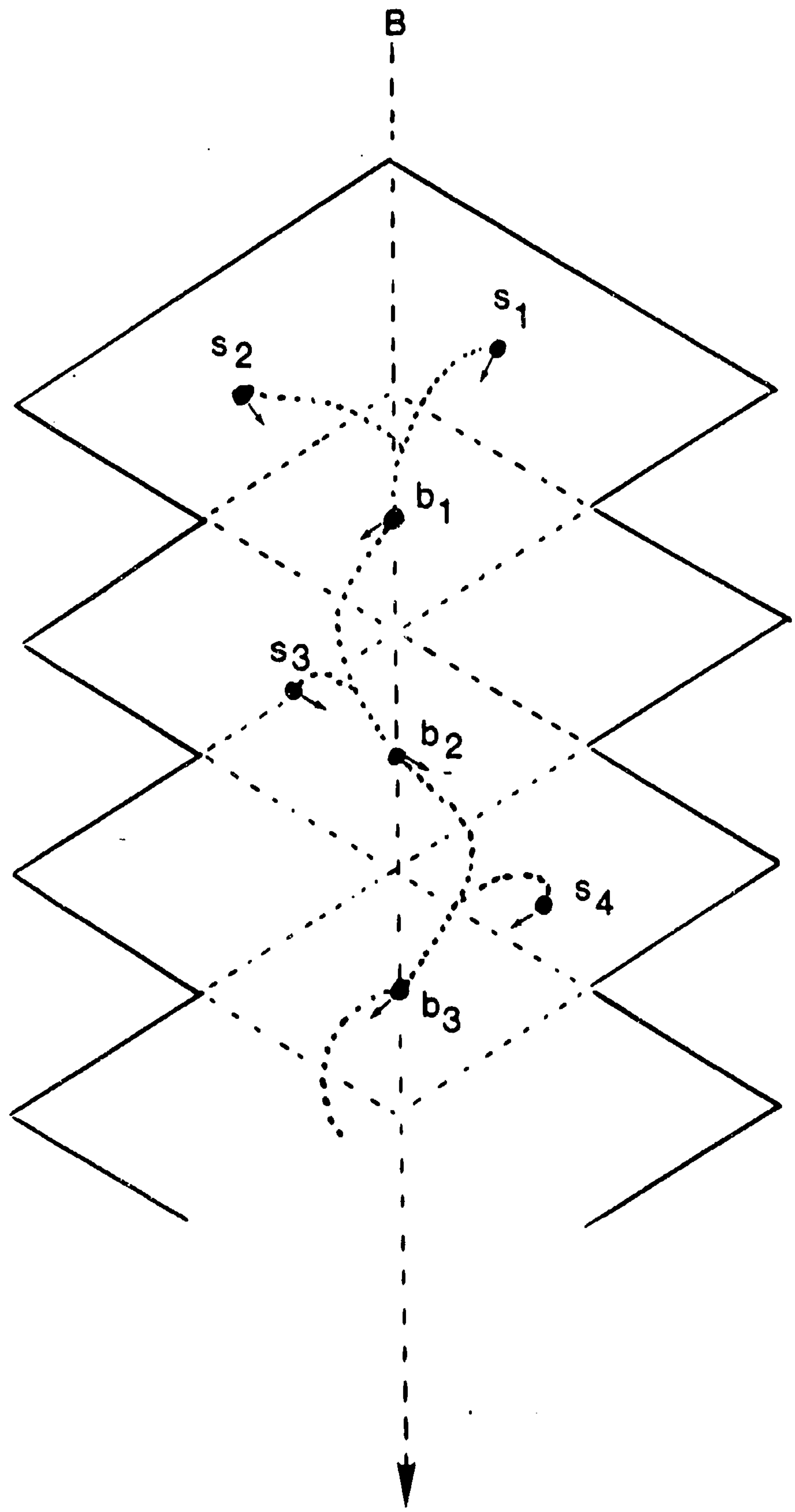
Figure 3 represents a three-dimensional space. The space (SxS) is indicated by the interval ($s_1<s_i<s_4$), while B, with the interval ($b_1<b_i<b_3$), encompasses the behavioural development of the process into a significant final state. By that, the process forms an attractor. The Space-Behaviour coordinates include a stable non-linear oscillating process and are therefore the natural choice of the Control space ($C = S^n xB$) with coordinates (s,b). A point ($c_i = (s^n,b)$) in C is called a control point and represents a particular topological invariant. C contains the entire bifurcation set (R^n) with ($r_1<r_i<r_n$). A bifurcation is a dividing point where a concealed operation in one type of description becomes visible in another. It also includes the one-dimensional variable (B) with coordinate (b_i). The variable B represents the Behaviour space because it depicts the quantity which forms the cusp. The function from C to B is single valued. The dotted cusp lines form the surface of Figure 3.

