

SELF-ORGANISATION AND LANGUAGE CHANGE*

MARTIN EHALA

Tallinn Pedagogical University

0. *Introduction*

This paper is about self-organisation in language and its role in linguistic evolution. Though the principles of self-organisation were first formulated in the domains of physics and chemistry, the ideas have later found application in works on biology (Garfinkel 1987), economics (Radziki 1990), psychology (Barton 1994) and other human sciences. Even the study of language in terms borrowed from the theory of self-organisation is not a new one. From the beginning of the mid-seventies a trend of dynamic linguistics arose in Germany and attracted research for about a decade (see Ballmer 1985, Ballmer & Wildgen 1987). Similar ideas were also expressed within the framework of gestalt morphology (Anttila 1985) and others (Lindblom et al 1984), but it seems that both these attempts as well as 'dynamic' linguistics have remained quite marginal.

However, recent years have shown a renewed interest towards self-organisation. For example, the emergence of the concept of neural networks in psycholinguistics and artificial intelligence (Rummelhart et al. 1986) has successfully used the principles of self-organisation to account for the system's ability to learn (Carpenter & Grossberg 1987, 1991; Hanson & Olson 1990). Recent developments in non-linear phonology have also shown the expansion of this framework into the domain of synchronic linguistics which is also accompanied by an increased interest in self-organising (Mohan 1993). As the theory of self-organisation is concerned primarily with the dynamics of systems, the potential of the ideas of self-organisation in the diachronic study of language, appears to be worthy of being taken seriously also by historical linguists.

* I would like to thank my supervisor April McMahon for encouraging me to develop the ideas expressed in this paper, and Peter Matthews, Nigel Vincent and Roger Lass as well as two anonymous reviewers of *Diachronica* for their comments on earlier versions of this paper. Grateful acknowledgement is also made of assistance received from Trinity College, Cambridge, in the form of an Eastern European Bursary and Internal Graduate Studentship which enabled me to undertake the research course at Cambridge University which has led to the results presented here.

In this paper I will outline the general foundations of language as an open self-organising system, and introduce a model of language change based on the theory of self-organisation (see Prigogine & Stengers 1984).

1. *Patterns of self-organisation*

To illustrate self-organisation, consider the following case from physics as described in Prigogine & Stengers (1984): if we have a layer of liquid, its molecules are distributed symmetrically and move chaotically without structure. When the lower surface of the layer is heated, a permanent heat flux is set up from the bottom to the top. Until the gradient of temperature has reached a certain threshold, the heat is transferred by conduction, which does not affect the structure of the system (conduction is a kind of transmission similar to the flow of electricity along wires). After the gradient has reached the critical value, the state of the system becomes unstable, and a new stationary state emerges where heat is transmitted by convection (the movement of heated molecules). In convection, the initial chaotic distribution of molecules in the layer is replaced by a complex spatial organisation called Bénard's cells (see Fig.1). In this structure, circulating molecules constitute left-hand and right-hand moving circles. The probability of such a distribution occurring by a chance is so low that it should be almost impossible. Yet, contrary to expectations, it occurs.

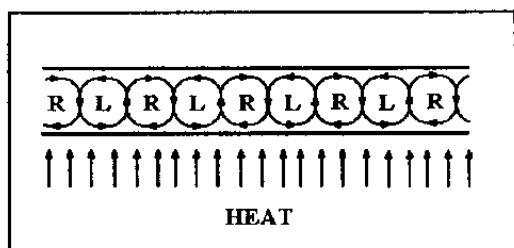


Fig.1: *Bénard's cells*

As we have seen, when the gradient between the lower and the higher surface reaches a certain threshold, Bénard's cells emerge. As presented in Fig.1, the cells move alternately clockwise and counter-clockwise. However, before the cells emerge, it is absolutely impossible to predict which way the cell emerging at a certain point will move. It could be said, then, that the choice of a particular stable state at the point when the previous one has lost its stability is attributed to chance. The phenomenon where the system loses its stability and is forced to choose between new stable states is called bifurcation.

This is presented in the bifurcation diagram (Fig.2) according to Prigogine & Stengers (1984:161).

In this diagram the evolution of system X is plotted as a function of a control parameter λ . When $\lambda < \lambda_c$, the system is in a steady state a where all deviations caused by system-internal or system external fluctuations die out. When $\lambda = \lambda_c$, the system X becomes unstable. This point is called the bifurcation point. At this point the system has to choose between two new stable states (b_1 or b_2). When $\lambda > \lambda_c$, the evolution of the system will continue in a new steady state.

