Evolution of growth in the development of competence

Bierschenk, Bernhard; Bierschenk, Inger

2003

ISSN 0281-9864

Evolution of Growth in the Development of Competence

Bernhard Bierschenk
Inger Bierschenk

2003 No. 88
2013 *Revised Edition*

Copenhagen University
Denmark

Lund University
Sweden

KOGNITIONSVETENSKAPLIG FORSKNING

Cognitive Science Research

ISSN 0281-9864

Evolution of Growth in the Development of Competence

Bernhard Bierschenk
Inger Bierschenk

2003 **No. 88**
2013 ***Revised Edition***

Cognitive Science Research
Lund University
University of Copenhagen

Cognitive Science Research

Copenhagen Competence
Research Center
University of Copenhagen
Njalsgade 88
DK-2300 Copenhagen S
Denmark

Adm. editor

Helge Helmersson
Dep. of Business Adm.
Lund University
P.O. Box 7080
S-220 07 Lund
Sweden

Abstract

The article presents the third study of a series that has been designed to manifest consciousness and to measure developed competence. The emphasis of the main hypothesis of the present experiment has been put on the student's ability to adapt to the main idea of a given story and to express his comprehension verbally. In what way the two students of the previous two experiments have been able to accomplish the experimental task, is reflected in the state attractors of the produced fitness landscapes. The Student, who has continued to follow the analytic-descriptive approach, has focussed on the conditions of that part of the story that relates to a critic of empiricism. Since it has been shown that the process of naming the resulting state attractors provides a sound theoretical basis, it can be concluded that the student has not been conscious of this purpose and consequently been unable to abstract the criticism of empiricism. In contrast, the other student has continued to follow the synthetic-reflective approach. The produced narrative has made evident that this student has been able to abstract the criticism of idealism. It follows that the proper outcome is "rationalism", which is validating that the degree of developed competence can be approached in a direct and obvious manner.

In everyday language, the word 'idea' is used to speak of one's plans of action, a scheme, an opinion or an insight. In contrast, in the scientific context the notion is used either in a Platonic sense, which means the intellectual equivalent to a form, i.e. an archetype, or in the empirical sense, which means in pre-modern terms sensations and in modern terms features. In the pre-modern sense, an idea cannot be experienced or sensed. Thereby, implied is a mental content that is not identical with the perceptual process. The modern sense connects to René Descartes (1596-1650), who dropped the notion of an archetype. This means that an idea can directly be perceived in the "mind". Especially John Locke (1632-1704) became attracted to this understanding, which relates ideas of the mind directly to the real world. In particular, he proposed the metaphor of "White paper" on which experience can write directly its impressions.

In fact, the cognitive sciences of today are using the term "idea" in roughly the same fashion. Based on the writings of the British empiricists of the 18th Century, an "idea" is conceived of as a "mental" event. Underlying this event are brain states, which support some as yet unknown mechanisms of information processing that yields the phenomenal experience. This hypothesis is based on the assumption of the cognitive sciences that an internal organisation of ideas is based on "logical propositions" and that an out-flowing construction of propositions must be "logically sound", since this inferential conclusion obeys the laws of logic. When the origin of a verbal expression is identified with the output of a neural substrate, it is in principle equated with the presence of a "brain" program that can run on a Turing machine.

The present experiment is based on the contrasting hypothesis, namely the evolution of an idea, whose structure is developing on the basis of thermodynamic trajectories. Moreover, it is expected that the comparison of trajectories that differ in direction and orientation will demonstrate the presence of a biologically determined "Bauplan". Joseph Henry Woodger introduced this notion to account for a homologous structural plan underlying evolutionary transformations (Raff, 1996, p. 196). Thus, this notion had been introduced into biological literature with the purpose to account for the deep commonalty in the genetic regulatory mechanisms underlying the "evolution of body plans" (Thompson, 1942). But with reference to the evolution of an idea, this notion has no significance in the absence of its producer.

As a first measure, to discover the "Bauplan" of an idea requires the reconstruction of its configuration space. Accordingly, to discover the identity of the producer means to get the producer known on the premise of his telling or writing. To know the producer from writing implies that the act of writing comes into existence and that the entire activity of text production warrants the writer's ideational structure. As a precondition, reconstruction of the structure of an idea or a concept requires specification:

1. To have in mind or to plan an action pre-requires a specific purpose. To have in mind some purpose signifies an intent, which implies meaning. Meaning comes into existence through the process of doing or performing according to one's way of thinking.

2. The line of direction followed in the course of doing or performing indicates one's assertion relative to intended movement or development. To have a directed orientation implies individual awareness of one's relation to a set of ideas or a situation.

Based on these specifications, it can be stated that it is the direct expression of an idea that needs to be processed. To discover the ideational roots of a "Bauplan" means, that a structure must be made evident. This structure will become manifest only to the degree that the configuration space of its pronunciation can be reconstructed. However, its reconstruction must be based on the essential function that operates when an idea is writing itself into text.

Thus, the evolution of an "idea" or "concept" is expected to emerge through individual text production, i.e. writing on "White paper". It follows that the textual embodiment of an idea requires coping with coherence in changing imagination as opposed to perceiving or conceiving objects or events. Since changes in an idea are structural in nature, it means that its manifestation must encompass the identification of structural relations that remain over change. It follows that the boundaries of an evolving idea cannot be stretched infinitely. The development of an idea during text production is a matter of preserving structural invariance over time. Moreover, preserving an idea through text production means that it is possible to conserve an idea, once its structure has been embodied into text.

Since structure cannot be imposed a priori, it can be discovered and made known through Perspective Text Analysis (PTA). A goal of PTA over and above the analysis of single text productions is a qualitative analysis. With a qualitative analysis are all possible state attractors determinable. This implies the study of text as continuous system. Further, the areas the attractors are occupying in the unfolded phase-space are determining the evolution of the idea of a particular writing. Hence, the basic focus in the production of an idea will be on textual pattern dynamics as outcome of a subtle interplay between intentionality and orientation, for which the Agent-action-Objective (AaO) axiom provides the proper foundation. Conceived of as systems, it will be shown that the [AaO] carries intentional cues and contains information about the produced orientation in its pattern dynamics. It follows that an idea put into writing has the function of letting viewpoints as well as a perspective come into existence.

Much of the implied preciseness in the evolution of an idea concerns the identification of the relationship between a cascade of increasing information flows and the embodiment of its strands. But evolutionary pressure operates and constrains its growth and development in various ways. Since this kind of pressure is forming the boundaries of its structure, individual experience of an idea can textually be integrated to a certain degree. Of great import in this integration process is the concept of "Fliessgleichgewicht" (floating equilibrium), which provides for the establishment of symmetry. The analysis of symmetry in the produced spaces leads to qualitative statements about emerging solutions.

Thus, getting to know the emerging solution requires knowledge about how evolution is constraining decent modifications in the information flow and variations in the textually embedded structures. Getting to know the evolution means to initiate the act of unrolling (from Latin 'evolutio') its increase in complexity (McNamara, 1997, p. 11). This is an important step since it makes evident the helical properties of the flow fields of the A's and O's. Helical properties can be stated whenever the trajectories of these fields show preferred winding directions (left or right). Through the rotation of the "super-strings" (B. Bierschenk, 2001), the phenomena of "flipping" and "bifurcation" are emerging, which are a natural part of the AaO-system. Hence, differential rotations are characterising the stretching, bending, and curling of floating string elements. Thus, the corresponding "Functional Clause" (FC) is producing the transformation of kinetic energy to kinematic effects. When conceived over time, the sum of these transformations results in the morphology of a particular text and is an expression of evolution.

With reference to the involved transcription parameters, it has been observed that the rotations in the periodic behaviour of the FC are dependent on Tori (T^1, T^2 and T^3). The superscripts mark the condition where one, two or three components of the FC are

participating in the rotation process. A morphological consequence of changes in this process is the manifestation of the changing magnitudes of growth. Finally, structural manifolds of the resulting "rings" are caused by the complexity of the dynamics of the parts of a ring. Thus, a ring is defined partly through the interacting parts themselves, partly through their interaction with the flow fields. Influenced through the potential energy distribution by the participating verbs, interactive potentials lead to the generation of the ring structures. These may be extremely flat, but are definitely not two-dimensional.

How the actual changes are influencing the shape and size of ring structures has not been possible to investigate without PTA. Hence, the aim with the present experiment is a continued demonstration that the phenomenon of synthesis is describing itself and that a full description of synthesis is attainable through the establishment of the geometric shapes of involuted textual flows.

The Bauplan as Expression of Self-referential Properties

To account for the deep commonalty in the biologically rooted outcomes of the AaO-mechanism means to account for its own description. It follows that the "shape" of a space refers to the self-referential property of the [AaO]. As a rule, all FC's consist, from the reproduction point of view, of the same kind of AaO-information. Hence, the question can be posed how space-time patterns come into existence. And it is now possible to give the answer: In getting access to the messengers (B. Bierschenk, 2001; I. Bierschenk, 2003). Hence, the capacity of the AaO-mechanism to capture the essential governing function of the messengers is based on the FC, which is developing the operation space.

The messengers are contributing to the formation of A-O-bonds, which means that pattern formation can be traced as the primary result of local textual movements and the constraints that the messengers impose through long-distance inhibition. Further the FC generates and regulates the evolution of a text. Within the context of the FC, it has been possible to demonstrate that the A-O-pairs provide the condition for an effective control of the interplay between intention and orientation within a system of language specific coordinates. Since these are also the coordinates of the unfolded "spaces", which however are intrinsic, they constitute the self-evident foundation for capturing the kinetics of emergent A-O-pairs and to track their growth in structural complexity.

In the present context, the concept of "shape" refers to language as a biological system that has the capacity to produce (i.e., built anew) the complex structures of a text with every new generation cycle. This means that the involved production cycles of the FC must work in non-linear fashion and according to a biologically determined space. Since structure develops as a consequence of information flows that at one place differ from the flows at other places, its operational expression has to be accomplished with regularity and strictness. But flow concentrations are also causing restraints at certain borders, which locally counteract free information flow. However, local restrictions can be useful only if there is a textual con-text. In this sense, evolution may be conceived of as the contextual determination of the local processes that produce the "operational closure" of a FC. These processes are resolving locally the language specific equations, which is observable as evolutionary order.