Applied to the Caption text, the ($n = 2$) clusters specify the terminal states that are required to specify the developmental process on the Visual Cliff. The variable for s_1 is 'The Glass Floor' and for s_2 it is 'The Danger'. Moreover, they define the State space for the process. B_c is a distribution with a unique maximum at (b_1). It shows that the function represents the maximum of the curve in the single point (b_1) which also is the highest point of the cusp captured in the text. Thus, the attractor in the interval ($s_1<s_2$) has developed into a significant final state, marked by the singularity, called *The Falling-off Place*.

It follows that the scientific problem now can be stated as the Figure of the text which is described by this singularity. Synthesis on the basis of the (AaO) formula is the reconstruction of the subject matter of analysis in a different, namely the topological dimension. In agreement with the formula (7) the Schema as generative process unfolds the mentality governing language production in correspondence with the analytical content of the language produced. This is the dynamical aspect of the (AaO) paradigm

Figure 3.

Behaviour Space: Nonlinear Homorhesic Process Unfolding into a Helical structure.



which is most amazing, because an unexpected arising consciousness can be discussed in a natural way. Consciousness can with Sperry (1966) be characterized as dynamic patterns which control language behaviour. These patterns effect a course which not only is bound to the texture but is anchored in the mentality. The creation and production of text logically must create "emergent novelties" (Rosen, 1978, pp. 90-93).

In general, any consciousness that can be formulated into text would be an expression of an intentional act. There is no need for further reference to any specific underlying mechanism. It is postulated that the quality in the verbal expression is defined by its underlying Schema. As outlined in Figure 3, the synthetic concept *The Falling-off Place* is part of the theoretical expression in that, it designates a terminus or a limit and thus a topological invariant and this invariant allows an immediate translation of its mathematical property back into the Gibsonian theory of direct perception.

The Perspective on the Figure

The transformational process, originating in Table 1, shows that two textual agents have operated. The first one, agent ('X'), has governed the viewpoints associated with 'The Glass Floor' and is therefore profiled or typified with the help of this concept. It can easily be observed (Tab. 1) that this agent in a systematical way is related to the problem of coordinating sight and body movement reflected by the first textual string. The second textual string refers to the experimental environment, hence, the reference to a material being placed flush against the undersurface of the glass. Thus the first group of viewpoints refers to a device that could simulate for the infant the experience of falling. If this is the case, the result would be a Visual Cliff. With knowledge of the experimental context it is now possible to substitute the variable (X) with experimenter or with text producer because the experimenters are also the authors of the paper that appeared in Scientific American.

The second group consists of textual strings that are related to that part of the experimental setting which gives the impression of depth. Therefore, it simulates the danger of falling. The agent ('he'), has governed the viewpoints associated with 'The Danger'. Thus, the pronoun 'he' can now be substituted with child. Consequently, the agent can be typified with the name of the second grouping which is "The Danger". The systematical relation of this agent with the cluster means that it concerns the ability to develop judgment in relation to the problem of coordinating sight and body movement. In conclusion, substitution of an unknown for a known agent can be carried out if and only if the affinity relations underlying the agent and objective configuration have been analyzed.

Thus far, it can be summarized that the perspective puts the viewer into the Visual Cliff pictures. Gaining objective scientific knowledge requires the extraction of the perspective, because the perspective of the viewer represents the subjective inference and distortions brought about by subjectivity of the text producers. The observed structure of the Figure component is concerned with the perception of an edge, but this does not result in a better representation of reality nor does it enhance the reality of the picture series. The analysis is concerned with eliminating or at least minimizing subjectivity in order to gain in objectivity. An edge in itself does not imply that the observer conceives the ecological significant information nor does it imply that the edge has to be perceived as a call for action.