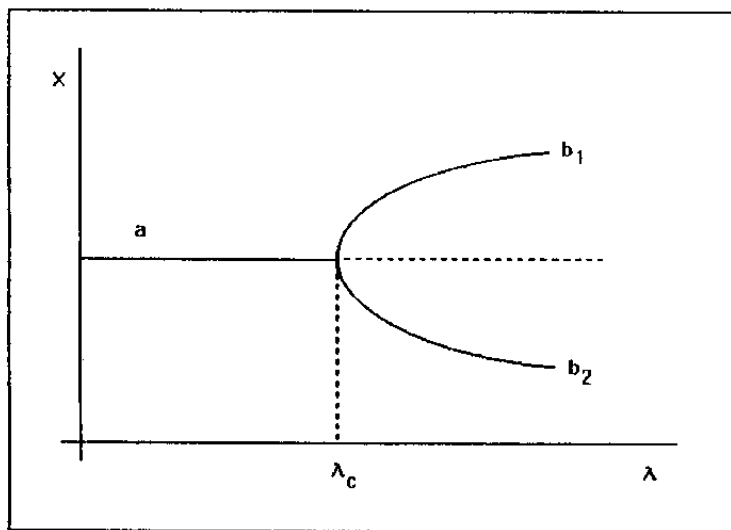


Fig. 2: *Bifurcation diagram*

If we take the layer of liquid as the system X , its initial chaotic state corresponds to the state a on the bifurcation diagram. The control parameter λ for this system is heat. Thus, the system remains in the state a until the heat flow has not reached its critical value λ_c . When this happens, the state a becomes unstable. At this point, random fluctuations of the molecules in the layer determine the choice between a right-hand or a left-hand moving cell. As the result of this process, the new stable state (convection) emerges in the system. It should be noted that fluctuations themselves are unable to initiate change while the system is in a stable state. Only when the control parameter has reached the critical value, does change become possible.

This basic pattern of change seems to be operating also in other, much more complex systems. For example, the role of fluctuations has been long recognised in evolutionary biology as the major source for evolutionary changes. It is also well known that most of the biological fluctuations (or mutations, as they are traditionally called) die out without any impact on the population where they occur. The fact that not all mutations lead to a change, indicates that mutations do not cause changes, but are only the means of change. Only when a control parameter for a given population changes to a critical degree, a certain mutation may have a survival advantage over the average members of the population, and will start to multiply until it becomes the dominant pattern within the population. If we agree that there could in principle be more than one possible response to the change of the control parameter, the point where a mutation starts to grow, effectively is a point of bifurcation — natural selection is the factor which determines which one from the set of mutations present at this point actually leads the population to a new state.

As the patterns of self-organisation were first discovered in chemistry and physics, and were accounted for in terms of thermodynamics (see Prigogine & Stengers 1984), the notion of self-organisation is directly connected with physical notions such as energy and entropy. It is indisputable that, in the instances where certain phenomena in the social or biological domain are explained by referring to principles borrowed from physics and chemistry, we are dealing with some type of reduction. But does it actually mean that biological or social phenomena are in some sense physical? While in biology the answer could be affirmative, in the social sciences such a position can hardly be defended.

However, most of the research devoted to self-organisation in biological or social systems does not aim ontologically to reduce its subjects to physical phenomena, but rather to establish an epistemological connection between regularities found in certain physical phenomena and in social or biological phenomena. An epistemological reduction intends to show that the theories and laws of a branch of science are special cases of theories and laws in some other branch of science. As means of obtaining scientific knowledge, epistemological reductions have widely been used in the history of science.

Bearing this in mind I will now attempt to provide an account of language as a self-organising system, concentrating on the problems of language change in more detail. I do not attempt a total reduction. I simply try to show that changes in language follow the same pattern as changes in other self-organising systems, and that new structures in language emerge in a similar manner as in other self-organising systems.

2. *Self-organisation in language*

As we have seen, the patterns of self-organisation are connected with symmetry-breaking and the emergence of structure. If we place a hypothetical observer into the layer of liquid then s/he would not be able to describe the space where s/he is until the emergence of Bénard's cells. After that the notions of left and right, up and down acquire meaning as the symmetry-breaking allows the concept of space to be worked out. As Prigogine & Stengers (1984) notice, if the concept of space is connected with asymmetry, it ceases to be isotropic as assumed in Euclidean geometry, but rather like an Aristotelian space which is defined by the events that happen in this space. If events change, the space will change.

