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**Invariant Formulation of the Kinematics
of Body Movement on the Visual Cliff**

Bernhard Bierschenk

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No. 80



Copenhagen University
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**KOGNITIONSVETENSKAPLIG
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Cognitive Science Research

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Abstract

No one has ever been able to look into the language space nor has anyone been able to measure the phenomenon of consciousness without the interference of an observer. This article is changing this situation completely. From now on it is possible to produce measures of consciousness without the presence of classical observation devices. In particular, the observation problem can be bypassed since the "observer" is part of the "observed". This means that the phenomenon is describing itself. Since there is no longer any need for mirroring the state of consciousness by the state of an apparatus, the classical problem of an observation on the apparatus has disappeared. It is shown that the measurement situation has been changed fundamentally. A full description is attainable through the establishment of the geometrical shapes of involuted textual flows.

This article presents a reanalysis of the caption to the Visual Cliff experiments. The conditions of "The Schema Axiom as Foundation of a Theory for Measurement and Representation of Consciousness" have required a phase-independent processing and an exact reproduction of the identified control parameters in the form of periods, fractions, shear, and strain has not been in focus (B. Bierschenk, 1991). In contrast, the refinements presented in the article are based on the phase-dependent mode and require that the reanalysis is taking into account fitness values in the form of radians as well as the control parameters. It is demonstrated that this is generating a more elastic and fluid form of adaptation to the properties of the caption of the Visual Cliff, which were formulated by Gibson and Walk and presented in *Scientific American* in 1960.

The radians, together with the control parameters are producing coordinated displacements of text segments that can be identified with dynamical system states. The shown developments make evident that the coordination of the A- with the O-component of the Agent-action-Objective (AaO) paradigm is absolute in the biological sense and consequently established on the basis of processes that are independent of the material (grapheme) composition of these components. Furthermore, the reanalysis of the caption in terms of a phase-controlled A- and O-kinematics has contributed to an invariant formulation of important terminological refinements.

In a fundamental sense, the variations in the shading of the established termini are of particular interest, since they seem to have great theoretical value. Hence, whenever the depicted process is advancing from one state to the next, the establishment of distance is a measure on the degree of directness, which is driving the system toward the intended path. It follows that a distance below zero corresponds operationally with a path that exhibits a certain degree of indirectness. In conclusion, independent of the kind of distance, as expressed by negative or non-negative values, rotational pattern dynamics means that the intention of the text producer is an ingrained property of the attractor states of the generated fitness landscapes.

Furthermore, in using the rhythmic, clock-like working mode of text building behaviour in the study of information synthesis, it is possible to determine phase-dependent displacements of a particular grapheme or string of graphemes in relation to some others. Thereby, it is made obvious that text production implies the displacement of textual elements through rhythmic movements, which can be measured with precision. In confining information synthesis to the working of two clocks, namely the A-clock, governing the rhythmic textual movements in the Agent-component of the AaO-paradigm, and the O-clock, governing the oscillations in the Objective component of the paradigm, wholeness and order in text production can be apprehended.

Finally, from the precision in the working of the involved clocks, topological consequences of rhythmic movements in text production can be extracted. If the context for text production is conceived of as part of the resulting information synthesis, related text generation may be viewed as development of a system that is constructed on the basis of lawful regularities. These regularities can be determined at the ecological level. From the ecological point of view, a text producer's style of approaching his environment has been defined as an expression of his personal way of maintaining contact with his surroundings. Hence, in terms of Gibson's ecological approach to perception (1966, 1979), it means that a text producer's approach to his environment is constrained by his sensitivity to environmental affordances. But affordances are specific to the environment in which a particular text is produced. Therefore, any sensible textual expression must have been properly adjusted to situational circumstances.

The Axiomatic Foundation of the Steering and Control Mechanism

A fundamental fact of all living systems is that they are “*self-referential*” and thus that they contain their own description. Further, in departing from the fundamental hypothesis that nature is the producer of language, this hypothesis requires that the steering and control mechanism, responsible for proper production becomes recognisable. From a strictly scientific point of view it is, however, not sufficient to take the point of departure in nature. Methodological considerations have to be based on an a-priori assumption. In the present context, the assumed basic principle, underlying all living systems is the following:

AaO → Axiom (1)

The principle, stated in Expression (1) presupposes a dual steering and control mechanism, which is anchored in the A-O-dependency. Further, as the a-priori principle of all living systems, it is the foundation for the establishment of “*synthesis*” and consequently meaning. By this assumption, it is likewise stated that the principle is reflecting natural law. However, the reflection requires the introduction of a copy of the principle, which makes it functional:

[AaO] → Functional Axiom (2)

Hence, the functional axiom implies a copying process, which is establishing the biological mechanism underlying natural language production. By this assumption is meant that the principle becomes functional in the moment when a copy of its components is being realised. Functional in Expression (2) refers to the production of a “*standard copy*”. Each time such a copy is being copied, the copying process is carried out irrespective of its meaning.

However, from an evolutionary point of view, it can be stated that irreversible time enters into the process, which makes the mechanism always departing from any strict or uniform reproduction. Hence, the mechanism steadily is producing new forms of expression. This circumstance is symbolised in Expression (3):

[ØaØ] → Incompleteness (3)

When either the A-component or the O-component of the dual steering and control mechanism is missing at the textual level, incompleteness is to hand. It would not be out of place to mention that Expression (3) has far-reaching consequences for the study of language as a phenomenon of nature.

Except that the duplication, according to Expression (2) takes place in strictly mechanical terms, the co-operative interaction between different A's and O's is producing various displacements of the components through their “*dislocation*”. This condition is symbolised as follows:

[Aa(Ø_AaØ_O)] → Interacting Sequence (4)

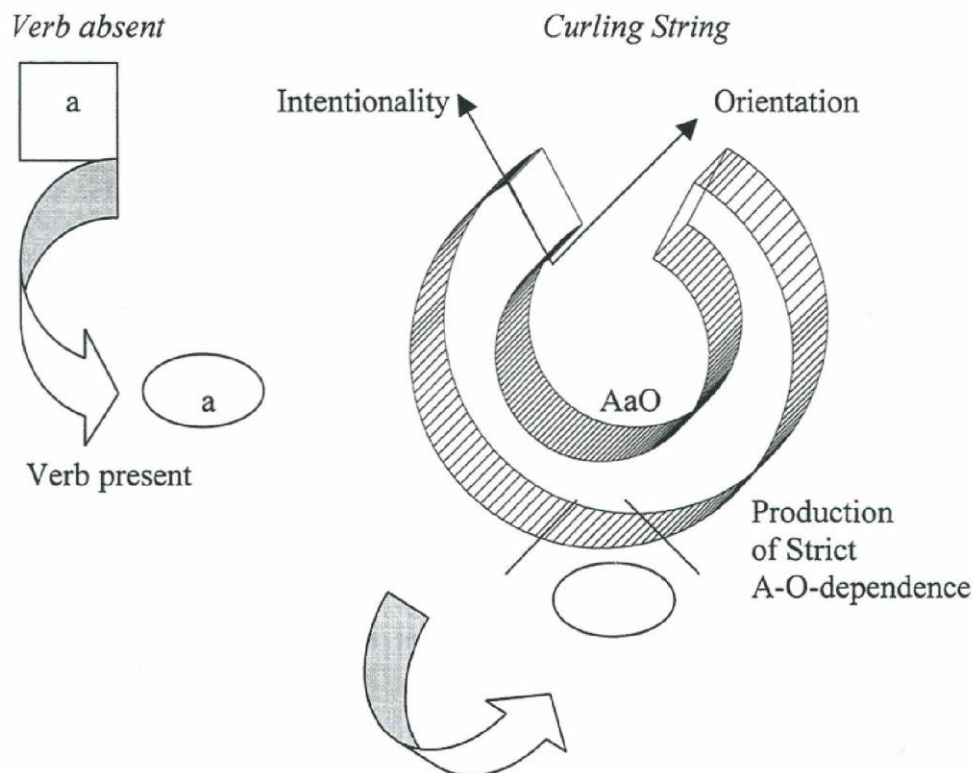
Hence, through dislocation of different components in the order of succession, every new language expression is establishing itself as a new form and the result of novel terminal states. When the language production process is ordering the copies in interacting sequences, irreversible time is governing the process, but this requires that some copies emerge incomplete. This circumstance is influencing profoundly both the evolutionary process that generates radical flow morphologies and the “*channelling*” of the flows, which requires that channels are swiftly formed in order to transport the corresponding textual flows.