The Ground

It is obvious that locomotion involving the Visual Cliff as point of orientation is the necessary prerequisite for the detection of the transformational invariant which specifies the nature of change on the floor. Gibson (1979, p. 157) writes:

"A cliff is a feature of the terrain, a highly significant special kind of dihedral angle in ecological geometry, a falling-off place. The edge at the top of a cliff is dangerous. It is an occluding edge. But it has the special character of being an edge of the surface of support, unlike the edge of a wall. One can safely walk around the edge of a wall but not off the edge of a cliff. To perceive a cliff is to detect a layout but more than that, it is to detect an affordance, a negative affordance for locomotion, a place where the surface of support ends."

Obviously, the Figure of the Caption to the picture series presents the scientific problem, namely direct perception of an abrupt change in the surface of support. Moreover, the text is intended to describe what affordance an abrupt change has for the child. In the Caption, meaning has been defined by relating the cliff to avoidance behaviour.

Both real and virtual environments require a ground. The ground structures the observer's perception of objects and events. Reasoning by the experimenters means stating the ground for visual perception or imagination. However, in natural discourse the reason for behavioural orientation may be more or less structurally given and extractable. Grouping the viewpoints of the Ground component means partly the empirical definition of a minimal grouping, partly the application of the same t-test criterion as in the identification of the groupings of the Figure component. The clustering of the binary matrix (k_4) of the Ground component has resulted in the following dendrogram data:

```
Cycle    I    J    Coeff.    Items grouped

                             1 3 4 5 7 2 6 8 9
                             | | | | | | | | |
1        1    3    0.000      -  | | | | | | |
                              |__| | | | | | |
2        1    4    0.000       --  | | | | | |
                               |___| | | | | |
3        1    5    0.000        ---  | | | | |
                                |____| | | | |
4        1    7    0.000         ---   | | | |
                                  |    | | | |
5        2    6    0.400          |     -  | |
                                  |     |  | |
6        8    9    0.400          |     |   -
                                  |     |___|
7        2    8    0.400          |      ---
                                  |       |
8        1    2    1.111           ------
```

```
Mean = 0.289    Predicted Clusters = 2
Dev. = 0.378    Realised Deviates  = 2.13
```

$(t_{.80} < 3.01 < t_{.90})$

The process of concentrating the viewpoints of the Ground component starts from the empirical grouping of nine viewpoints. On the basis of the shred-test, two groups of textual strings carrying the viewpoints emerge:

Group 1
1. on the visual cliff
3. across a sheet of heavy glass
4. beneath the glass on one side and several feet below it on the other
5. on the centre board (top left)
7. from the 'deep' side

Group 2
2. of a board
6. to its mother across the shallow side (top right)
8. in fact a solid surface
9. over to the mother (bottom right)

The first group consists of five textual strings. Prototypical for all of them is that they help to determine a floor which has been experimentally modified in order to simulate the cliff. No doubt, the prototypical character of the first group relates to the awareness of depth and thus the possible detection of a *negative affordance* for locomotion, i. e. the discovery of "a place, where the surface of support ends". Consequently, the first cluster can be named 'The Detection of Negative Affordance'.

The second group refers to information that can be picked up from the solid side of the glass floor. In this case the surface can both be seen and felt. It is this group of strings that carry the information about the solidity of the glass surface. The experimenters reason for this has been to study the child's ability to test the glass surface for its solidity. Thus, the second group represents the 'Surface of Support'. Both groups contribute to the definition of the surface conditions: a visible and an invisible side. Gibson (1979, p. 157) writes:

"The glass affords support under both conditions but provides *optical information* for support only under the first. There is mechanical contact with the feet in both cases but optical information for contact with the feet only in the first."

The structured configuration concerns the judgment of the consequences of locomoting on the deep side. Obviously, the transformational impact of the second group on the first gives expression to the experimenters reasons: *Avoidance*. It is inferred that the child is afraid of falling off the cliff. Thus, the result of an optical information processing can be measured sensibly only on the basis of propriospecific information. Gibson (1979, p. 157) writes: "One's body in *relation* to the ground is what gets attention."

Perception and proprioception are complementary (Gibson, 1979, p. 157). This fact can be observed when the analysis of the Caption text takes its point of departure in the Schema model. The strict dependency between the textual elements becomes visible. Different agents have different functions in the text development and have been chosen to give expression to what is conscious to the experimenters.