This is an important methodological position. In speech, as in the case of convection, we have certain events; let us call these events the totality of speech acts occurring in a certain community. These events have a certain type of regularity just like the molecules in the liquid. It is possible to describe these regularities as a structure. In the first case we have the structure of convection (Bénard's cells), in the latter case the structure of language. But in both cases we must admit that such a structure or system does not have an actual physical reality, as irrigation systems or steam engines have it. In both cases what we call a system or structure is an abstraction behind the observed phenomena — there are no cells in the liquid and no language in the air somewhere, there are only certain events following certain physical regularities or social rules. These regularities could be described as certain structures or systems.

If we view the structure of language in such a manner we would get the opposite picture of the structuralist linguistics — it is not grammar but speech that defines the language. If speech changes in a certain direction, the language will be defined differently. "From this point of view linguistic change is not 'change' but *the construction, the making of language*: it is the originary phenomenon through which a language arises, comes into being", to use Coseriu's (1983:57; emphasis in the original) words.

The position outlined above is also consistent with the Saussurean principle that nobody possesses complete knowledge of a language that is perfect only within the whole speech community. This somewhat mysterious position of Saussure's could be reinterpreted as saying simply that language is a macro-structure which exists only as a structure defined by individual speech acts, continuous in its being and becoming like species or human societies. In the light of all this, the synchronic and diachronic study of language can be separated only if some idealisation is made. This is probably unavoidable, to make any generalisations possible, but these two approaches should be compatible to

the extent that if put together, one could comprehend how the system exists in time.

One of the necessary requirements for such a conception of language to be adequate is to have a plausible account of how the structure-generating processes in the evolution of language work. Perhaps the most characteristic evidence for these processes in language is provided by the phenomenon of grammaticalisation (see Heine et al 1991, Hopper & Traugott 1993). Grammaticalisation is a crosslinguistically widespread process by which grammatical categories arise from independent lexical words. It is widely attested in contemporary languages, and given that the emergence of human language started from a simple animal communicative system, it is the most likely process that could have given rise to the complex grammatical structure of human language.

According to Hopper & Traugott (1993) the emergence of grammatical structure falls out from the interaction of two processes — reanalysis of linear relations between lexical items in the speech flow, and analogical extensions of such new meanings to other similar relations. Both of these phenomena rely on the creative process of using metaphors and analogy. Thus, as far as one is able to make a metaphor, and there are others who are able to interpret metaphors and expand its use to other cases, language is starting to be created. Thus, if people start to use a language, however simple, their communication initiates the process of self-organisation, which, due to grammaticalisation, discourse organising strategies and perhaps other processes governing communication, starts to create more complex grammatical structures. In some sense the idea of language as a self-organising system is very close to Hopper's (1987:142) concept of Emergent Grammar which

is meant to suggest that structure, or regularity, comes out of discourse and is shaped by discourse as much it shapes discourse in an on-going process. Grammar is hence not to be understood as a prerequisite for discourse. [...] Its forms are not fixed templates, but are negotiable in face to face interaction in ways that reflect the individual speakers' past experience of these forms, and their assessment of the present context.

In this sense language is undeniably functional — if there were no need to communicate, language would never have arisen, provided, of course, that language has arisen through a self-organising process like the one described above. This position immediately raises the problem of teleology in language evolution.

The problems of teleology in language evolution have been discussed throughout the history of modern linguistics. In the 19th century, evolutionary theories in linguistics were essentially teleological. 20th century linguists tend

not to speak in terms of 'progress' or 'decay' when discussing language change. But the fact that certain changes in some languages seem to have been directed towards a particular synchronic state as a goal has motivated linguists still to look for teleological explanations (Sapir 1921, Lass 1974).

In the theory of self-organisation, the idea of teleology is expressed by the notion of attractor. This notion is widely used in physics and chemistry to characterise the stationary state towards which a system (or a subsystem within a system) tends to evolve. The attractor state is thus the goal of a system.

In the theory of self-organising systems, the notion of teleology can only be used in the sense of a tendency towards a steady state. In closed systems this is the state of heat death, in open systems it constitutes a kind of structure (Bénard's cell is a steady state for convection). The tendency to reach and maintain a steady state is the only goal for self-organising systems. This is called homeostasis. According to Rapoport (1986) the phenomenon of homeostasis does not necessarily assume systems to have goals and purposes. In fact, a steady state can be arrived at as a consequence of a dynamic, nonteleological process "which can be 'explained' (i.e. modelled) without reference to future states" (p.182).