From a thermodynamic point of view, order means the production of certain textual pattern flows and the FC is marking those places in the texture, where the information flows are attracted to appearing holes. Whenever a hole appears, it can be said that the FC is in a non-equilibrium state, which is pushing towards equilibrium. This discovery has formed the basis for the development of bookkeeping routines and a supplementation mechanism, which has the capacity to generate the necessary informational balance. Supplementation implies that those parts of a language expression become characterised, which require that certain textual elements are stored (i.e. conserved) in the deformed states of the FC. Thus,

bookkeeping is manifesting the operational closure of the [AaO], which is resulting in super strings.

The development of the gradients of the concentration space is producing position dependent variables, which however develop in a complex manner. This is the kinematic effect of the FC, which implies that movement of textual segments signifies that stability and loss of stability must be an inherent property of text development. When its growth is influencing the flow fields, it means that the fields remain stable and locally dependent attractors can develop. Finally, since the balancing operations, which are stabilising the fields, concern both magnitude and direction of the super strings, textual movements must be conceived of as dislocation of layered textual segments. Moreover, the elasticity of developing super strings can be reconstructed and extracted from the redundant properties, which have become accessible through the joining of textual segments.

The Segmentation of Patterns within Segments

Already in the beginning of the nineteenth century, Karl Ernst von Baer (1828) showed that there is no strict recapitulation of any primitive form of expression during a developmental course (McNamara, 1997, p. 28; Raff, 1996, p. 6). Further Ernst Haeckel's (1834) hypothesis that evolution requires that new forms of expression appear as a result of new terminal states and condensation (McNamara, 1997, pp. 23-32), remains not only valid but has significant implications. In particular, in approaching evolution as displacement operations, the role of change in pattern development appears as the fundamental mechanism or driving force of evolution.

Typical of the dynamics of the information flow is that it is manifesting both textual continuity, which has constraining effects, and discontinuity, which is related to deformation and strand-rotation. The latter indicates that a "structural plan" is governing the periodic sequencing of certain structures. Within a certain component it is possible to discern the positions (places) where the structures are becoming visible through an evolving helix. For example the helix of the β-strand of the O-component is winding the β-strand around the O-component so that its defining path toward the global state attractor can be differentiated repeated times. Through reappearing sequences of holes (∅) and controlled neighbourhood, differentiation becomes possible and can be observed. Thus, controlled supplementation operations are achieved through discrete propagating cell states. The function of supplementation implies that textual segments make up their "filaments" in the form of strings of graphemes.

In this sense textual variability and variety of textual elements become identical with the "filaments" of the super-strings. Hence, individual textual elements are the units of the concentration space. Hence, individual textual elements do fluctuate, but they do not develop evolutionary. Individual strings can change in the composition, become visible and propagate. But evolutionary growth can appear only through integrated strings of graphemes or through layered textual elements. Through the influence of the kinematic gradients, which are building up during the production, position dependent variables become activated.

The interaction of an α-variable, representing the textual agents of the A-component with a β-variable, representing the textual objectives of the O-component has not only the capacity to form patterns, the interaction also makes possible to explain "re-generation" processes on the basis of the function of the cell states. For example the production of a new FC contributes with uniqueness and individual variability to the evolutionary process. But regeneration does not mean that the [AaO] systems have to be identical. The regulative function of the cell states is not reconstructing the nature. Instead, it is reproducing the correct "neighbourhood". Thus, sequencing of the propagating cells is achieved through states, which exclude each other, but activate themselves over long distances. It follows that only one of a

number of alternative states becomes stable. The correct state is achieved, if long distance stabilisation can be guaranteed through the copying function. Obviously, what is governing the process of substituting dummies with copies, are the messengers, which are working with the purpose not to reconstruct the "Bauplan", but to define permissible neighbourhood.

After performance of the act-in filaments, every step in the generation of a variable is irreversible and the reached magnitudes and concentrations remain stable, despite the fact that the process has progressed towards another state. For example, the information flow can "float" a particular textual element as filament to a specific level, however, the "deflating" following, would not remove the element. But a later flow with a higher potential concentration can float the same element as part of another filament even higher without removing the previously reached level.

The Morphogenesis of Holophors

By naming a thermodynamic trajectory, families of state attractors, consisting of resonating patterns can be made visible and used in the reflection of the invariant property of wholeness. This property of text production has been captured in the concept of "holophor". The combining form ('holo-'), meaning "whole", marks a sequence of discontinuations, but without any intervening textual dissociation. Further, since text is conceivable as information carrying system, this property has been preserved in the suffix ('-phore'). The latter is addressing that part of a physical system, i.e. the FC, which carries, bears or transcribes the information. Thus, the basis for the morphogenesis of the holophor can easily be grasped through the regulating property of the gradient. A gradient, when built up by local sources and displacement, is reaching continuously higher growth in complexity. This kind of complexity refers to the distance between the "propagating cells".

A holophor is generated, whenever the resonating pattern of one textual variable is intersecting that of a second, which is carrying the value that leads to the forming of a state attractor. This operation opens a new perspective on the dynamics of information flows. What is needed is the assumption of a system of biological clocks, which is governing natural language production (B. Bierschenk, 2001). From the precision in the working of the involved clocks, morphological consequences of rhythmic movement productions can be extracted from the text. Furthermore, if the context for text production is conceived of as part of a resulting information synthesis, related variable generation may be viewed as basis for the development of a system of termini that is constructing itself on the basis of lawful regularities, which can be determined at the ecological level. Since "wholeness" signifies the validity of text processing no other reference system is required.

Associated with the "point attractors" of the system are textual segments, which constitute its constraining context variables. As a rule, it is always possible to associate a name with fused textual segments, which is expected to capture its descriptor condition. In this sense, a descriptor communicates the state that the kinematic trajectory has been attracted to in the realisation of a particular "Bauplan". The closeness of a particular descriptor-name to some other descriptor-names makes its fusion possible and transforms the entrenched point attractors into a structured configuration.

Once a new terminus has come into existence, its transformation through successive state attractors imposes rigour on the process of naming and generates the mentioned informational specificity. Shared termini may emerge, which become specified through their "new" structural relations. Through the causal relationship between termini and their underlying structure, individual specificity makes evident that the text producer is contributing uniqueness in his way of grasping the centrality of an idea or a concept.

Development of Competence

To explain changing time requires the study of the relationship between development and evolution. Internal processes, arising from changes in a developing text, are articulating its evolutionary meaning. Changes in textual growth are expected to produce observable changes in the shape of a textual space and related changes in its attractor landscape. Hence, establishing the termini of its state attractors means the manifestation of "specificity".

Method

In the view of the 18th Century writers, ideas are grounded in experience, which varies from person to person. Furthermore, learning by experience implies that differences in opinion do not come into existence because of differences in mind but because of differences in individual life histories. Based on the assumption that the mental world must be grounded in the natural world, Voltaire's novel "Candide" has been chosen, since it seems to be inspired by an understanding of the import of personal improvement. Accordingly, if one's mind becomes entrenched in some form of "social constructions", then the explanation of human behaviour can be couched as a narrative of the intentions of the characters. In Candide, thinking and planning as well as beliefs and memories are patterning the activities and thereby transforming the minds.

Participants

The present experiment was carried out during the academic year 2002/03 and an entire social science class from a gymnasium at the city of Lund in Sweden, consisting of 30 students, did participate in the study. The students were enrolled in the social science program at their second year. At that time they were between 17 and 18 years of age. However, the two students in focus have been selected according to the design and procedure described in Bierschenk and Bierschenk (2003a, pp. 6-9). But the instructional program, which preceded the present test, is described in Bierschenk and Bierschenk (2003b).

Materials

The novel "Candide" of Voltaire constitutes the test material of the present study. As contextual background, all participating students were asked to give their account of the novel as final exam of the study of literature of the 18th Century. A detailed description of the relevant teaching period is given under the heading "Design and Procedure".

The novel "Candide" or "Optimism" was published in 1759. Traditionally, this work is classified as satiric. But it is also a story of adventure with spicy properties. The notion 'candide' circumscribes naivety and optimism. Hence, this notion is grounded in the idea that the optimism of the 18th Century, expressed in its belief in future prospects, is a naïve belief in the best order of everything. A critique of society, as Voltaire has launched with his story, has its aim in making evident that the idealism of Gottfried Wilhelm von Leibnitz (1646-1716) does not stand reality. The content of the story can be described as follows:

> Candide is a young fellow without experiences, who has been raised in the milieu of a protecting palace. His tutor Pangloss is responsible for his education. Pangloss beliefs in idealism and he is lecturing about this world as the best of all worlds. One day, Candide becomes caught, when he is together with the daughter of the Lord of the castle. As a consequence of his involvement with the Lord's daughter Kunigunda, he must leave the castle. This is the starting point for a travel through many countries.

The goal with the description of the journey is to show how the young man is required to experience the effects of his optimistic upbringing. For example, he becomes exposed to war, tyranny, cruelty and intolerance as well as to the consequences of the great earthquake of Lisbon. During his travel, Candide is meeting Kunigunda again and his teacher Pangloss as well. Both have earned flaws and experienced violence. But the governing circumstances are separating them again. However, despite all changes, Candide is dedicated to manage a reunion with both characters from his young days.

On his journey, he is passing by a country, called "Eldorado". In this country do the roads consist of gravels of gold staff and the children are playing ball with precious stones. Eldorado represents the empire of happiness and Candide's own moral development is reflected in this ideal country. However, as an outcome of this challenge, Candide wants to go home and show his gold. It is namely only there, where he can experience the contrast of being richer than anyone else, something that he could not realise in the country of equality.