A differential typological analysis of the functioning of the agents will give information about which processes may be thought to operate in the manifestation of a focused perspective. The grouping of the Agents associated with the viewpoints of the Ground (matrix k_3) has resulted in the following computer output:

```
Cycle    I    J    Coeff.    Items grouped

                             1 2 3 4 5
                             | | | | |
1        2    3    0.222     |  -  | |
                             |  |  | |
2        2    4    0.222     |   --  |
                             |   |   |
3        2    5    0.222     |    ---
                             |     |
4        1    2    0.933      -----

Mean = 0.400    Predicted Clusters = 2
Dev. = 0.356    Realised Deviates  = 1.50
                (t.80 < 2.12 < t.90)
```

Two natural groups of Agents can be observed. The first contains one textual string (X). The second group consists of the other strings:

Group 1
1. X

Group 2
2. the apparatus
3. the child
4. despite this tactual evidence that the 'cliff'
5. he

The systematic covariation of the first Agent group with the viewpoints (1, 3, 4, 5, 7) addressing 'The Detection of Negative Affordance' (matrix k_4) clarifies the experimenters stated reason: Measurement of the perception of the affordance of the layout through the judgment of a sharp drop by the child. Apparently, the researchers' aim is to learn more about how infants become aware of the meaning of a sharp drop. The agents of the second group are meaningfully related to the viewpoints (2, 6, 8, 9) implying 'Surface of Support', because the focus is here on alternative locomotion. To run the experiment, there has to be some action function. The apparatus and the child are required to provide for locomotion and for behavioural orientation across the cliff. Obviously, the Ground is the absolute axis of reference and marks distance as an extension along the floor. The Ground gives the operational definition of the viewpoints that denote the points of orientation. This is the implication of a focus on alternative possibilities for locomotion.

In sum, the authors of the Caption text have been successful in realizing their purpose of describing the picture series of the Visual Cliff experiment from a theoretical point of view. The topological analysis shows that the Figure component represents the significant environmental change, defined over the contrasting sides of the experimental layout. In order to bring out the theoretical important aspect of the theory of ecological perception, the results point toward a description by the horizontal contrasting of pairs of pictures. But the Ground of the text must have been described by a vertical contrasting of the picture pairs, because the latter contrast gives evidence to avoidance as the other theoretical constituent of the experiment.

Single Subject Experiment

Perceivable events are defined by their discontinuities. Whether a certain event defines a risky environment depends on the structure of its affordance. A negative affordance, as in the Visual Cliff example, implies the detection of the ecological significance of discontinuous support. For example, many parents, who have carefully observed their infants at crawling age, may have noticed that initially they crawl over edges of different kind without being aware of the risk of falling. The design of a child's environment therefore has a decisive influence on its cognitive development. The adult has to exercise "prospective" control which means that the adult's ability to overlook a child defines its security range. Overlooking a child's activity comprises a covariation of physical experience and perceptual integration of the environment. But not before this integration is expressed symbolically can consciousness be observed. Symbolizing means that properties and phenomena, relations and connections, processes and consequences can be named and expressed as text. This ability is highly dependent on the adults own exposure to environmental change and shifting of perspective which has as its consequence that the function of viewpoints is changing.

Method

In general, any single subject's ability to relate itself to the event on the Visual Cliff has to be determined on the parameters characterizing the individual's level of performance and variability in performance. Strictly speaking, it is always appropriate to test the hypothesis of perspective and objective structure on the basis of a single subject experiment. Moreover, such an experiment is required if one wants to substantiate the conclusions drawn from the results of the analysis of the Caption text. Moreover, this kind of experiment needs no further legitimating, because it is the only defendable approach to schematizing processes. The individual's point of observation and angle of inclination determines position and distance to the event on the Visual Cliff. What from one observation point is perceived as an objective may be an intention from another.

Subjects. Since the original Visual Cliff experiments have been carried out with infants of crawling age as subjects, parents of infants of the same age were invited to participate. The parent was picked from a sample of sixteen who were booked for a routine control at a rural district's Child Care Centre.

Materials. The parent were required to make as exact observations as possible on the pictures series of the Visual Cliff and to formulate these observations into a narrative. It is assumed that a verbalization in close connection to the pictures materializes the subject's particular orientation. This would imply that the viewpoints are intentionally chosen and the perspective is contained in the verbal flow.