Establishment of Completeness

To be able to identify the A-component presupposes that its identity can be discovered, which is possible only under the condition that a text producer writes something. Getting to know the A-component this way implies that an action becomes real and that its linguistic expression reflects the nature of the action, which is the production of a strict A-O-dependency. However, it is crucial to be able to catch the corresponding movement at the textual level, which is carried out as follows:

Figure 1.

Establishment of Completeness



The “ring opening” depicted in Figure 1 suggests “expansion” and consequently flexibility in a string of graphemes. The “curling” of a string demonstrates a first measure in the development of a language space. Successful development builds on the identification of the verbs present. Without the presence of a verb no channels can be formed. On the other hand their presence is establishing the ways in which the A’s and O’s contribute to the development of a space. Hence, the a-component is determining the specific bonding relations, which the participating verbs have produced.

The Curling String

The production of a language space and its effect on developing flow morphologies becomes accessible only if a complete textual surface can be produced. Such a surface requires that the dummies can be supplemented with text segments, i.e., sewed up. But this operation can only be performed under the condition that there is either a thread or a string

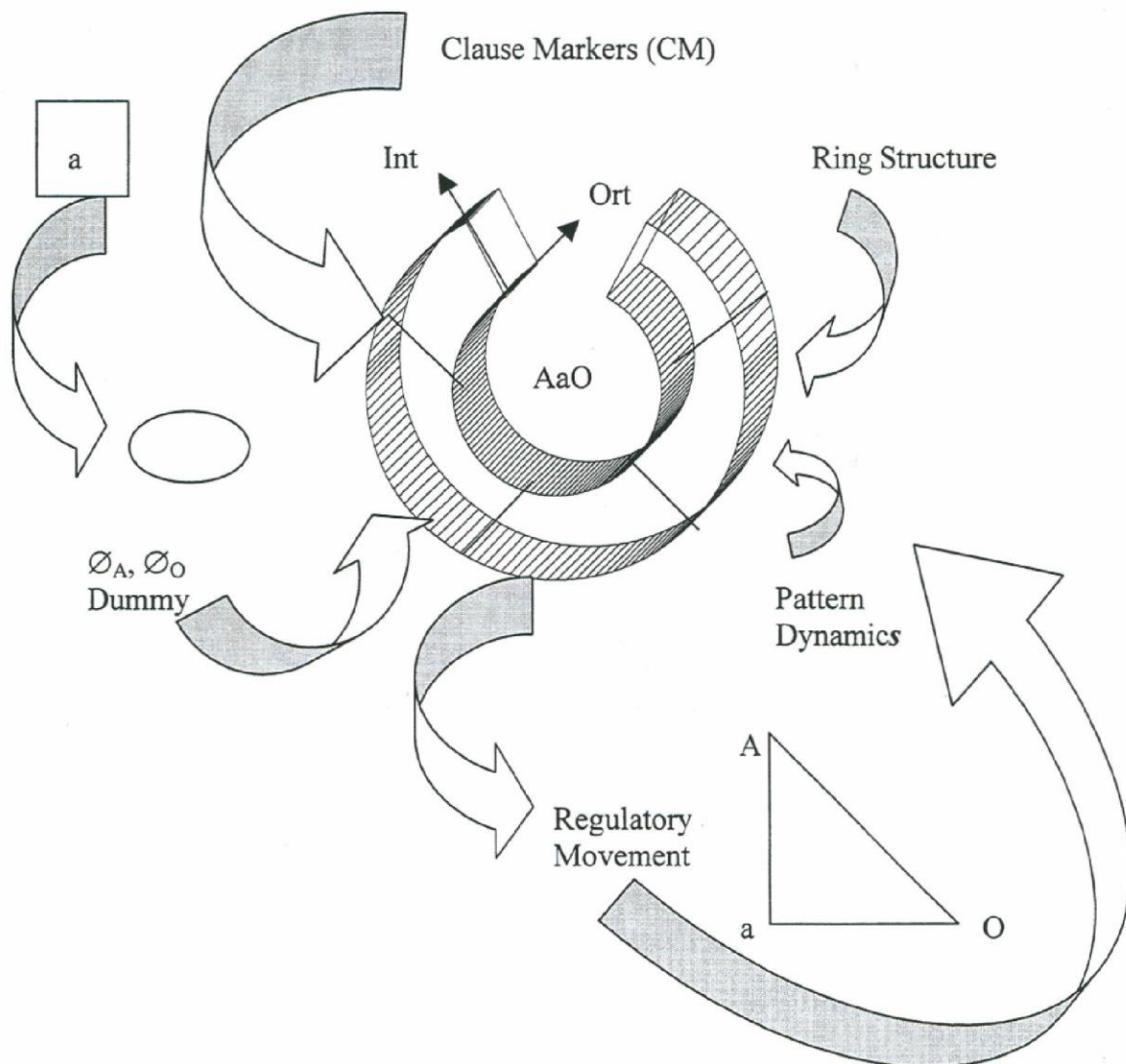
with which the mechanism can work. Therefore, their production and use must necessarily refer to intentionality (int) as well as orientation (ort). This means at the same time that dimensionality is inherent within the string itself. Further, it becomes identifiable and differentiable in the moment when a grapheme is produced. Hence observing the production of natural language expressions in a meaningful environment is hardly possible without an intention and orientation. Figure 1 presupposes that the intention can be separated from the orientation. It follows that a grapheme is a suitable marker of an identifiable string. Any string may be associated with some of the components (A, O) and give expression to the variability within each component. The difference of this variability may refer to variance in the complexity of the strings on one hand and to the curling of the strings on the other, which express distance in place and time.

The Ring Structure

The intentional dimension is manifesting stretching through the co-operative action (a) in order to make text production adaptive in relation to some objectives (O's). Its functional operations are demonstrated in Figure 2.

Figure 2.

Ring Structure



The second dimension indicates the importance of orienting the production toward a particular Objective (O). However, when the A's and O's reside in the same biophysical system (i.e., an organism, a text), this system must be treated as self-referential.

Hence, natural language, conceived of as self-referential system, is organising itself and characterised by a biophysical mechanism, which is developing the structural aspect of a graphical expression in the form of a grapheme and strings of graphemes. It follows that a ring structure is always open to expansion before it is absorbing textual elements. In its function, it is performing either as an indicator of structural relations or as a communicative tool when it is forming the channels of the textual flow. In its latter function, it is always a-posteriori and regulative. But both functions contribute to the development and shape of the language space.

As shown in Figure 2, in case there is a dummy of one or the other type, this means that a textual flow is observable, which is concentrated to those places where the dummies have emerged. As to the channel formation, the dummies mark "holes" in the textual surface, which implies that they may be used to decide upon the character of a particular flow morphology, resulting from the corresponding textual pattern dynamics. Finally, the triangle of Figure 2 marks that two copies have been coupled on the vertical axis. Vertical coupling is a mark of spiralling structure as well as an indication of an evolving configuration, which is the result of a "winding factor" (Winfree, 1980).

The mechanism, obviously, operates in accordance with a pendulum. In its forward or downward move, textual segments are driven into those places, where text is missing. But in the backward or upward move of the pendulum, explicitly integrated textual segments are moved into places, where they stay permanently. It follows that pendular movements create accelerations in textual flows, which are directed toward centres, where the involved textual elements become strongly concentrated.