But Candide is also thinking about his loved Kunigunda, who he wants to meet again in order to become reunited. This wishful thinking becomes finally fulfilled and he is accepting that her former beauty has gone. Together with Pangloss and Kunigunda, he is purchasing a small farm on which they can make their living. Still, despite all hardships, Pangloss has maintained his optimistic vision of the world. But Candide has gotten his eyes opened for the realities of life. Any country of happiness or ideal world is not to find anywhere out there. What counts is that one is doing one's best on one's own conditions. Because of his acquired insight he is finally saying: Let us now cultivate our own garden.

The red thread, connecting together all of these adventures, is the narrative about how a human being gradually looses his illusions. The conviction of the "ideal" the "good" must be abandoned in favour of genuine reality. For Candide, the flaws in the Creation become too many, which implies that he can no longer believe in a purposeful world. He himself has abandoned his belief in utopian schemes, because he has discovered his own human needs, e.g. love and greed. But one can also say that the novel puts the problem of theodicy against the optimism of Leibnitz. The result is a pondering about questions concerning how a just and mighty god can allow that so much of madness can happen in the world. The accidents and the decay of Kunigunda may be viewed as an allegory for the external beauty, i.e., the ideal and the delusions. Finally, Pangloss, represents the symbol for a dogmatic attitude, i.e., he has not been able to grasp reality, which has past his eyes and which he has experienced in a painful manner. In this way the learned is in the end becoming a dwarf and by experience, the naïve is loosing his innocence for the benefit of himself, his group and his society. This is the message that the reader is expected to pick up. There is a red thread at the concrete level, in that Candide has involuntarily been divorced from Kunigunda and their reunion together with a number of other episodes makes the adventures spicy. At the abstract level Pangloss (Leibnitz) is the main character and governs the development of optimism gradually towards scepticism.

Design and Procedure

The study of the Renaissance, reading of "The Dwarf" of Pär Lagerkvist, and a succeeding deepening task had made up the content of the literature studies of the autumn term of 2002. Reading of "The Dwarf" at the beginning of second year of study generated the database for a test of the students' ability to produce a synthesis of the novel (Bierschenk & Bierschenk, 2003b).

After this phase of accounting for one's reading, in order to study the novel, according to a particular scheme, work with a deepening analysis was initiated, which introduced new categories compared to the categories used during the first year of reading. Thus, the novel were characterised in terms of a historic problem novel (the ideas of the Renaissance), with its dramatic edifice. In this work did all 30 students participate and the analysis was carried out during three consecutive lessons. Since each session was extended, working through the novel this way, was much like following a textbook on the subject matter. However, the purpose of this step-by-step procedure was to give the students the instrumental means for carrying out the next following step on their own. Hence, the "next step" required them to choose a novel of the same kind and to produce a deepening analysis of its theme. In order to make their choice, the students were provided with a list of historic novels.

A relaxing period followed now. During this period the class participated in a course on verbal and written communication. This period began in the week (41) of 2002 and was terminated occasionally in the week (2) of 2003. Thereafter, the literature studies were taken up again and terminated finally in the week (10), which was the last week of the reading period. A new relaxing period, associated with the course on communication, was finally closing up the study year. In conclusion, the period from the week (41) to the week (2) had no literary content. Instead, the students worked in groups in their study of messages in media, and produced only oral accounts. In addition, writing exercises in the form of outlines, correcting, editing and making a fair copy had the task to extent the relaxing period further. This period was finalised with an exercise in oral argumentation concerning a subject of one's own choice.

Parallel with the relaxing period was the reading of one's own novel in progress. This kind of deepening analysis of literature had been trained with going through "The Dwarf". But the task now was to familiarise oneself with categories of import for the study of historic novels, like the milieu and colour of the time, the dramatic edifice and the relationship between the main characters. The assignment was expected to be ready for handling in at the same time as the literature studies were taken up again, that is in the second week of 2003.

The new period of study was dedicated to the history of language (week 3 and 4) and to the 18th Century. From the time of the working with "The Dwarf " to the beginning of the study of the 18th Century had the students again a time of rest. The exercises during this period were again different types of writing. Therefore, potential synthesising during this period is connected with homework. The history of language and the writing exercises must be conceived of as a necessary stretching transportation, suitable after these exercises and with clear connection to Swedish writers. During these two weeks, the students worked with facts about the development of the Swedish language and participated in an easy but competitive text dating exercise.

When the study period of the literature of the 18th Century began, a detailed plan was made up for the weeks (5 to10) and a tide and stringent exam scheme were set up to govern this period. The study of the earlier literary epoch was treated fairly traditionally with homework and going through textbook materials as well as with a conventional exam. This time, the students were asked primarily to read the texts. Reading of the background sections in the corresponding textbook provided the optional part in the study course. Different aspects were applied to the texts, which means that every single aspect made up a grading level and were controlled independently of any other. The exam was carried out in the form of prepared homework and in three steps. One step was taken each week during the period (week 6 to 9), except week 8, which was a vocation. Moreover, all examination was carried out at the same lesson hour of the timetable. The three testing occasions are corresponding with the three grading levels of the Swedish system.

Going through the homework implied that the texts became related to some typical 18th Century concepts. A couple of text had to be analysed with the concepts of allegory and satire and to be compared with each other. A quotation from a writer of the Enlightenment period was also presented and the students were asked to give their explanations. The first task was designed to test association and understanding, the other analysis as well as the third task was constructed to investigate into the students' ability to transform, i.e., to produce a synthesis. The task were formulated as follows:

Writing task 1: Corresponds to Grade level (G) = Passed

Part (a). Explain the meaning of the concept "empiricism" and give an account of how one can see that the writers of "Robinson Crusoe", "Émile", and "The Boys" were thinking according to this kind of spirit.

Part (b). What kind of concepts do you think have been transformed into "Gulliver's Travels", "The Enemies of Enlightening", and "Some Advice to my Dear Daughter"? Explain.

Writing task 2: Corresponds to Grade level (VG) = Well passed, i.e., with good marginal

Make a comparative analysis of "The Enemies of Enlightening" and the given section of "Gulliver's Travels". Both are allegories, critical of society. What do they criticise? In what way is the style of the novel underlining the message? Make an investigation and describe their similarities and differences.

Writing task 3: Corresponds to Grade level (MVG) = Very well passed, i.e., with honour

"Everything is good which Nature's originator has created; everything becomes distorted when it comes into human hands" has been said by Rousseau. Reason about what you believe the author has meant and how he has transformed his ideas into literature.

After a general introduction to the epoch, going through the homework was directed toward those tasks that had relevance for the actual exam. Before the first exam (G) was pending, the students were asked to focus on the so-called "isms" of the 18th Century, i.e., empiricism, rationalism, utilitarism, etc. The students were expected to pick up the significance of the concepts through reading about them. Further, they got to know that the exam would asked them to connect a particular concept to a certain text and to explain why they did so. It turned out that the first part (a) of the first task was easy, while the second part (b) appeared to be much more difficult. Several students had difficulties with the conceptual foundation of the texts, e.g., to comprehend "Gulliver's Travels" and the "Enemies of Enlightening" as an expression of rationalism.

A consequence of this condition was that their grades of the first exam were lower than expected. But all students passed the first level. Going through the lessons before the second exam became therefore more heavily concentrated on the significance of the concepts allegory and satire as a means in general and an exemplification of the particular style of approach in the stanza of the Swedish writer Kellgren. The result of the second exam (VG) showed a clear improvement in the comprehension of "Enemies of Enlightening".

As an introduction to the third exam (MVG) the students did read and work with a section of Rousseau's "Émile". This section is an extension of his thinking about natural upbringing and its significance for society. This time, the students got to know that they would get a task concerning Rousseau. But they did not know what kind of treatment they were asked for. Therefore, the reading assignment was only given in general terms, which required the student to read comprehensively in order to be able to reason about Rousseau's ideas. No means of assistance were allowed. As a consequence, some less able students had

already finished their study of Rousseau at the time of the first exam. What they remembered was some facts of the immediately preceding lesson of preparation. This circumstance could, however, not lead to a satisfactory solution of the task at hand.

The purpose with the study program has been to give the students the opportunity to adapt gradually and stepwise to a certain degree of difficulty. Further, to get them to see literary texts in a more abstract fashion than what is required at the preceding stages meant to get them to understand the texts as representations of certain ways of thinking. Another aim was to get a greater number of students to pass a higher degree of difficulty, than what normally used to be the case. This aim was fulfilled in several cases. Finally the stepwise preparation should also facilitate the reading of Voltaire's novel "Candide", which had been distributed when the literary course started in week 2. The examination was carried out after the three homework assignments were finalised. One week of vocation and one week of individual preparation were intermeshed.

The examination was carried out in the writing room and at the end of week 10, 2003. The following questions were posed:

1. (a) Which one of the concepts (empiricism, rationalism, utilitarism, materialism, deism) do you think are the most typical of this novel? (b) Explain. (Choose only one)

2. You have learned that the 18th Century writers liked to write satiric. (a) What kind of lesson do you think the satire of "Candide" is communicating? (b) Justify your statement.

3. As you know, Voltaire has been a learned writer. (a) What kind of learning do you think the novel is communicating? (b) Develop your answer and give an explanation. (c) Point out some places in the book (Chapter or episode) that can serve as an underpinning of your statement.

The three questions have been formulated with regard to the degree of difficulty and the content of the corresponding three writing tasks that the students had fulfilled before the exam. It is the answer to the third question of this exam, which constitutes the test material of the present study.

Results

Progressive processing of the produced texts demands an expression of synthesis as the result of the student's perspectivation, i.e., angular articulation. In addition, the rhythmic driving in text production is generating the complexity of their geometric forms, which are carrying their structural information. Now, the purpose is to make evident that this kind of processing requires the establishment of morphogenesis and consequently the unfolding of the drifting in their phase-spaces. The written response to "Candide" will be assigned the labels (A3) and (B3). The Swedish texts and their literal translations into English follow now:

Text (A3): Original Swedish Production
Att man ska ifrågasätta och tänka själv. Att inte vara så naiv. Candide blir hela tiden lurad under hela boken. Till exempel av den portugisiske kaptenen som stjäl hans förmögenhet. Han litar på kaptenen, en man som han precis träffat och som hela tiden höjt priset för hans färd. Redan då hade en inte så naiv person börjat ana oråd.