Design and Procedure. The subject were given orally the task to describe the content of the four pictures so as to make somebody get a conception of them who has not seen them. Further, information was given of (1) how to identify the glass surface, since this cue in the pictures (bottom left) has not been properly perceived as far as the pretest could show and (2) how to regard the picture series so as to make possible to conceive the pictures as a conceptual whole.

Data. The task was to produce a written narration. Ecological significance means that the infant's behaviour on the Visual Cliff may be taken as an indication that the environment "afford" something for the child. When our experimental subject is able to study the infant's purposeful behaviour and to express it wordly, the result should be a text reflecting these "affordances". The kind of text produced has been analyzed by means of the presented formalism.

Results

The Schema approach must be capable of not only controlling the organizational layout of the viewpoints and their variations in type and complexity but it must also control the perspective chosen. Moreover, this intertwined logic of analysis and synthesis must cope with the affordance and abstract its invariants on the basis of language specific variables. This ecological orientation presupposes that the coordination of body movement and visual ability can be developed and measured through changes of the viewpoints. Since these are supposed to be interacting with and dependent on changes in the perspective, it is interesting to study the outcome of what the experimental subject has picked up from the experimental set-up.

Figure 4 represents the subject's Phase space ($R^n xT$) with ($t_0<t_i<t_4$). The time interval encompasses the development of the process into conceptual depth. The process depicted is of a transformational kind. It transits through a number of states and produces at each progressive step a singularity as its response. The singularities are represented by the nodes on the enclosed part of the surface. It is a Phase space which is the result of any successive state's transformational effect on the immediately preceding state or singularity. The transformational process is metaphoric and as such asymmetric in kind. When the process moves inward, i.e. two phases cross each other, a more deeply embedded and thus a more elaborate mental structure emerges. If the course of the process changes direction and moves outward, this structure looses in embedding.

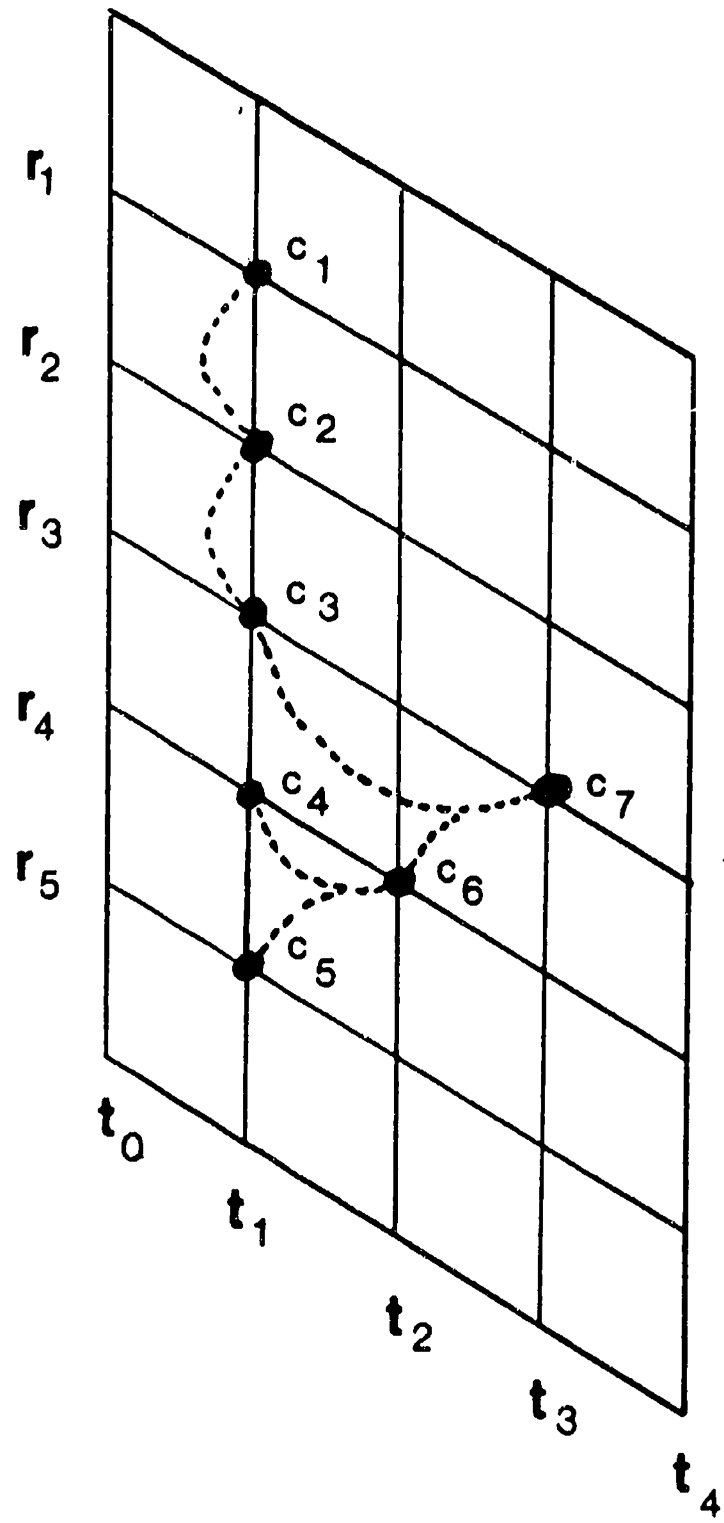
The attractor in the interval ($r_1<r_i<r_3$) develops smoothly as a stable oscillating process. Though two different paths develop in (r_4) and (r_5). Both imply two short jumps, i. e. a hysteresis which is initiated by sudden changes in direction. When the third path crosses the second one a new and deeper embedded attractor comes into existence at (t_2) . Still deeper embedded in the unfolding helical structure is the highest point of the curve which is the singularity at (t_3).