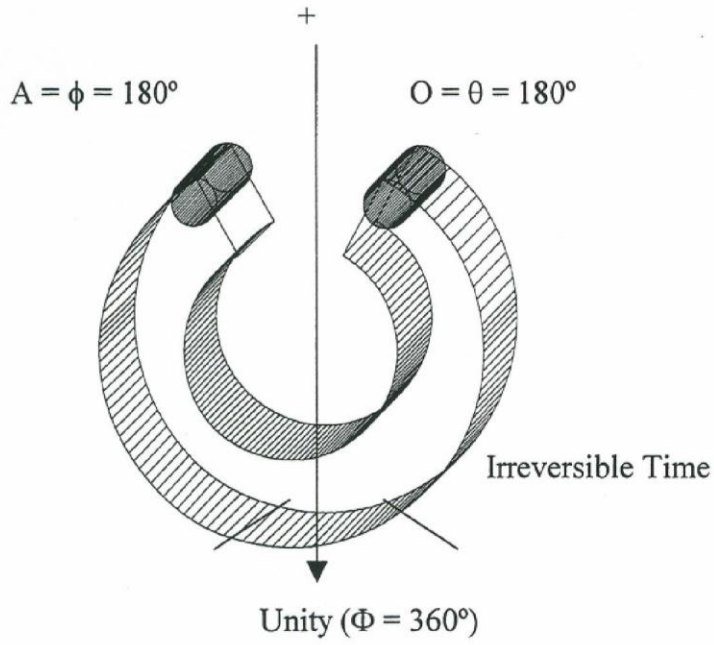
But even more important is the fact that the pendulum obeys two laws. One requires the mechanism to keep and conserve the strict dependency, which must hold within the A-O-pairs. The other requires that the pendulum always is establishing symmetry. Together, the two laws lead to strict co-ordination, which results in the establishment of "blocks". The "block" concept concerns synchronisation. This means that an A-O-pair within a block remains both co-ordinated and unchanged when exposed to different phase transitions. As may have become evident, a textual agent and a textual objective give expression to a dynamics, which comes about within strict borderlines. Thus far, involved phase dependencies are marked by the "Clause Markers" (CM), which are interlocking the thermodynamic patterning.

Irreversible Time

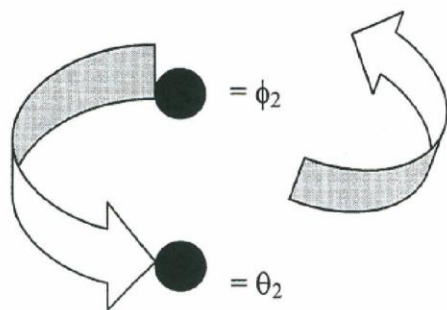
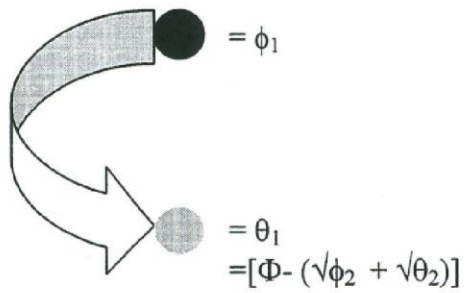
As a minimum, a block is an expression of both displacements in equal steps and firmness in its evolutionary development by known and unknown order parameters. In addition, block-wise operations do allow neither a rhythmic nor a clock-like rotation within individual components. A liberalisation of the movement patterns of the components would imply that every single component within the pair is following its own autonomous rhythm. By handling this individuality, the system has been capable of establishing two autonomous clocks (the black dots), namely an A-clock governing the A-component and an O-clock governing the O-component. Figure 3 is demonstrating the clocking mood of the mechanism.

Figure 3.

The Clocking Mood



The Ring-Structure



Example

A Researchers
a observed
 \emptyset_o [infants + on the cliff]
CM that

A infants
a crawled
O on the cliff

Characteristic of the cooperation of the clocks is that the angle from one to the other is captured in the exponential relation ($e^{i\theta}$), where (i) specifies the intentional plane of the angle of rotation, while ($|\theta|$) specifies the magnitude of the angle and the straight brackets denote the absolute value of the operation. When a certain number of rotations through the angles have been processed, the result appears as “multiplicative redundancy”. According to Hestenes (1986/1993, p. 68), this condition can be expressed as $[(e^{i\theta} e^{i\phi})^n = e^{i(n\theta + n\phi)} = e^{i\phi} e^{i\theta}]$, which follows from de Moivre’s theorem $[e^{i\theta, \phi}]^n = e^{in\theta, \phi}$. However, the exponential function and its series expansion require that angles become measured in radians (Hestenes, 1986/1993, p. 75).

Related to the text example of Figure 3, it is easily demonstrated that the A-clock in the case of the first clause is initiating a work cycle with a spin of $(-1/2)$. The same operation applies to the A-component of the second clause. However, the O-clock is initiating work-cycles of different kinds. While the O-clock in the second clause likewise performs a work cycle of a spin of $(-1/2)$, its operation in the first clause is clearly of a different kind, since the coordinative dependency between the clauses is initiating a work cycle with a spin of (-2) .

Expressed in geometrical terms, the meaning of the involved rotations is the following: The O-clock first moves one turn counter-clockwise and is thereby establishing zero degrees for the empty place (marked by the dummy). Thereafter, the clock is initiating another turn to mark that the empty place will be filled with a complete functional clause (i.e. the second clause). Since the entire clause constitutes unity ($\Phi = 360^\circ$), the second turn leads to the establishment of (360°) for the dummy. However, Figure 3 has shown that the involved pendulum moves both components counter-clockwise and in the same direction to eliminate the implied zero point of the first clause.

This operational prerequisite is describing a shadow-like movement, which is indicated by the grey tint of the spot. This condition has to get its operational expression, which means that the root of the components is reducing the original articulation. It follows that the roots of the copied components are subtracted from the angle of articulation at the reference point. This procedure serves perfectly the expression of the implicit parts of a textual flow.

A conclusion to be drawn from Figure 3 is that the rotation of strings of graphemes is driving the rhythmically operating work cycles in the direction toward the sharpest increase in acceleration. Once again, the displacements of grapheme strings can be updated and the change in angular articulation can be calculated without intervening disruptions. Through the clocking mood of the pendulum, it is possible to denote corresponding increases, which finally carry structural significance. Structural significance is addressing the fact that the present approach has not had any use of “free parameters”. From a functional point of view, it means that the approach is not fitted into one or the other empirical context. Thus, this fact may be used as a valid basis for an unambiguous and definitive test of the validity of the AaO-axiom.

Experiment

In the text example in Figure 3 the dummy (\emptyset) is symbolising some environmental or contextual variable, which may be an object or event. In this case it is an event, which incorporates an Agent and an environment. The relation between the two Agents is asymmetrical in the sense that the second Agent is experiencing an unknown environment, while the first Agent already is “knowing” the environment through integrated experiences. Consequently, in his observations (as reported verbally) the knower is always present in the known. Thus, the thesis is that knowing is the result of an active inquiring agent (the knower). Gibson (1979, pp. 156-158) makes the corresponding assumption when he is experimenting with the “Visual Cliff”.

As exemplified by the picture series of the Visual Cliff experiments (Gibson & Walk, 1960), the formalism proposed transforms the organism and the environment through a twist into cognition. Thus, inherent in the process of communication is the process of transforming meaningful behaviour into symbolic expressions. At this level, the transformation entwines the perspective and viewpoints in the same way as organism and environment are entwined at the preceding level of processing. The structure embedded in the caption to the picture series may be visualised as a complementary arrangement of its components in a three-dimensional space. The process, anticipated to operate in this structure, will be demonstrated in Figure 4.

Figure 4.

The Design of the Visual Cliff

		O	
	-+ a	-	+
A	-	Stationary Placement (Centre Board)	Surface (Visible Support)
	+	Edge (End of Support)	Depth (Invisible Support)

The manipulation of the action component of Figure 4 is manifesting itself through a binding of the values (-,+) to the A and O components respectively. Binding these values with respect to the complementary roles of A and O gives the events described by the picture series of Gibson and Walk (1965, p. 65). All pairings possible in the described event space are (--, -+, +-, ++) and the change of information in the picture series can be studied except for the first combination of symbols. A functional fixation of both organism and environment means sensation and is establishing the zero-hypothesis of perception. The first measure carried out is a fixation of the A-component representing the organism to which the value (-) is bound. The second measure implies a binding of the value (-) right adjusted. The top left picture of the Visual Cliff series is depicting the result (--): A child is placed on the centre of the board.