Text (A3): Literal Translation

That one shall question and think on one's own. Not to be so naïve. Candide becomes all the time deceived during the entire book, for example by the Portuguese captain, who steels his furtune. He trusts the captain, a man, who he had just met and who all the time had raised the price for his journey. Already at the moment some person not so naïve would have begun smell a rat.

Text (B3): Original Swedish Production
Att man ska odla den gräsplätt man står på, och skapa sin egen lycka istället för att jaga efter något som borde ger en det. Människor har en tendens, som beskrivs i Candide, att tro att gräset är grönare på den andra sidan. Det märks väldigt tydligt när Candide och Cacambo befinner sig i Eldorado, och trots att det verkligen är paradiset på jorden åker de vidare för något som kanske är ännu bättre. # När sällskapet väl stannar upp i sin lilla gård, så går livet lättare. Lyckan är vad man gör den till.

Text (B3): Literal Translation
That one shall cultivate the spot of green grass one stands on, and create one's own happiness instead of running after something, which should give it to you. People have a tendency, which is described in Candide, to believe that the grass is greener at the other side. This can be observed very clearly when Candide and Cacambo have reached Eldorado, and despite the fact that it really is Paradise on earth they leave for something, which perhaps is much better. # When the companions finally come to a hold in their little garden, life becomes easier. Happiness is what you make of it.

Unfolding the Spaces

The extent to which the radians of Figures 1 to 4 can give expression to the degree of curvature of a shape can be made evident in terms of the Gaussian curvature, i.e., the product of curvature in orthogonal directions. Therefore, interpolation of the radians has been carried out with the smoothing method of SigmaPlot (2002, Version 8). This method is using the negative exponential, which applies the Gaussian weight function [$e^{-u^{**2}}$] to weight the radians and a quadratic fit. In general, if a completely flat, e.g. a uniformly expanding shape would come into existence it would maintain zero Gaussian curvature. However, this is an unrealistic situation, since the spin structures of the β-variables as well as the α-variables will always wind and develop in some direction. However, when the development at the tip of a variable is arrested, the corresponding shape will wind up as a cusp-shaped contour. This is the case in the Figures 1 and 2. Both show a positive Gaussian curvature, which means that a variable is developing more slowly at its borders, compared to its centre. Conversely, if a variable is rolling helically at its tip, the resulting shape will buckle as shown in the Figures 3 and 4. Hence, the characteristic form of these shapes is a rolling wave, which is described by a negative Gaussian curvature. Further, the Figures 3 and 4 are showing surfaces, which to a great extent are buckling only slightly.

This marks a condition where the acceleration at the tip of the variables of these regions is coordinated with the speed in the variables. This circumstance can be observed in the intervals 4 to 10. Moreover, under this condition, speed and acceleration are more balanced, compared to their manifestation in the intervals 1 to 4. Concerning the shapes of Figure 1 some acceleration can be observed at the beginning (interval 1 and 2) and at the end (interval 4). Deepening in the shading implies that the spin structures of the participating variables have adopted a negative curvature. Hence, faster acceleration at the tip of the involved variables means deeper folds. The latter is manifested where the points of growth are deepening.

Figure 1.

Text A3: Analytic – Descriptive Approach to Candide

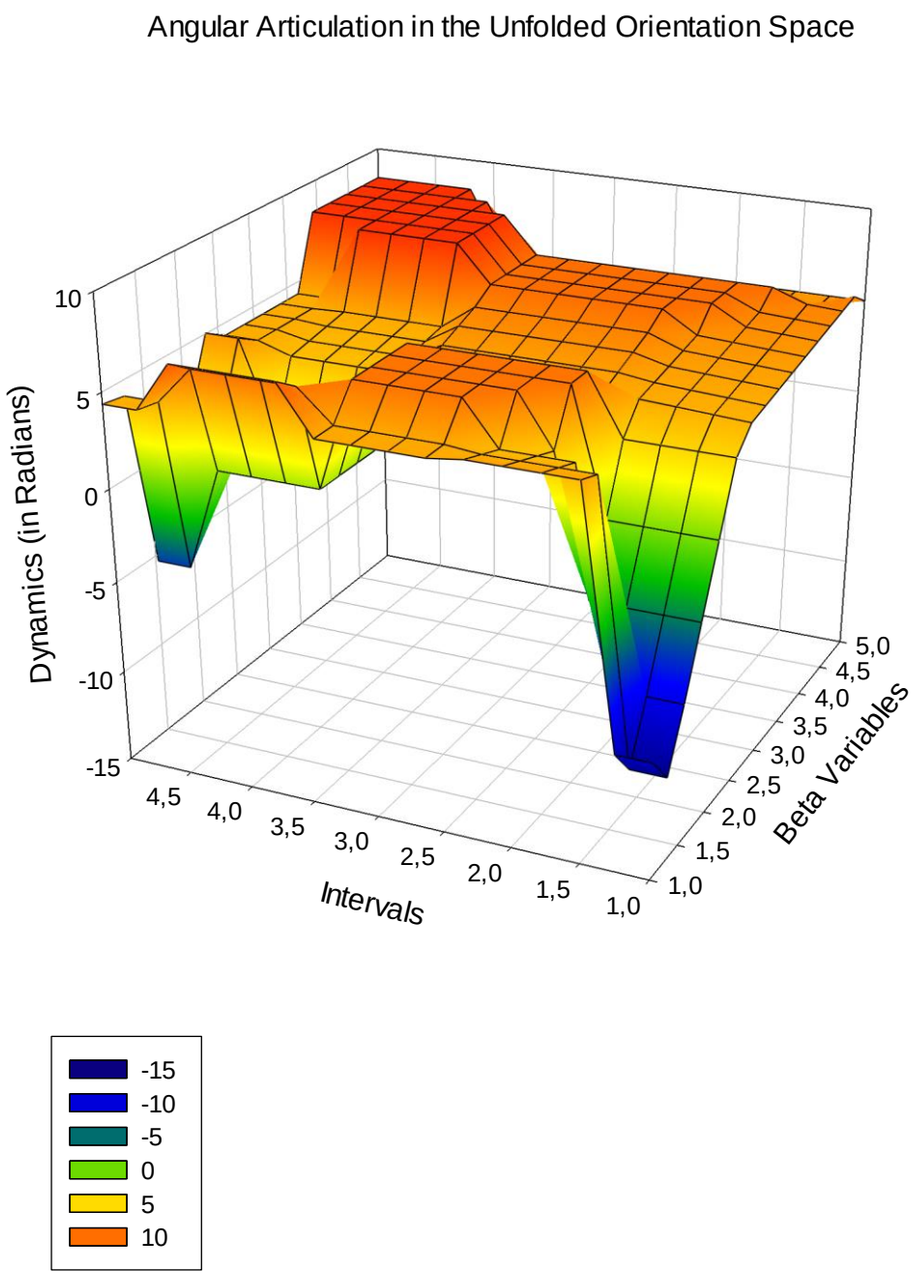


Figure 2.