The perspective transformation of the depicted course can be achieved through the Agent control. The strict dependency of the matrices established by the (AaO) formula is most critical for observing what is in the focus of the perspective. The structured configuration of the Agents (in case it can be established) in relation to the configuration of the viewpoints can be comprehended topologically.

The working of the Agent control is described precisely by a pendulum, whose movements are constraint by the way in which the groupings of the Agents are linked. Figure 5 gives the resting point of the pendulum. It is the highest point of its curve, namely the singularity where the process bifurcates. For example, by swinging the pendulum from state (s_7) to state (s_8) the first invariant of the perspective (c_6) becomes available. By swinging the process back and force between states and singularities the process establishes the focus. Moreover, the transformational restructuring of the viewpoint-related agents implies the detection of structural

Figure 4.

Phase Space: Hysteresis



invariants that do not specify an identity between the structure of the perspective on the Figure and the structure of the Figure itself, though occasionally structural identity may result.

As indicated by Figure 4 the occurring structure is not dependent on the number of state variables. Their number may be large compared to the controlling attractors which are five. Dotted cusp lines symbolize the nonlinearity of the process.

The problem now is to collapse the topological dimensionality such that the whole process can be represented on the surfaces of a cube. For that purpose, the movement of the process is marked with a circle around any singularity resulting from an inward move. If the course of the process moves outward, the structure looses in depth and corresponding circles are removed.

The following convention has been established. The edge of the background surface of the cube represents the Phase space (P) of the Figure component, with ($p_1 < p_i < p_n$) progressive steps. Any singularity (P_{ci}) produced by the steps is represented by a node on the surface. The focus of the perspective on the Figure is mapped onto the foreground surface of the cube.

In order to achieve a compact representation the bottom of the cube and its top are used to map the Ground component correspondingly. For the other components, if they emerge as a structured configuration, the surfaces of the left and right hand side may be used as well as a projected surface beside the background.