Gibson's ecological theory of perception presumes that the development of meaning be dependent on the viewpoints being changed. The third measure then implies mobilising the O-component to which the value (+) is bound. More than one viewpoint of the same kind may be observed. No change of perspective is implied. The result (-+) is made visible by the top right picture: The child crawls to its mother across the "shallow" side. Moreover, it is presumed that the observer's perspective can be viewed from various angles. By mobilising the A-component and by fixating the O-component (+-), a change in perspective is observed. The bottom left picture is documenting the result: Called from the "deep" side, the child pats the glass. The final relationship, to be described, can be observed by mobilising both the A- and the O-component (++). The result implies maximal information synthesis, which is pictured bottom right: The inferred behaviour is that the child refuses to cross over to the mother.

The relation (--, ++) and (-+, +-) is complementary to each other. This aspect is indicated by the two contrasting profiles. However the double asymmetry gives every pair a certain control over the development of every other and awareness is determined by re-orientation. Basically the asymmetrical pairs constitute the mechanism for a judgement of one's own possibility to come to solutions allowing an adaptation to fundamental changes.

The Language Space of the Caption to the Visual Cliff Pictures

It is commonly agreed upon that language is a more abstract level of processing than is vision. Nevertheless, a linguistic analysis has to be able to show the language space and to pick up the ecological invariants of this space, although using language-specific instead of vision-specific cues. Based on the caption it is discussed in what way verbal descriptions and textual transformation mediate the integration of experience as invariant structures. The caption is worded as follows:

“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 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).”

It is further assumed that ego-motion is encompassed in perception. The perception of the environment is an activity that twines together the perceiver and the perceived in an interactive relation, without which the meaning of the perceived cannot be established. Basically the asymmetrical pairs of Table 1 constitute the mechanism for a judgement of one's own possibility to come to solutions allowing an adaptation to fundamental changes. The significance of the implied double mechanism of change concerns the developmental control over observational differentiation and integration of the variations of object-orientation. According to Gibson, a pictorial or symbolic expression incorporates both extero- and proprio-specific information. So, a matter of great concern will be the testing of the ability of language to mediate differentiations of the ecological kind and to give expression to the integration of experience into invariant structures.

Text as Context for Angular Articulation

Whenever events observed on the Visual Cliff structure the language of the Experimenter, this language contains textual movement information, belonging to these events. With this orientation toward the dynamics of textual movement patterns, the underlying flows are expected to reflect different degrees of angular articulation. Furthermore, information on rotational states and fluctuations concerning the displacement patterns of the components is a crucial factor in the study of the structural aspect of the caption. However, the effect of this factor on the developing flow morphology becomes approachable only if a complete textual surface can be produced and related to the clocking mode of text production.

Unfolding operation. Since a transformation implies a “string” rotation through the right angle, this special property can be used in the operational definition of a change in attitude. Since it can be shown that an assumed change is dependent only on the direction in the rotation of a string-relation, it turns out that this definition leads to remarkably simple measurement operations. It follows that the clockwork of the AaO-mechanism must have the capacity to update the impact of a cycle (κ_i), which signals a particular displacement. Since a transformation implies a rotation of a string-vector, the presence of a string means that the vector has rotated counter-clockwise through the right angle.

Folding operation. Progressive processing of any magnitude on the distance between the actual state and the equilibrium state of a system demands an operator-valued function or a q-number as measure of the existence of an operator-valued relation or a groupoid. A groupoid is a set of elements (G) that is closed under a binary operation, whose domain is all of (G). Hence (G) will be made the foundation for the manifestation of the kind of order parameters that generate the dynamic aspect of convolution. The (G) is replacing the classical frequency group, which has dominated the taxonomic approach and is computed, when regular latticed spaces form the basis of a complex-valued function. In changing from this kind of function to the operator-valued function of Connes (1994), G will play a crucial role in the “foliation” of the states of a system and the determination of its thermodynamic limit.

The “Connes-fusion” as method of foliation. The basic conditions of this procedure concern the process of producing “leaves”. The state of being in leaf means the arrangement of leaves in a leaf bud. Ornamentation of a bud consists of the degree of change in the articulation of a variable, which is reflected in the cups and foils of its topological appearance. It follows that progressive processing is definable on the basis of the distance (Δ) operator for the time domain [E(t)]. A folding matrix makes the coupling process manifest and assigns the foliation its direct physical meaning. Connes is, according to Mackenzie (1997, pp. 32-37), “doing something extraordinary”, because Connes’ space consists of only two measures and their “alter-egos”. Hence this space can be represented as a pair of numbers on which classical arithmetic operations can be performed despite the fact that every measure is twinned with an indistinguishable alter-ego” (Mackenzie, 1997, p. 36). The “alter-ego” of a number is represented by a zero value. Foliation appears immediately in the fusion process. At every moment half the difference between the effects of resisting versus non-resisting an operator value is taken as basis for fusion. This space develops on two simple C-matrices, however differing in embodiment of the copies and in the production of smooth (G*). Emerging is a double space-time account. It consists of the ordinary space-time product, manipulated by a very tiny discrete “two-point” space (Connes, 1994, p. 176). This space corresponds to the discovery of the progressive continuation in the branching of a foliation. Simple numerical calculation may be carried out according to Expression (5):

$$\begin{aligned} \omega &= [\frac{1}{2}(a_2b_1 + a_2b_2) - \frac{1}{2}(a_1b_1 + a_1b_2)] \\ \omega &= [\frac{1}{2}(0 + 1) - \frac{1}{2}(1 + 0)] = \omega = 0.00 \end{aligned} \quad (5)$$

Evidently, this fusion process generates identical main and interaction effects. The use of ($\frac{1}{2}$ -densities) removes any artificial choices in the set-up of the operating connection matrix. A smooth (G*) is special case of a “locally dense” groupoid (Connes, 1994, p. 11). Finally, it can be concluded that the breaking of symmetry must appear in pairs both within and between components. Whenever the deviation in a particular pair exceeds the critical value ($\omega=1.00$), it can be concluded that a system begins to respond in discontinuous manner. Thus, when length no longer is connected arc-wise, the hyperbolic curved (ρ) space becomes available as the result of convolution processes.

The Space of the Caption

A consequence of the rotation is that the displacements of text segments can be updated and the changes in articulation can be calculated without intervening dissections. Through the clocking mode of the involved AaO-mechanism, it is possible to denote corresponding increasing or decreasing values, which is shown in Table 2. One goal of the presented radians is to demonstrate dynamical pattern and pattern dynamics with an orientation in the dynamics of a textual flow. The textual patterns of the caption are expected to reflect different rotational states und fluctuations concerning the components of the AaO-mechanism.

Table 2.