Text A3: Analytic – Descriptive Approach to Candide

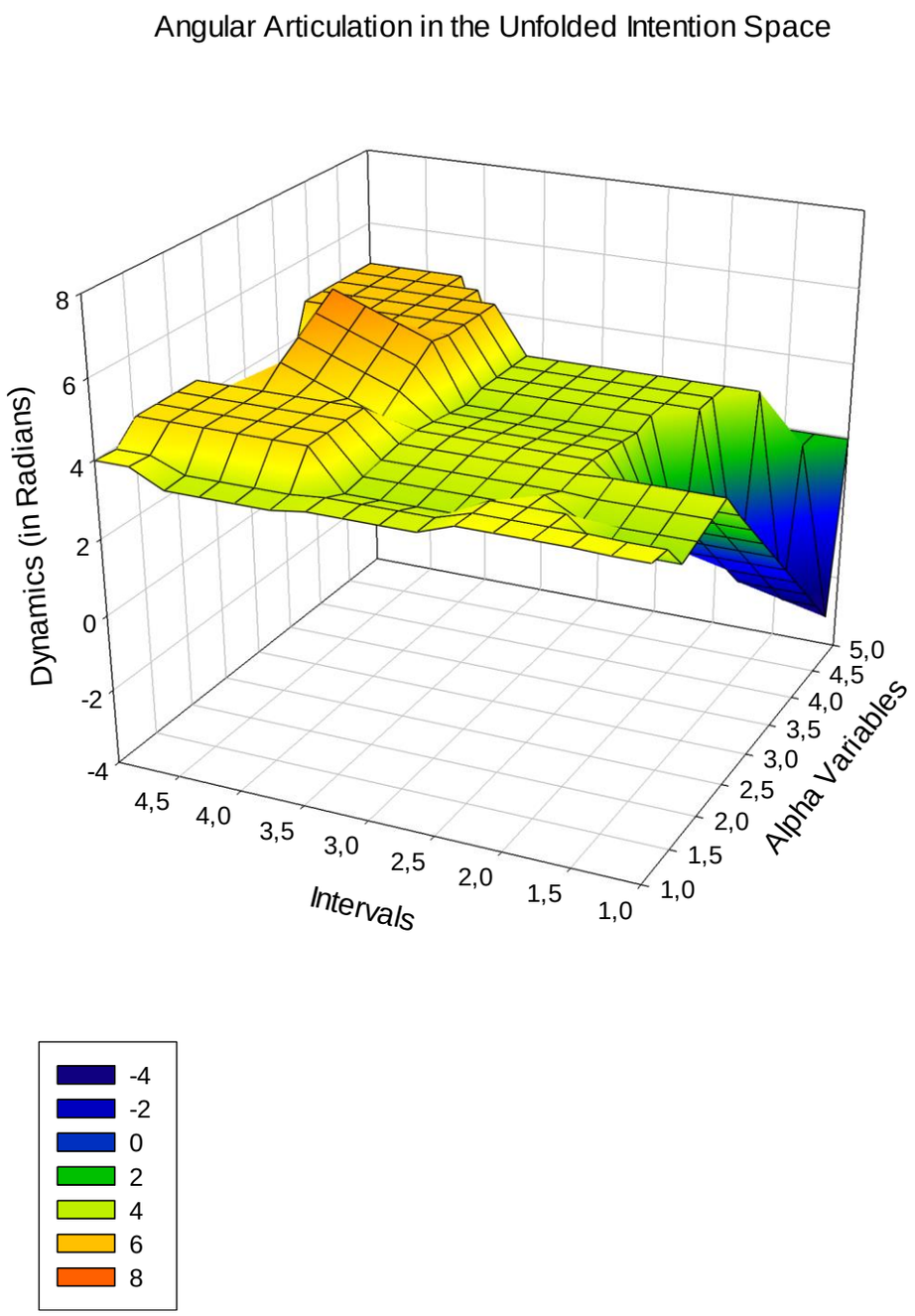


Figure 3

Text B3: Synthetic-Reflective Approach to Candide

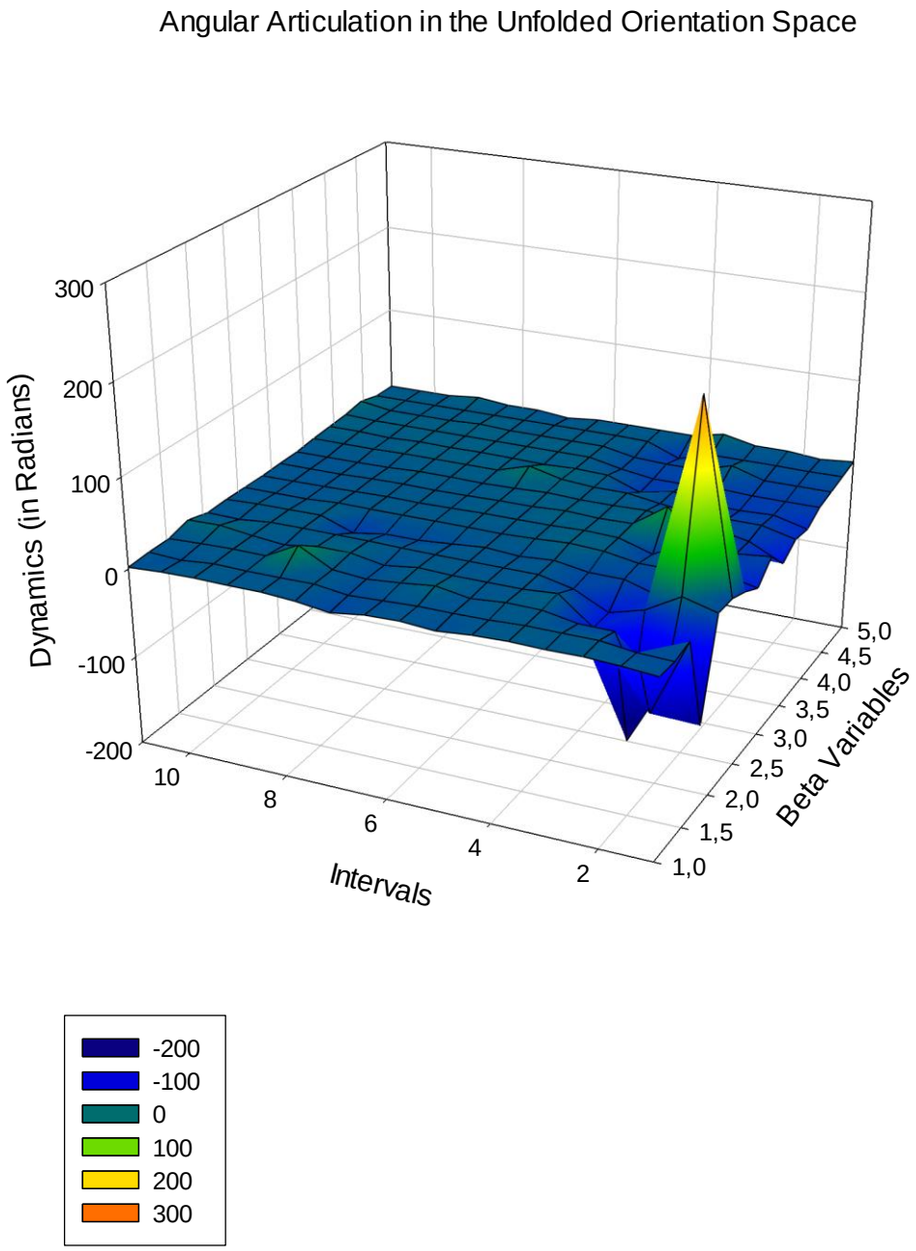
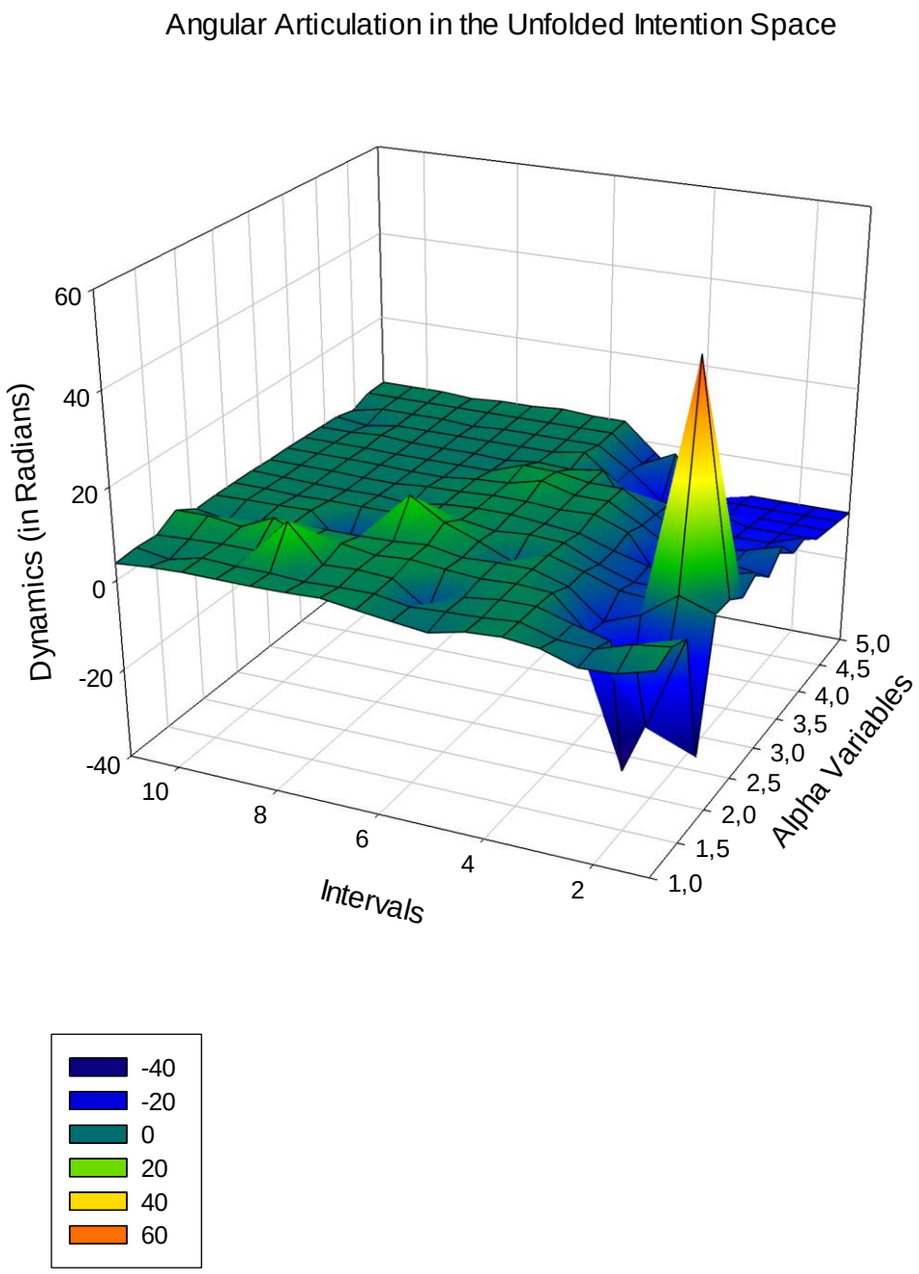


Figure 4.

Text B3: Synthetic- Reflective Approach to Candide



In contrast, speed, i.e., slow growth, is associated with slight shading and consequently with higher speeds in the variables. This condition is producing positive changes in the slow growing regions. Thus, evolution works from the inside, which is stressing the fact that the development of increased complexity is dependent on corresponding degrees of acceleration. Consequently, it can be concluded that the Figures 3 and 4 manifest faster development and a higher degree of shape change as well as more balanced development, when compared with observed changes in the Figures 1 and 2.

When the produced α-variables of the A-component and β-variables of the O-component are put in relation to the number of produced intervals, the resulting mesh-systems of Figure 1 and 2 are obviously much smaller, compared to the mesh-systems of the Figures 3 and 4. Further, the dynamics, as expressed by the radians, is forming a subspace, whose structure is highlighting the complementary character of the subspaces of the A- and O-components.

Thus, the main goal with the unfolding of the spaces is to manifest the dynamics of different rotational states of the β-variables as well as of the α-variables. More concretely, the study concerns the interval-sensitive unfolding of subspaces. As demonstrated, the mechanism, responsible for differentiation, has established the naturally occurring intervals and the number of β-variables, which however differ with respect to Figures 1 and 3. This implies that the functional aspect of a coordinated displacement of textual filaments can be identified with a dynamical system. It follows that the exactness and precision in textual movement coordination is dependent on "ability" in the formulation of one's ideas into a discourse as well as on rotational variability. The latter condition is a prerequisite for proper adaptation of the text producer's text building behaviour to the task of producing the discourse on Voltaire's Candide.