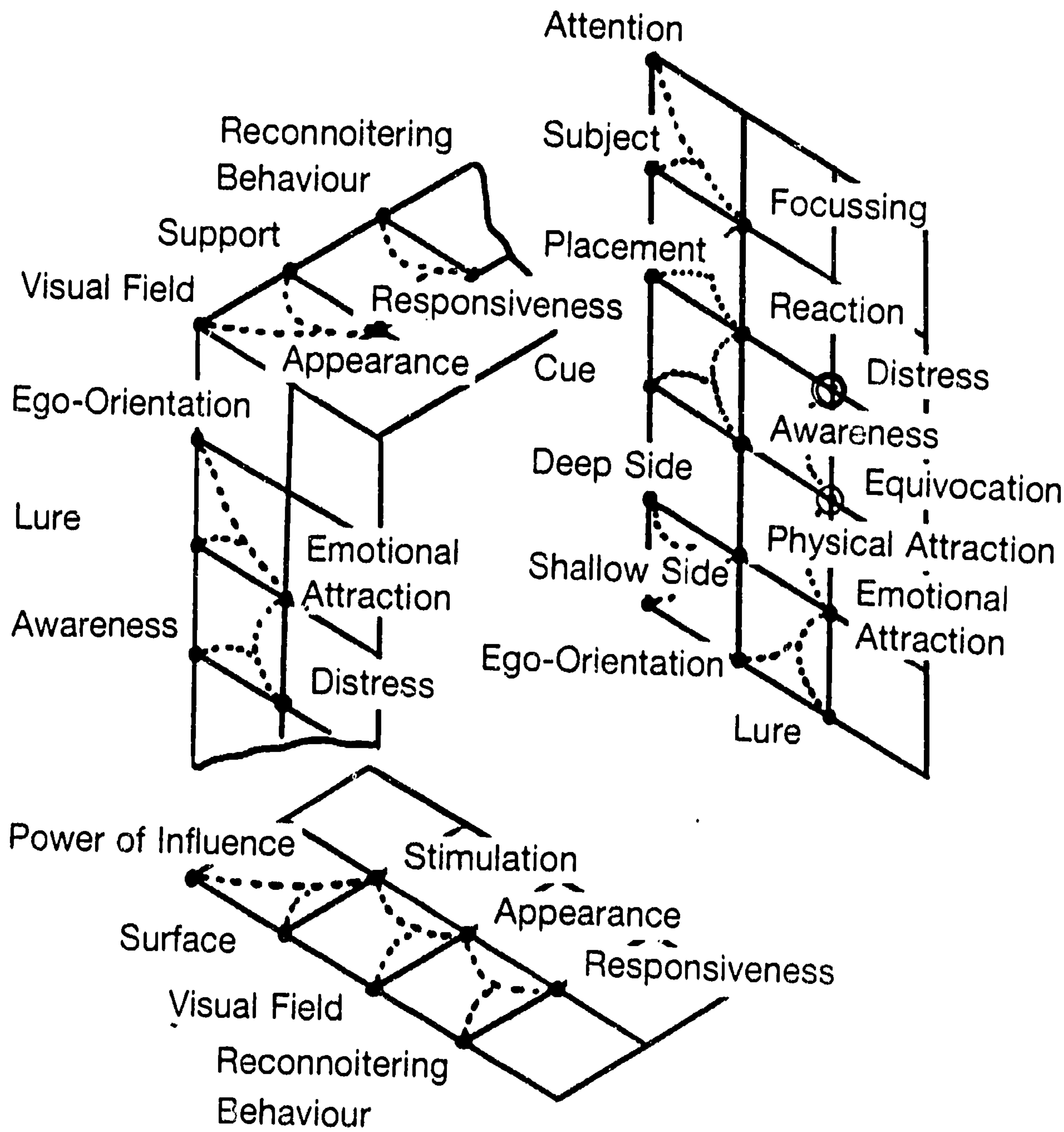
Processing of Exterospecific Information

The surfaces of the cube (Fig. 5) reflect the compact topographic representation of narration of the event on the Visual Cliff by the experimental subject. Clearly, the Figure component of the cube shows five distinct phases. The first phase starts with 'Attention' and ends in the singularity of *Awareness*. Thus, the environmental condition is conceived as an awareness-experiment providing for the study of a child's ability to become aware of the pertinence of change. The second phase picks up the information related to the textural surface and is terminated in *Physical Attraction*. Speaking in Gibsonian terms, the hight has not yet been associated with affordance. The third phase concerns the child's Ego-orientation. A change in perspective is enforced through a 'Lure' which results in the singularity *Emotional Attraction*. The implication of this is an Ego-motion toward the 'Lure'. When the third phase crosses the second one, a fourth phase comes into existence and ends in *Equivocation*. It indicates that our experimental subject has identified two different kinds of attraction and perceived their competing difference. Moreover, the terminus is deeper embedded in the unfolding cognitive structure.