Angular Articulation of the Caption to the Visual Cliff Pictures

Strings	Radian	Sum	Strings	Radian	Sum
.			board	0.40635	
Child's	0.33284		(top	0.40248	
Depth	0.32970		left)	0.40635	$O_9=6.698970$
Perception	0.34540	$A_1=4.147940$,	0.31714	
is	6.92056		the	0.32342	
\emptyset_O		$O_1=2.553358$	child	0.32970	$A_8=4.110260$
[that]			crawls	0.41022	
\emptyset_A		$A_2=3.463351$	to	0.39474	
tested	0.41022		its	0.39861	
on	0.39474		mother	0.41022	
the	0.39861		across	0.41022	
Visual	0.41022		the	0.39861	
Cliff	0.40635		shallow	0.41409	
.	0.39087	$O_2=6.281010$	side	0.40248	
The	0.32342		(top	0.40248	
apparatus	0.34226	$A_3=3.805680$	right)	0.40635	
consists	0.41796		.	0.39087	$O_{10}=8.308890$
of	0.39474		\emptyset_A		$A_9=0.000000$
a	0.39087		Called	0.41022	
board	0.40635	$O_3=5.479920$	from	0.40248	
[that]			the	0.39861	
\emptyset_A		$A_4=3.549185$	deep	0.40248	
laid	0.40248		side	0.40248	$O_{11}=5.886270$
across	0.41022	$O_4=4.45566$,	0.31714	
a	0.39087		he	0.32028	$A_{10}=3.777420$
sheet	0.40635	$A_5=2.317076$	pats	0.32656	
of	0.39474		the	0.32342	
heavy	0.40635		glass	0.32970	
glass	0.40635	$O_5=6.687360$	(bottom	0.33284	
,	0.47571		left)	0.32656	$O_{12}=4.779080$
with	0.48984		,	0.31714	
a	0.47571		But	0.32342	
\emptyset_O		$O_6=-5.585029$	despite	0.33598	
[that]			this	0.32342	
\emptyset_A		$A_6=1.293784$	tactual	0.33598	
patterned	0.34226		evidence	0.33912	
material	0.33912		that	0.326556	
directly	0.33912	$O_7=4.160500$	the	0.32342	

Table 2.

Cont.

beneath	0.41090		cliff	0.32970	$A_{11}=6.094740$
the	0.39861		is	0.39474	
glass	0.40635		in	0.39474	
on	0.39474		fact	0.40248	
one	0.39861		a	0.39087	
side	0.40248		solid	0.40248	
and	0.39861		surface	0.40635	$O_{13}=6.261660$
several	0.41409		,	0.31714	
feet	0.40248		he	0.32028	$A_{12}=3.777420$
below	0.40635		refuses	6.95196	
it	0.39474		\emptyset_O		$O_{14}=-0.000833$
on	0.39474		to		
the	0.39861		\emptyset_A		$A_{13}=3.556441$
other	0.40635		cross	0.40635	
.	0.39087	$O_8=9.891720$	over	0.40248	
\emptyset_A		$A_7=0.000000$	to	0.39474	
Placed	0.41022		the	0.39861	
on	0.39474		mother	0.41022	
the	0.39861		(bottom	0.41796	
centre	0.41022		right)	0.41022	
			.	0.39087	$O_{15}=7.101450$

The capacity to reproduce the language space as it is evolving during the generation of the caption will now be discussed with a focus on the unfolded spaces of the O- and the A-component respectively. Figure 5 illustrates the space of the textual objectives.

Language Space as Function of Textual Movement Production

Whenever observational events structure the language of the observer, this language contains textual movement information, belonging to these events. Therefore, it is assumed that the mechanism has the capacity to reproduce the language space as it is evolving during the generation of the caption.

The unfolded space of the Objective-component. Figure 5 shows the space of the textual objectives. The "objectives/interval" shows the number of objectives (i.e., the sliding within a particular interval), whereas the "intervals" are characterising the naturally occurring periods and fractions of periods the way they have become manifest during text production. The "dynamics", as measured in radians is visualising the accelerations in the rotations as well as temporary reductions. To convert the corresponding scatter plots to mesh plots, the grids have been interpolated with its standard transformation function of SigmaPlot (1998, pp. 290-292). Version 5.0 of SigmaPlot is using an inverse distance method, where the distance weight value (p) has been set as ($p = 3$). Obviously, an unfolding operation entails the concept of time and its expression through successively increasing and decreasing shades in articulation.

Figure 5.

The Unfolded Space of the Objective Component

The Unfolded O-Space

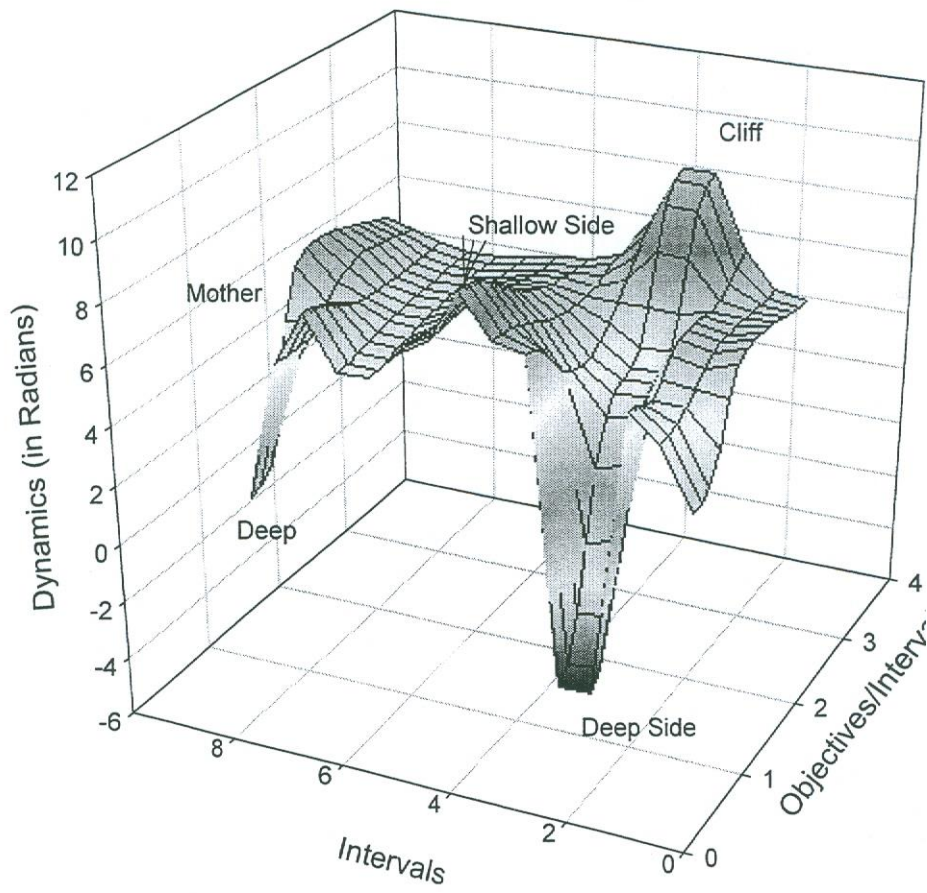
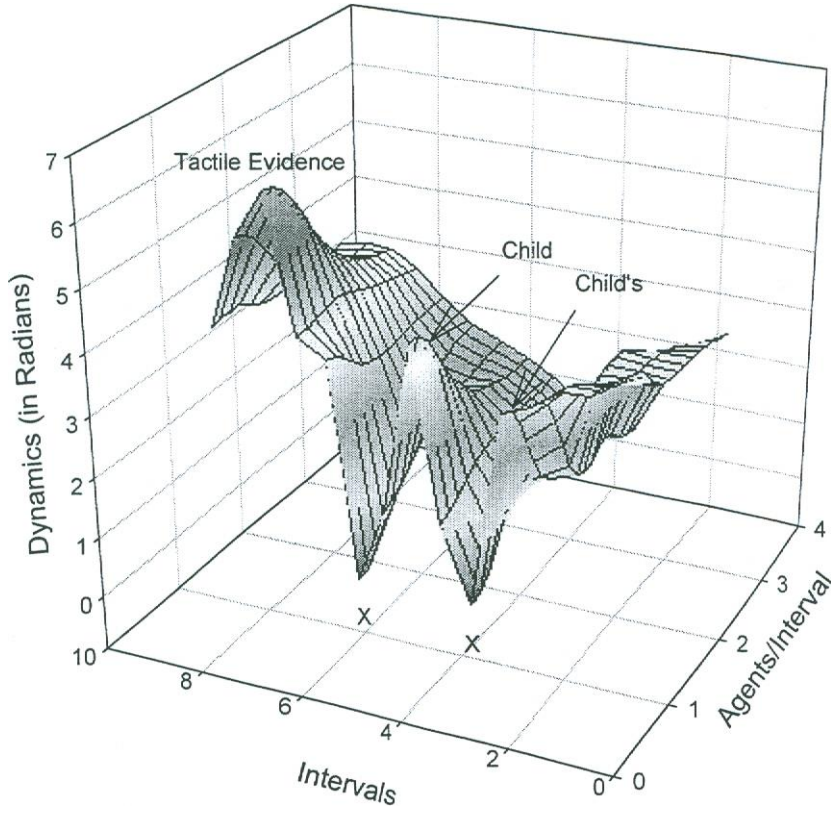


Figure 6.