As shown in the Figures 2 and 4 production differences can be observed with respect to the α-variables. What is particular can be extracted easily. The special character of an in-depth perspectivation appears in the form of an overshadowing operation, which is achieved through folding. This is a particular kind of fading and appears in Figure 2 and in Figure 4 in the first and third interval. Since the textual material (i.e., the filament) is first copied and thereafter duplicated through the procedure of re-iterating a copy, it can be concluded that the process of copying at each re-iteration step leaves behind a mark of itself, which effects the developing trace as well as the overall dynamics in the formation of a trajectory.

Figure 4 is amplifying further the deepening of a perspective through local fading and global inhibition. Based on the development of the intervals of Figure 4, local fading in the first interval is generated through a local shadowing activity, which is communicating that the filament of the first α-variable is governing the perspectivation throughout the first interval. That a global inhibition is controlled through the boarders of the intervals becomes evident in the contrasting of the behaviour of the α-variables in the second with the third interval. Shades are competing with each other in the perspectivation of a particular part of the surface. Thus shadowing is achieved through "delays" in the development of a trajectory.

The most typical silhouette appears in the space of the O-component, where a global constraint is enforcing variable (β_3) of the first interval and variable (β_5) of the second interval to carry a concentration of α- and β-shades, which means that the floating equilibrium of these variables becomes established through shading operations. It follows that a global attractor potential is producing the equilibrium of the O-component. In contrast, the orientation space of Figure 1 is dominated by explicit expressions and "pointers", which render a more direct attraction of viewpoints. The demonstrated difference in the forming of the shapes of Figure 1 and 2 concern the critical changes in the degree of functional rotation. Thus, whenever the depicted process in the unfolded orientation space of Figure 1 is

advancing from one state to the next, the established distance is a measure on the degree of "directness", which is driving the development of the gradients through the five intervals.

The relative coordination of the A- with the O-component suggests the text building in the A3-example to have forced the A-clock to adjust its speed to the running of the O-clock. In contrast, different functional requirements have influenced the operations of the clocks in the B3-example. Adjustment of its clocks has changed the development of the trajectories in subtle ways since the surface is quite flat. As shown, the differences in the kind of displacement of textual filaments have had profound effects on the acceleration of the clocks. By contrasting both examples, it becomes evident that a biological coordination of the text-specific [AaO–FC–AaO] transcription factor is at work, which must be conceived as the foundation of the synthesising processes, governed by the AaO-paradigm. Thus, synthesis proceeds according to the way in which this transcription factor is coupling the A and O-components and how it is transforming the coupling into an A-O kinematics.

The Attractor Landscapes

A convenient device for visualising the results of the A-O kinematics is to rule a coordinate grid on the convoluted configurations of its concentration space and to examine the distance between the state attractors. This operation opens a new perspective on the dynamics of text building and implies a discussion of the meaning of the emerging landscapes. To generate the foundation for a mesh plot, the introduced smoothing method has been used once more. Related to the Figures 5 to 8, the distances in the attractor spaces are represented on the basis of "Strain", which is marked on the X-axis and "Shear", which is specified by the Y-axis. These functions are forcing the aggregated radians to create landscapes, which are characterised by mountains and valleys.

"Shear" and "Strain" are recorded through the "redundancies", produced by the copying and duplication operations. Redundancy is a by-product of a process that is establishing a latticed texture. However, "shading" must be equated with the differences between the energy originally invested during text production (loading with perfect AaO-units) and the shear and straining effects manifested during processing in the form of copies, which are inserted into imperfect AaO-units.

Thus, in manifesting the effects of energy investment and the patterning of strings of graphemes into a latticed layer for information exchange, it is conceivable that some text materials may have been produced that would be distinguishable by linear elasticity. When this kind of elasticity is present, Shear and Strain functions would be expected to result in a straight line, whose slope signals the amount of produced stress or elastic stiffness. However, text resulting from the working of a biophysical mechanism must exhibit non-linear and consequently non-commutative elasticity, which means that the elasticity of a text is non-constant but increasing with increasing degrees of angular articulation.

In order to keep the discussion focussed on the central import of the landscapes, five singularities have been described. Together they show that each landscape has its specific configuration of termini. For example, the resonance in the folded orientation space of Figure 5 is characterised by mountains, which form a massif in the background and a massif in the foreground. The specification of the peaks can be achieved on the basis of neighbouring attractors. If these attractors are regarded as expression of distance or depth, then the emerging landscape has empirical implications. The two termini in the background are manifesting a concern with a character, which shows himself in his actions to be deficient in judgement or understanding.

Figure 5.

Text A3: Analytic – Descriptive Approach to Candide

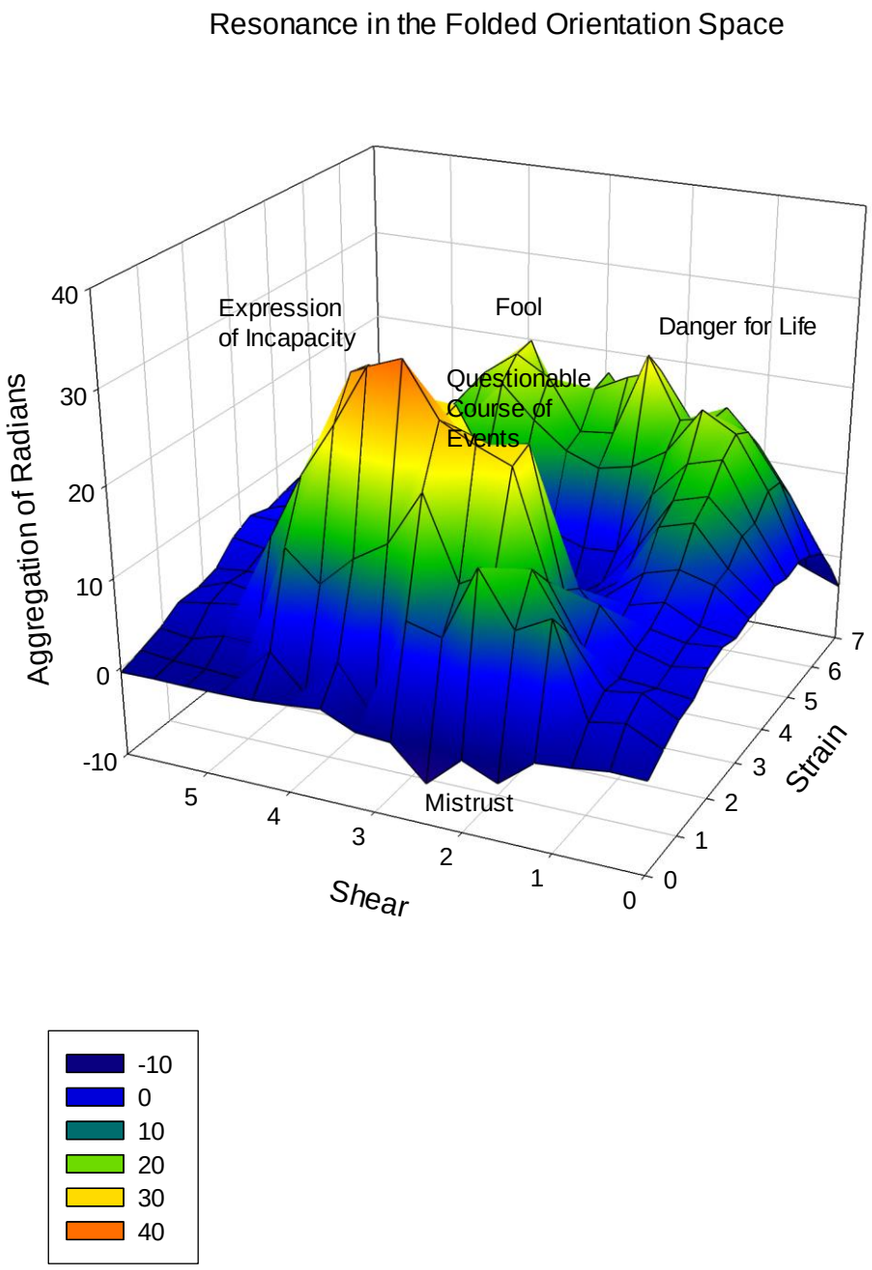


Figure 6.