An apparent problem in the narration of the Visual Cliff experiment by this subject has resulted from the function of the 'Lure'. This is clearly brought out when the fourth phase crosses the first one. The fifth and final singularity is marked with two circles. They indicate a further deepening of the cognitive structure. The attractiveness of the 'Lure' for the infant has been conceptualized as a confounding factor. This "uncleanness" of the original Visual Cliff experiment consequently results in *Distress* as the root of the Figure, i.e a stressful situation for the child. One of the subcomponent shows that the subject was able to detect and narrate environmental change as defined over the two contrasting sides. The other subcomponent represents the observed transformation of locomotion through the 'Lure' into egomotion. In-

Figure 5.

Topographical Representation of a Narrative of the Event on the Visual Cliff



tentional egomotion transforms into provocation, which has to be conceived as "cognitive motion".

Processing of Propriospecific Information

With reference to the theory of ecological perception, it is important to separate the structure of the Figure from the structure of the perspective if one wants to study the child's reaction to its environment. Therefore, the analysis of a symbolic expression cannot be carried out successfully before the focus of the textual perspective is experimentally detached from its viewpoints. The model developed rests on its capability to determine the Agent function, i.e. the perspective, which governs the choice of viewpoints in the language production. Perspective control lies in the functional definition of the agents and the viewpoints. Identifying and isolating the agents effect implies that "propriospecific" (Gibson, 1979, p. 157) becomes available. The process of concentrating this information consists of directing the analysis toward an iterative process that determines the minimally sufficient groups that represent the whole configuration of agents. The purpose of differentiating the textual agents into salient groups on the basis of the prototypes found in the analysis of the viewpoints is to identify the agents who have the same profile of scores on these viewpoints.

The focus is on the stressful situation. Moreover, the subject's perspective constitutes a transformation which brings the appearance of the experiential layout and the child's responsiveness into focus. Perspective transformation of the Figure component produces what reported experimental outcomes give evidence for. Some infants who have reached an early crawling age (5-9 months) would give emotional expression to the provocation by crying toward their mother (Gibson & Walk, 1960).

Processing the Reason for Experiential Information

The Ground component provides complementary information. The subject seems to reason about what the Gibson and Walk experiment could actually show. The Ground represents possible forces of attraction while the course of the process specifies the child's *Responsiveness* with respect to the optical arrangement as its root.

The focus of the perspective on the Ground makes clear that the behavioural event is what has come into view. Obviously, "Ego-motion" is encompassed in Ego-orientation. Moreover, the results make evident: The experimental subject refuses to state the affordance of the perceived, i.e. to state the Gibsonian inference. The reason for the event on the cliff and consequently, with respect to the child, the reason for the realism of the negative affordance cannot be established.

Discussion

Thus, there is very little reason to doubt the preciseness and completeness of natural language when used in a scientific as well as in natural context. The metaphoric properties of language allow people to communicate information put into perspective which is always unambiguous. By the metaphoric use of language it is therefore required the natural, and not the semantically based ability to conceptualize.

The crucial assumption behind this presentation is that the world can be perceived when the medium for reflecting its structural qualities are the conceptual relations lying in the texture of natural language expressions. But the structure of a certain event cannot be demonstrated independently of theory. The Gibsonian theory of affordance is based on the Kantian schema and provides the necessary theoretical link. Accordingly, events that have affordances have ecological significance. The affordance properties of significant events are characterized by a structure which has to be specified by a model whose components are assumed to collaborate in order to attain or conserve the relations of the structure.

But the transient nature of the event requires its description in technical terms. Only a technical specification can make visible and possibly avoid conceptual ambiguity. Thus, the course of events and consequent action strategies have to be defined through laboratory operations (experiment and measurement). The series of pictures of the Visual Cliff experiment presents such a definition. The pictured procedure gives a formal expression to a child's experience of a provocation. The persisting invariants of the discovered structure give evidence to a stressful situation that is the result of the ambiguous definition of perceptual integration and synthesis.

Gibson and Walk (1960) have produced a Caption text to the picture series that contains the theoretical important singularities, namely the imagination of "The Falling-off-Place", i. e. a virtual cliff and "Avoidance" as its behavioural ground. Though, the negative affordance is unconsciously inferred. The operationalization of the theoretical objective in the form of the pictured organizational layout is not the primary information provider for the our experimental subject. Consequently, their is no clear support for a prospective reference, i.e. direct perception of depth and the development of meaning as related to the judgment of consequences. In conclusion, the parent of a child in crawling stage is able to make conscious the insignificance of the pictured event for a theory of affordance.

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