The Unfolded Space of the Agent-Component



Some outstanding features of the response surface have been marked with corresponding textual elements. The empirical relations of the Objective-component seem to have been packed in such a way that their informational value can be detected. What is substantial and consequently explicit is related to the mother, the shallow side and the cliff. However, the insubstantial and consequently implicit specification of “change” is shown below sea level. The discontinuity in the information flow is marked with the corresponding textual elements, which relate to the deep and the deep side.

The unfolded space of the Agent-component. Figure 6 depicts the space of the textual agents. By making explicit reference to “tactile evidence“, “the child” and “the child’s perception” the process in the Agent-component refers to the organism as context for the manifestation of the nature of change. The “unknown” agents (X) are deeper embedded and appear as a matter of fact as implicit and independent of any implications as to context or contents that can be described in terms of sensational attributes. Cross-sectional abstraction and displacement of textual segments provide the most detailed mechanistic information on a textual flow pattern.

The shapes of both surfaces are demonstrating reasonably similar peaks, but the distinctness of their informational configuration can be studied only with reference to the non-linear coupling between particular text segments. In coupling seemingly unconnected informational invariants, typical and contrasting trajectories on these surfaces may yield informational invariants, which are assumed to reflect the ecologically significant constraints of the caption.

Topological Configuration

A complete textual surface can be produced only under the condition that the dummies (\emptyset) of Table 2 can be supplemented with text segments. With respect to the caption, copying of the [A, O] states and places, where the missing text segments are inserted into [$\emptyset_{A,O}$] has to be carried out in agreement with the format of Expression (6)

$$[\emptyset] + S \rightarrow [\emptyset_{A,O}] \rightarrow [\emptyset] + S \rightarrow [\emptyset_{A+O}] \rightarrow [\emptyset] + [\emptyset S] \quad (6)$$

Expression (2) concerns the Supplementation (S) procedure, which implies a copying with a focus on the involved flow dynamics. The dummies [\emptyset] in the expression are marking the places for incoming text segments. Moreover, indexing with the components [A,O] means that linear geometric conditions are governing the layering of text segments. For example, a single A- or O-component implies that the surface-oriented empirical relation is utilising a perpendicular pathway and appears single-layered (1D), while their compound is utilising a collinear pathway, which implies that a twofold-layered text segment (2D) is channelled into its proper place. Hence, the attitudinal values of displacement (D) can be detected through angular articulations. When a certain number of rotations through the angles have been processed, the result appears at the textual surface level as “multiplicative redundancy”.

The conclusions to be drawn from the textual movements are in case that there is a dependency of one or the other type, that textual flows are observable, since these flows are concentrated to those places where the dummies have emerged. As to the movement formation, the dummies mark the “holes” in the textual surface, which implies that they may be used to decide upon the character of a particular flow morphology, resulting from the corresponding textual pattern dynamics. Further, the operational prerequisites are describing shadow-like movements, which get their expression through the subtraction of the roots of the copied components from the angle of articulation at the vertex of the reference point. This procedure serves perfectly the expression of the implicit parts of a textual flow.

As a result of the generative power of Connes Δ -operator, structural development in the O-component is displayed in Figure 7. In linking the variables, the process is emphasising the central role of the folding procedure. It dissociates repeatedly a variable sequence from the restrictions of the actual control parameter, i.e., sentence and clause markings. In overcoming the “borders”, constituted by the markers, the folding is proceeding effectively and resulting in an apparent overall synthesising effect. The actual folding is generating pathways, which are dependent on increasing and decreasing radians. In short, significant AaO-sequences are making up the generation of pathways. But these are resulting from the processing of pairs of values, which are interacting within the major trace. Together, the values are important for stability and changes in the whole configuration. Obviously, liberating the folding step by step from the marker restrictions makes the process responding to variations in the determination of the phase-transitions and the emergence of a synthesis comprising pathways of different length. The configuration of Figure 7 contains four substructures, which are bending the course toward the establishment of “*Meaning*” as final state attractor.

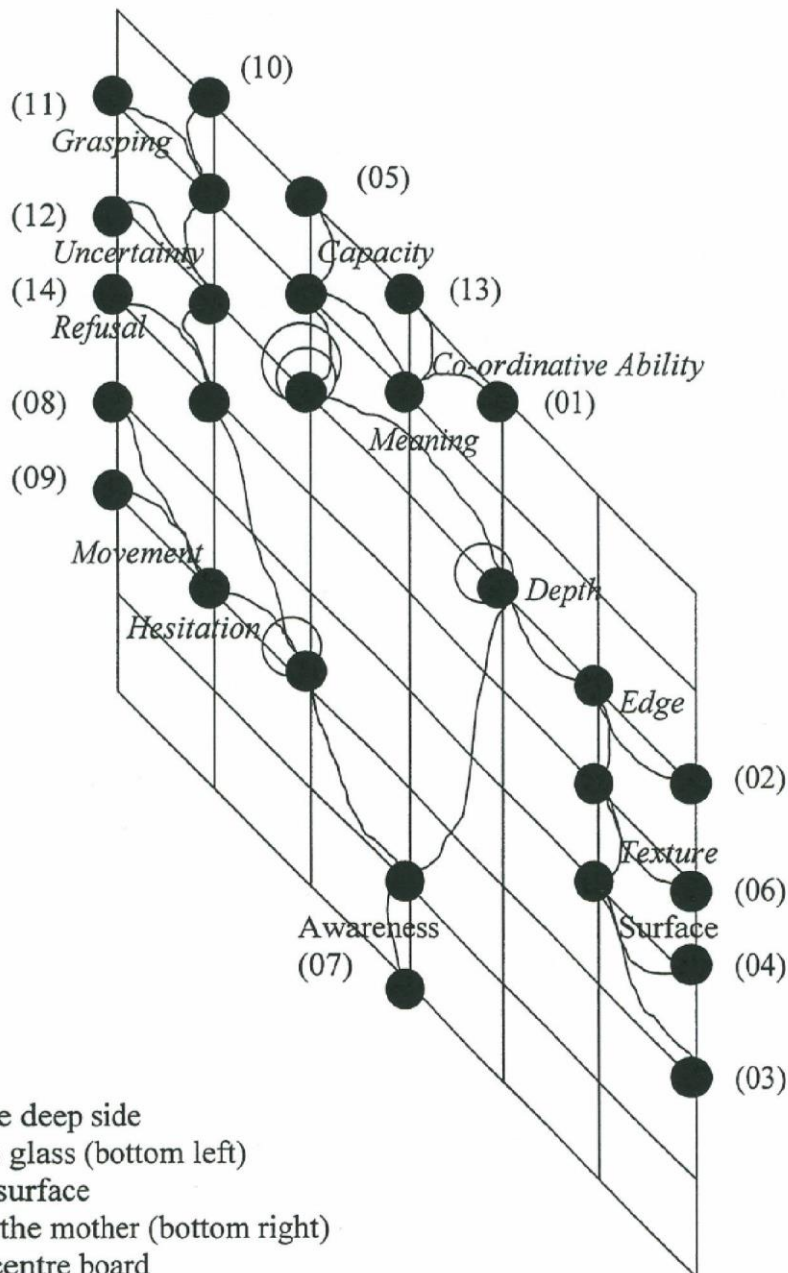
Systems of coordinates (or mesh-systems) have the capacity to describe the functional relation between the radians. To rule a mesh system on the results of a foliation is decisive for the expression of its import at the ecological level. As shown in Figure 7, multiple processes have operated in the production of a pathway and its subsequent crossing with others. Those crossings generate saddle-shaped configurations, which help to explain what arches under their concave faces. In the iterative processing of the given quantities, folding has the capacity to bond the variables correctly from the psychological point of view. In addition, the identified changes in the constraining system states can be related meaningfully to the transforming effects of the terminal states at the border of Figure 7. Once a new term has come into existence, its transformation through successive states imposes rigour on the process of naming and generates informational specificity.