Text A3: Analytic – Descriptive Approach to Candide

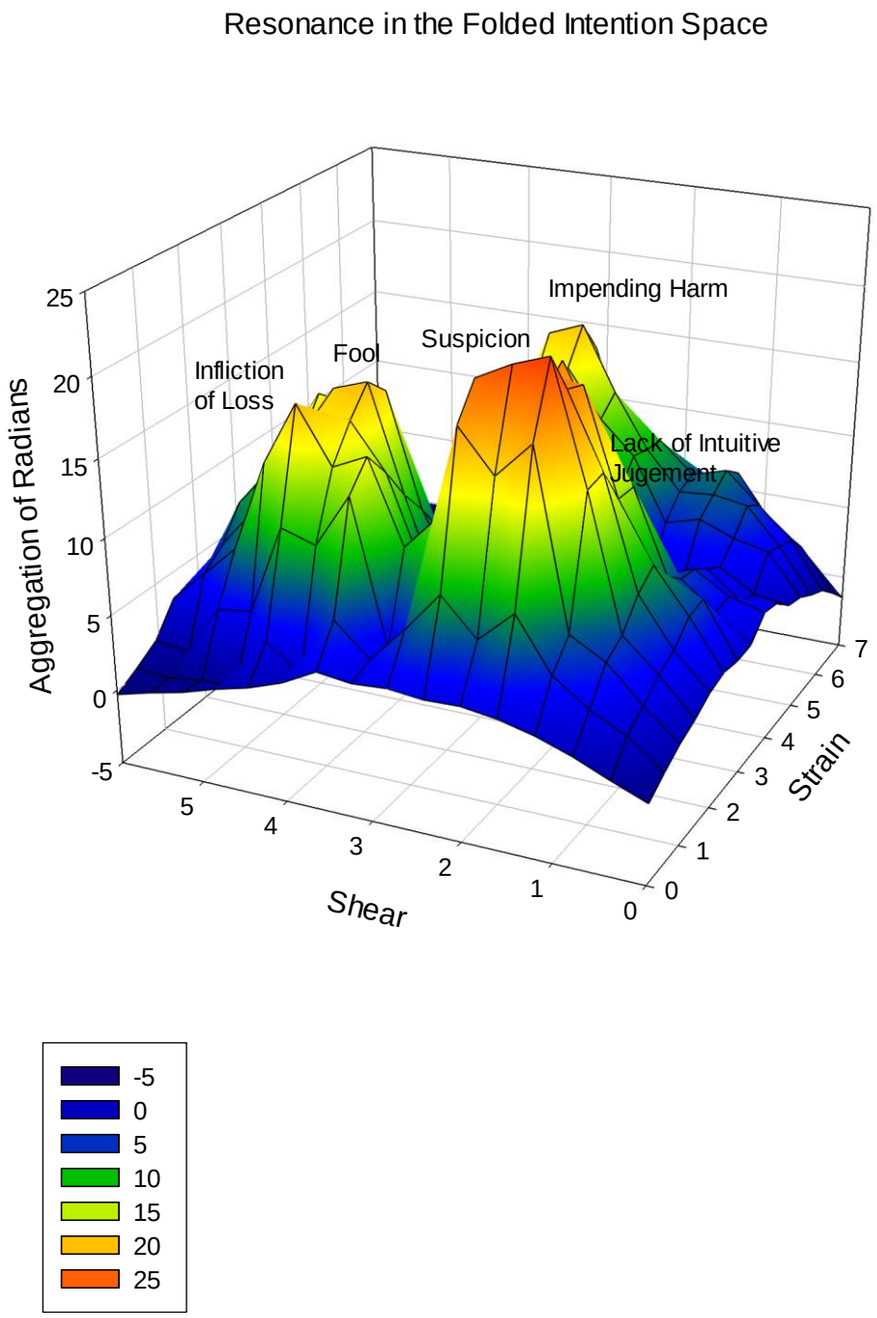


Figure 7.

Text B3: Synthetic – Reflective Approach to Candide

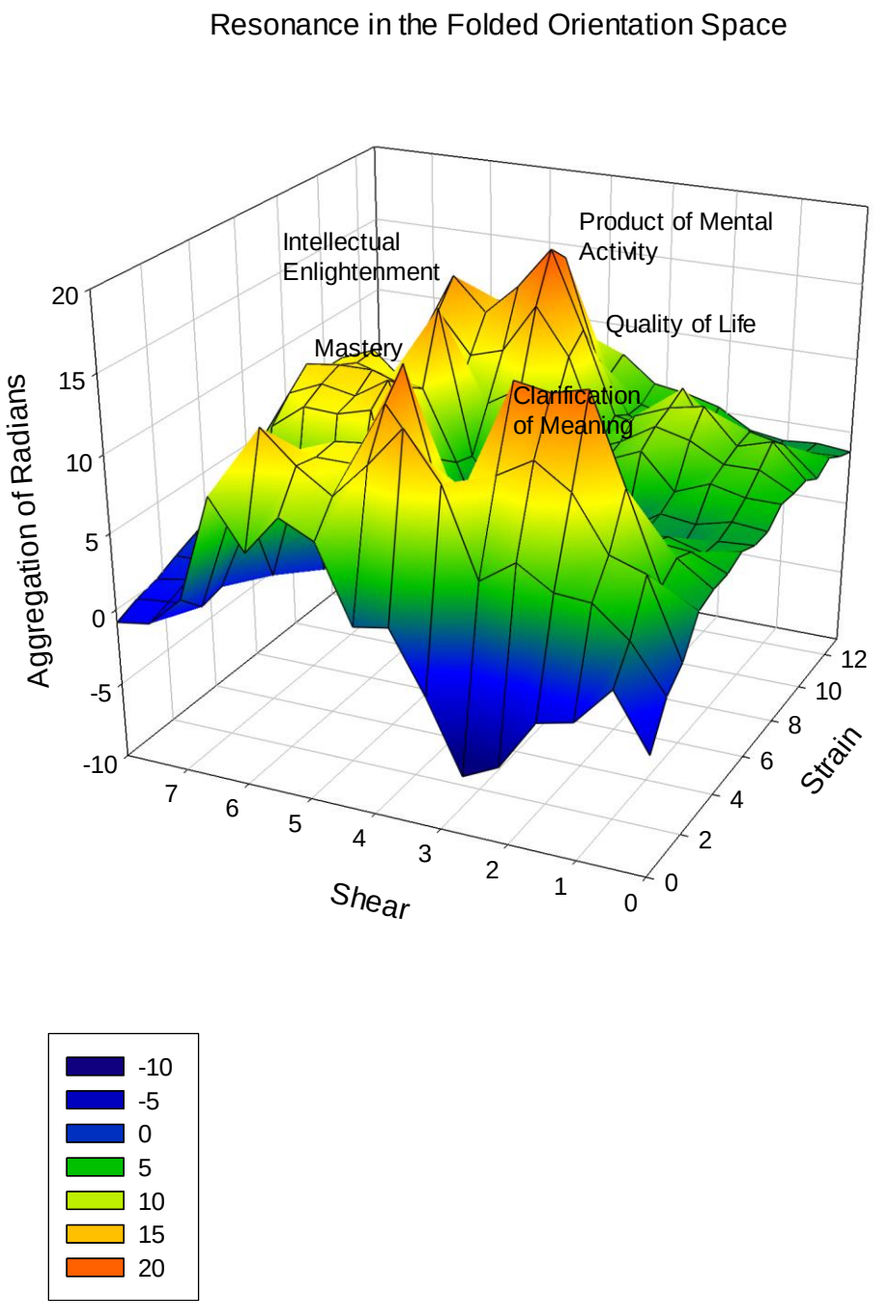
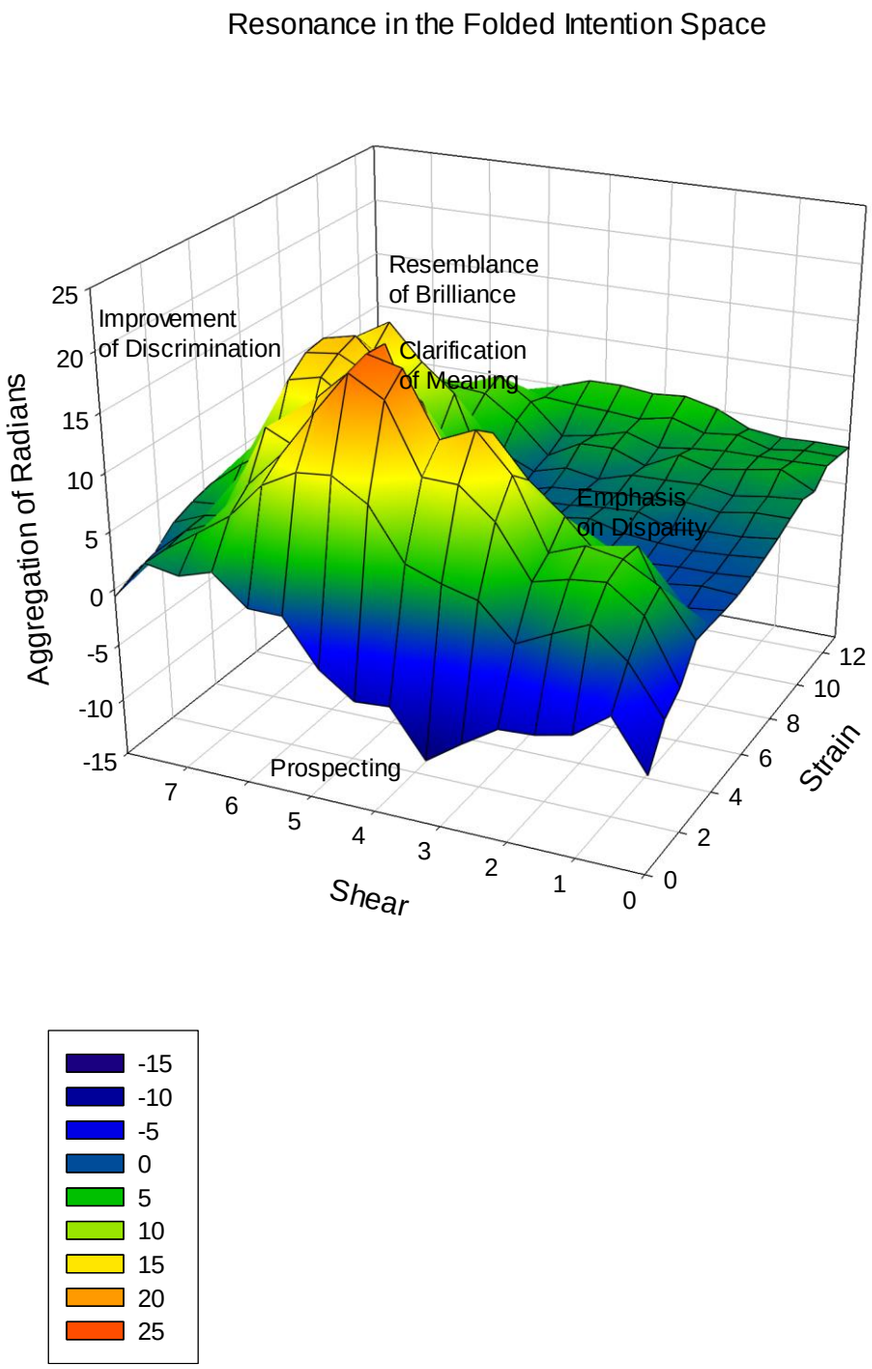


Figure 8.

Text B3: Synthetic – Reflective Approach to Candide



To be deceived or misinformed is in fact dangerous and brings the character to crash with reality, which implies *"Danger for Life"*. However, when this kind of collision appears to be insufficiently transparent or misperceived, it leads to inappropriate actions. In fact, acting naïve or unwisely on a given occasion is taken as the *"Expression of Incapacity"*, which leads to a *"Questionable Course of Events"*. What these termini are approving is that any individual, who is acting in the specified manner, is conceived to be inefficient, since he is not pulling out quickly and forcefully enough from the specified condition or situation. This conclusion is made explicit with the terminus "Mistrust", which appears below sea level. It follows that its implicitness is manifesting the absence of scepticism as a necessary means for situational control.

In order to make full use of the articulation in this token, Figure 6 needs to be taken into account. The termini characterising this landscape allow for the concise description of the folded intention and its lawful relationship to the folded orientation. The immediate implications of this "perspective" transformation are attested by their complementary relationship. The rotation in the A-component, as expressed by the rockiness of the landscape has constituted three massifs and a foothill. The latter makes explicit that the *"Lack of Intuitive Judgement"* is the source of the erroneous perception of reality. The mountain peak in the background is described with *"Impending Harm"*, which implies the likelihood of being in a risky position. However, the peak in the foreground signifies *"Suspicion"* as the necessary condition of alarm and for the avoidance of harm.

Thus, what has been perceived to be absent, but required in the prescribed situation, is the act of suspecting the existence of something wrong, however, without sufficient evidence or proof. For assessing the meaning of the first three termini, it is essential to note the absence of perceived fear, and consequently the absence of sensibility for the manipulative aspect of the situation. In the background of the other massif reappears the terminus *"Fool"*, which becomes characteristic of the formation of intention. In its neighbourhood appears *"Infliction of Loss"* partly as the unavoidable consequence, partly as evidence of purposeful deception. Together, the last two termini are characterising a looser, and hence, the absence of successful adaptation to unstable but otherwise important environmental conditions.

With respect to the mountains and valleys of Figure 7 and 8, it is obvious that evolution has produced a significantly higher degree of growth. Thus, what kind of landscape is developing depends on the constraining effects, which are resulting from rotational dynamics. Therefore, evolutionary time always prescribes the course of development. In the background of Figure 7 have two mountain peaks developed. The highest peak has been described with the terminus *"Product of Mental Activity"*. This peak seems to pertain to those functions that relate to a reflective sense. The other peak, appearing in its neighbourhood, carries the terminus *"Intellectual Enlightenment"*. The first part of it communicates a serious concern with one's ability to learn and reason, while the other is concerned with the critical examination of previously accepted doctrines and institutions. In the same region, however, at a lower level a peak has emerged, which has to be considered as a definite measure on the validity of the stated condition. Its terminus is *"Mastery"* and means in full possession of consummate skill.

The fundamental relationship, demonstrated by the first three termini, has its focus on one's capacity to gain insight. Deeply ingrained in the growing structure is the peak in the foreground, which has been described with the terminus *"Clarification of Meaning"*. This is the proper step to be taken in the elucidation of life. Associated with the steep is considerable conceptual depth. Therefore, it can be concluded that the underlying structural relation is terminating at the peak, identified with *"Quality of Life"*. Operationally, it corresponds with a

need for accomplishment or achievement. Together, the five termini demonstrate that achievements are the sources for the attainment of life quality.

Evidence that the developed termini relate lawfully to the mountains as well as to the property of the valley is manifested in Figure 8. The growing formation of intention is ringing in the *"Clarification of Meaning"* with two mountain peaks. The first one has been described with *"Improvement of Discrimination"*, while the other one concerns the *"Resemblance of Brilliance"*. Hence, at the top of the massif, growing intention appears to be twofold. Pronounced is the need for an extreme sharpness and clarity in the perception of the shades of reality. That this is a highly significant growth effect, is further enhanced through the terminus *"Emphasis on Disparity"*, which appears at the foothill of the massif. Therefore, it can be concluded that the latter contributes with the awareness that different kinds of information have complementary effects. When radically different aspects of perceiver and the perceived come into view, they contribute effectively to the articulation of conceptual growth. The terminus *"Prospecting"*, which appears below sea level, is capturing the distinctness of the functional relation between observer and the observed environment. What is implied and consequently arching under the massif is one's way of looking forward in life.

Discussion

The approach in the presented study links the individual text producer's capacity to apprehend text materials with the constraints, present in the discourse of the used materials. In particular, the focus of this study has been on the way in which developed text building behaviour reflects evolutionary growth. Conditioned by the bio-kinematic constraints of the AaO-mechanism and the adaptation to the used text materials, the dual roles of internal and external processes have been made the foundation for information processing and synthesis.

In the context of the present experiment, the produced texts (A3) and (B3) have to be conceived of as tokens of a bio-kinematic mechanism, which is governing the development of a particular "writing style". This article has presented its invariant geometric form. It has been possible to demonstrate that each token is producing its own unique physical context for the expression of evolving differences in the degree of synthesis. In essence, information processing and synthesis must treat the token as significant unit of analysis. The presented results have made this point evident, since the tokens reflect their own individual styles of changing the patterns of development and to produce changes in shape and size. The latter implies that spacing and timing can be described only with reference to a particular token.

To put this conclusion into perspective, the token (A3), compared to the token (B3) shows that the practice and experience in the usage of words is varying, which means that the usage of words and linguistic constructions differs greatly. In the case of (A3), the systematic arrangement of words into a textual whole, the constructions show only slight improvements in textual development. In its entirety, only a few "holes" in the texture mark places, where growth in the produced approach path shows up.

In contrast, the words and syntactic constructions of (B3) have acquired new functions that are related but nevertheless distinct. This result underlines existing variations in growth. The token (B3) reflects a degree of "in-directness" that is alien to the token (A3). This difference was demonstrated by means of the contrasts between the Figures 1to 4. In conclusion, the higher degree of integrative depth, and thus, in the concentration of synthesised information is responsible for the bubbling surfaces of (B3). In sum, the shallowness of the information synthesis, expressed in (A3), is significantly different from the "depth" in synthesis of (B3).

The "Shear" and "Strain" functions of the Figures 5 and 6, compared to the Figures 7 and 8 have resulted in considerably less convolution and consequently less changes in morphological complexity. How these differences in complexity relate to the ideas picked up from Voltaire's Candide will be considered next. Once more, it will be demonstrated, that evolution works from the inside. The starting point for the production of the discourse of the token (A3) has been a literary work in which irony, derision and wit in many forms is used to expose the folly ideas of empiricism and consequently learning by experience.

The producer of (A3) has chosen a facet of Candide in which Voltaire attacks John Locke's hypothesis that the senses inscribe one's experiences into a "tabula rasa". Hence, the concept of empiricism implies the belief that ideas are grounded in experience. Based on the axiom of association and consequently the premise of randomness, Candide is repeatedly exposed to the same kind of events, however, without any noticeable changes in behaviour. This scenario is, of course, meant to demonstrate the shortcomings and difficulties, associated with the ideas of empiricism. The holophors of A3 contain nothing that would connect to the contents, inscribed by experience and culture. Instead, the explanation is given in a narrative that is couched in the intentions of an "actor" and the complete absence of "instinct" and "evolution". The structurally significant aspects of this style of approach have been captured conceptually in the naming of the kinematic states of (A3).

The starting point for the production of the discourse of the token (B3) has been Voltaire's concept "Eldorado". The developed narrative concentrates on the interplay between intellectual progress and evolutionary growth. In this sense, thinking and planning are systematic transformations of patterns of mental activity toward a sustainable development, which appears at the edge of nature and society. In the understanding of "Eldorado" as critical factor of behavioural influences, it also explains those processes, which connect to Voltaire's view on rationality. Through sequences of textual transformations and through individual variations in the growth of the involved components, as well as through their variations in nesting, the emerging morphological structures of the holophors of Figure 7 and 8 are characterised with a higher degree of complexity. Their morphogenesis has generated termini, which correspond with the concept of rationality.

References

Bierschenk, B. (2001b). Geometric foundation and quantification of the flow in a verbal expression. *Cognitive Science Research, 81*. (ERIC Document Reproduction Service, ED 459 193, TM 033 479)

Bierschenk, B., & Bierschenk, I. (2003). The manifestation of symmetry between the emergence of consciousness and the development of competence. *Cognitive Science Research, No. 86*.

Bierschenk, B., & Bierschenk, I. (2003b). Growth in competence. *Cognitive Science Research, No. 87*.

Bierschenk, I. (2003). The essence of text. A dialogue on Perspective Text Analysis. (Rev. ed.) *Cognitive Science Research, No. 70*. (ERIC Document Reproduction Service, No. ED 430 053, TM 029 798) (Original Work, published, 1999)

McNamara, K. J. (1997). *Shapes of time. The evolution of growth and development*. Baltimore: The John Hopkins University Press.

Raff, R. A. (1996). *The shape of life. Genes, development, and the evolution of animal form*. Chicago: The University of Chicago Press.

SigmaPlot (2002). *Exact graphs for exact science. User's manual*. Chicago: SPSS Inc.

Thompson, d'A. W. (1942). *On growth and form* (Vol. 2, pp. 741-747, 748-849). Cambridge: Cambridge University Press.

Voltaire, F. M., de (1986). Candide eller optimismen (Candide ou l'optimisme). Stockhom: Natur och Kultur. (Original work published 1759, translated into Swedish by Olof Nordberg, 1976)

Accepted October 06, 2003

Authors' Note

The results of the present article have been presented as part of a Poster session at the 64th AEPF-Tagung (Meeting of the Empirically Working Educators, German Society of Education) at the University of Hamburg (September, 29 to October, 02) 2003. Hamburg, Germany,

Correspondence should be sent to Bernhard Bierschenk, Department of Psychology, Lund University, P.O. Box 213, SE-221 00 Lund, Sweden.

E-mail: bernhard.bierschenk@psychology.lu.se