The manifested path of Figure 8 has resulted from the cyclic working of an extraction process, which takes its departure in Figure 7. Hence, Figure 7 is orienting this process and generating a series of stepping operations. In the presence of a certain initial state, the cycle of extraction starts its work by oscillating through the whole configuration until the highest point of the developing curve is reached. The name of the singularity at this point is extracted. Since the identified kinematic state is the proper equilibrium of the first extraction cycle, it constitutes the first name of the singularity of the developing path in Figure 8. In taking advantage of a restart at the subsequent system state, a new swing is initiated. In this sense, cyclic moves back and forth are effectively contributing to an expression of the potential of the A-component. Through the causal relationship between the underlying morphological configuration of the text and the resulting information structure, perspective specificity makes evident the centrality of a particular verbal expression. As a consequence, exactness and precision in the measures of attitude change is reflected in the interplay between both, the O- and the A-potential, because the extraction process makes full use of their asymmetric relationship. The asymmetric relations are the result of remoulding. Thus shared termini are emerging, but become specified through their “new” structural relations. It follows that termini, reappearing at different levels and in different conceptual contexts, are related to the particular style of looping in the produced text.

Configuration of Informational Invariants as Function of Constraining Space

The detection of a “negative affordance” (Gibson, 1979, p. 157) is in the focus of the caption. However, the implicitness of the experimenters’ reason in the caption is manifested below sea level in the child’s “*Capacity*” to test the glass surface for its solidity. Obviously, the intention on the simulated cliff is stretching over a series of textual movements. These are folding and producing the synthesis of the caption, which implies its alternative description.

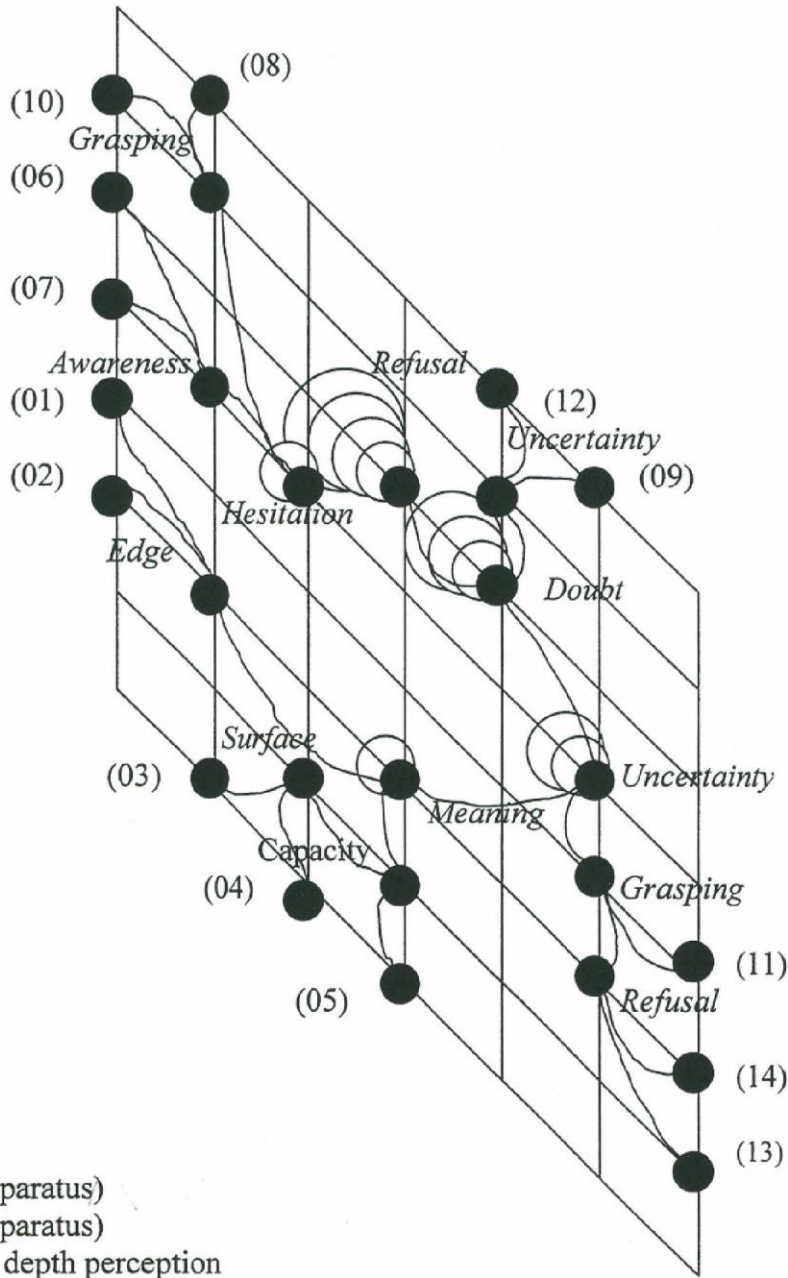
Figure 7.

The Topological Grid of the Objective-Component

- (10) from the deep side
 (11) pats the glass (bottom left)
 (12) a solid surface
 (14) over to the mother (bottom right)
 (08) on the centre board
 (09) to its mother across the shallow side (top right)
 (07) beneath the glass on one side and several feet below it on the other
 (03) of a board
 (04) a sheet of heavy glass
 (06) patterned material directly
 (02) on the visual cliff
 (01) (Child's + on the visual cliff)
 (13) (he + over to the mother (bottom right))
 (05) (The apparatus + material directly + beneath the glass on one side and several feet below it on the other)

Figure 8.

The Topological Grid of the Agent-Component



- (08) X
- (10) X
- (06) (The apparatus)
- (07) (The apparatus)
- (01) Child's depth perception
- (02) (Child's depth perception)
- (03) The apparatus
- (04) (The apparatus)
- (05) (The apparatus)
- (13) he
- (14) (he)
- (11) he
- (09) the child
- (12) this tactile evidence that the cliff

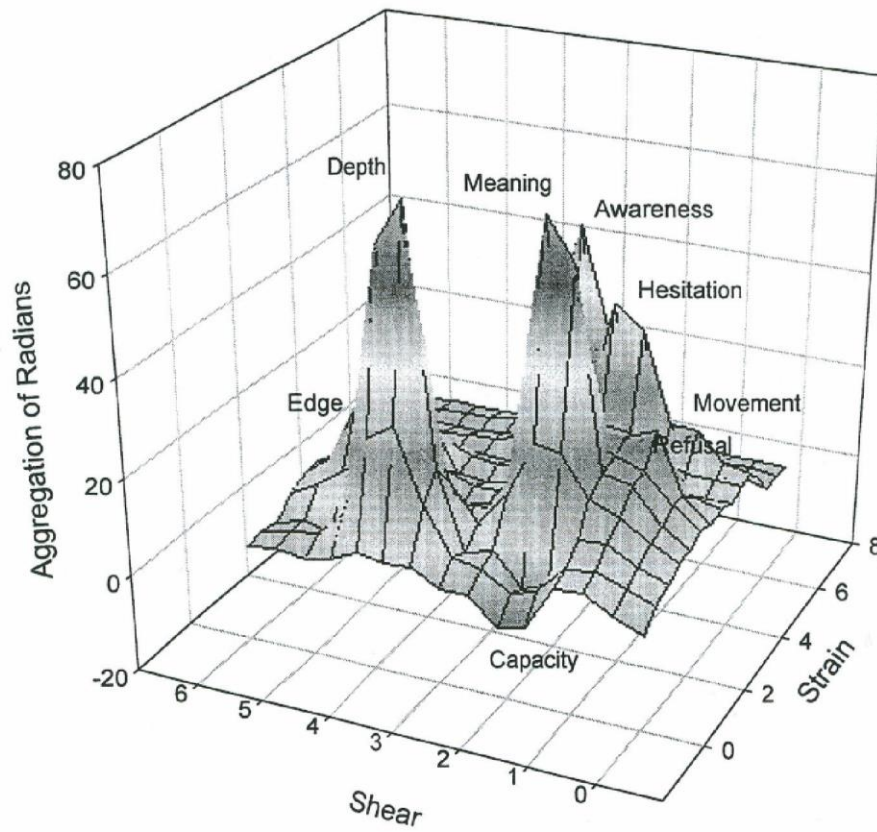
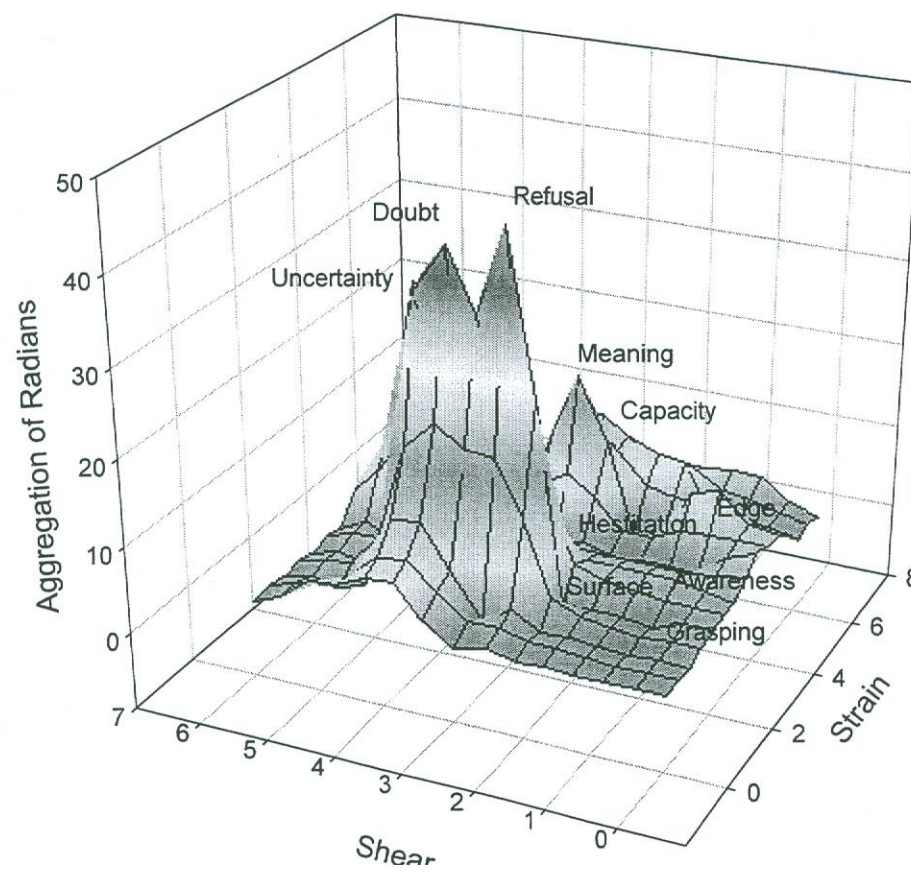
Figure 9.*The Folded Space of the Objective-Component***The Folded O-Space**

Figure 10.

The Folded Space of the Agent-Component

The Folded A-Space



The folded space of the Objective-component. The structured configuration of the O-space is shown in Figure 9. It concerns the judgement of "Depth" and its consequences for locomotion on the deep side. Synthesis entails that the variety of the involved textual elements becomes specified through terminological profiling. Obviously, the transformational impact of the child's optical information processing is brought to the fore by the three termini "Meaning", "Awareness", and "Hesitation". Apparently, the child's grasping of the meaning of a sharp drop has been verbalised successfully. Moreover, the special character and significance of an abrupt changing environment has been related successfully to the dangerous cliff.

The folded space of the A-component. As indicated by Figure 10, a structure is occurring that shows an evidently stressful situation. The caption of the pictured procedure gives expression to the child's experience of a provocation. Its description through the produced termini makes visible that the terminus "Refusal" is the theoretically important global state attractor, since its name relates the concept of avoidance as its behavioural ground to the falling-off place of the virtual cliff. The environmental condition in the caption has been formulated in terms of a pertinent change. However, in order to investigate into the "Capacity" of the child to perceive directly the "Meaning" of the cliff, the caption is giving expression to "Hesitation" and "Doubt". Both seem to be rooted in the child's experience of stressfulness, which finally leads to "Refusal".

Discussion

Text building behaviour obeys natural law and develops evolutionary. Language conceived of as a natural system becomes structured through rhythmic driving forces, which are transforming kinetic energy into verbal flows. The presented study has advanced the bio-kinetic hypothesis that the Agent-action-Objective (AaO) paradigm constitutes the fundamental preconditions for an alternative description of text building behaviour and a connection of the involved textual flows to an invariant formulation. Geometrically conceived, the term "invariant" refers to a coordinate-free treatment, which is provided with an application of Hestenes (1986/1993, 1994) functional geometry. Experimentally, it has been possible to demonstrate that language can be treated as a "bio-kinematical system", exhibiting periodic behaviour.

The central idea of studying the caption to the original Visual Cliff experiments has been, to determine the capacity of the experimenters to communicate the knowledge they gained of the effects of the simulated environment. Independent of the degree to which they have been able to formulate their synthesis into text, synthesis can only be communicated through natural language expressions, otherwise, their synthesis remains unknown for both, the experimenters themselves and for the scientific community at large. To restate, transforming synthesis into natural language expressions entwines the perspective with the viewpoints in the same way as the infant is entwined with his environment. But proper analysis could not be performed before the perspective could be detached experimentally from its viewpoints.

The basic hypothesis of the experiment has been that a subtle interplay between the oscillation of strings and the winding of work cycles is creating the language space. Thus, this hypothesis concerns the capacity of the AaO-mechanism to handle the subtle distinctions that are created by the textual strings in the process of producing space. At the same time the space hypothesis relates to the fact that the enveloping phase-controlled space is restricting the movements of the strings as the carriers of information. From the point of view of the experiment, this hypothesis implies that a verbal expression is suitable for processing, provided that it contains cues to its capacity of stretching and straining, and of winding and

bending. So, a verbal material has to respond in an elastic way to the evolving information structure. It is therefore not a coincidence to suggest that a text material must be characterised by flow properties and that these are decisive for the rotational dynamic, and consequently for the flow-morphologies being realised.

A consequence of this requirement has been the characterisation of the loss of stability in a textual flow. By this is meant that a scientific study of language as a natural phenomenon must begin with an observation of such losses of stability – in other words a study of discontinuity. Accordingly, an exact characterisation and formal description of the involved work cycles has to be concentrated on a likewise exact characterisation and precise description of the phase transitions connected with the evolving textual space. Finally it is of crucial importance that a test of the basic experimental hypothesis builds on an uncovering and a reproduction of those kinds of order parameters that are restricting the production of a space. The described mechanism has this capacity and therefore, it has been possible to base the experiment on the following methodological properties: (1) manifestation of the acceleration in a rotation and (2) identification of the fundamental order parameters, which are governing the production of a space.

Hence, the theoretical significance of the experiment lies in the determination of the phase transitions involved on the kinetic level and in the determination of the flow morphology of the text at different occasions of change. The changes at different phase transitions are of course influenced by the observations that the text producer has made and communicated. To communicate is a matter of realising both viewpoints as well as a perspective.

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Author's Note

The content of the article has been presented and discussed in a Poster session at 9th Herbstakademie on Self-Organisation of Cognition and Applications to Psychology, a Conference on Dynamical Systems in Cognitive Science, October 25-28, 2000 in Ascona, Monte Verità, Switzerland. Further, the principles of the AaO-paradigm and the resulting text-spaces have been demonstrated in the form of a lecture in the "Systems Analysis Course" of Lund University's Master Program in Environmental Science, conducted at the Centre for Environmental Studies, February 20, 2001.

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