Let us now take an example to show how this approach could help us to assess teleological hypotheses about language evolution. According to Nikola'eva (1991), language tends in its diachronic evolution towards the transmission of an ever-greater amount of information per unit of time. She also points out two devices that languages can use to achieve their goal: compression and suprasegmentation. If we take phonology, compression is expressed by changes motivated by coarticulatory phenomena, and by evolution towards flective and fusive forms. Suprasegmentation is expressed by the increasing role of prosodic and intonational tools in the linguistic inventory of a language. Nikola'eva further argues that different languages evolve at different speeds, so that not all languages are on the same level of evolution.

The evolutionary principle, outlined by Nikola'eva is undoubtedly teleological. From the 'rational' point of view, the goal of reducing redundancy and making language more information-bearing certainly looks reasonable and progressive. But this is not a point of view we could necessarily ascribe to self-organising systems. Instead of looking for rationality in language evolution, one should ask whether the maximally compressed and concentrated form would be a steady state, a kind of attractor for language to evolve towards.

In Lindblom et al. (1984) a self-organising model was suggested to simulate the emergence of a phonological system. If we assume that self-organising systems possess teleology only in terms of reaching and maintaining steady

states, the computer simulation of structuring the phonetic signal-space (articulatory+perceptual space) should give us evidence about preferred steady states for possible phonological systems. Thus, if the synchronic system tends to be totally free of redundancy (which should correspond to the maximum effectiveness in transmitting information per unit of time) we should take it as support for the view that languages are evolving towards this state. The opposite result would call the hypothesis of Nikola'eva (1991) into question.

The task of the computer simulation was to achieve the optimal phonological structure corresponding to the principle of "sufficient perceptual differences at acceptable articulatory cost" (Lindblom et al. 1984:193). The results of the computer simulation showed that the coding efficiency of the system derived in the course of simulation was only 62% of the maximal possible efficiency. In other words, assuming that the principles on which the simulation was based are valid, the results of the study of Lindblom et al. (1984) do not support the view that languages are evolving towards maximal coding efficiency as hypothesised in Nikola'eva (1991).

The computer simulation in Lindblom et al. (1984) was designed using functional principles. This suggests that the notions of stability and instability might be based on functionality, and that the evolution of language is a functionally driven process. This position needs to be clarified.

Broadly speaking, language certainly has a function and is, thus, a functional system. As its function is to convey meaning, all arguments over what is functional and what is not in language need to be related to the point of whether a particular feature helps to transfer meaning or not. While there can be little doubt that certain changes (particularly in the domain of syntax) can be guided by speakers' communicative needs, there are others that seem to have no function, or are even explicitly dysfunctional. Changes of the latter type are particularly common in morphology in cases when a general sound change erodes a particular word final segment which may also act as a morphological suffix in this language.

French, for example had a suffix /s/ which formerly indicated the distinction between 2nd and 3rd person singular. When a sound change started to erode /s/ from word final position, speakers did nothing to prevent /s/ from being lost in contexts where it conveyed important morphological information. Thus, this change was directly dysfunctional from the point of view of transferring the intended message. However, the distinction between 2nd and 3rd person singular was not lost as a consequence, nor did it remain ambiguous. Instead of the marker /s/ which was lost, the function of indicating the distinc-

tion shifted to the personal pronouns that grammaticalised into obligatory clitics.

This indicates that language change generally is not a rational process where the speakers' need to say something always prevents the meaning being lost. Nevertheless, it seems that important distinctions (such as the distinction between persons) are maintained even if the marker indicating them disappears. Thus, if we say that language is functional, this does not necessarily mean that its evolution is directly driven by speakers' desires to transfer certain meanings, but rather that it is a consequence of various processes which itself are not necessarily functional. Consequently, this means that teleological processes in language do not fall out from any kind of predesigned blueprint. And this is the whole idea of homeostasis: the processes that bring into existence a new state are itself not designed to reach this state.

As language is a very complex system, it is unlikely that it ever loses its stability as a whole and needs to evolve towards a new attractor state. Rather it seems that there are separate attractor states for various subsystems of language which may in some cases be contradictory to each other, so that evolution towards a particular stable state in one subsystem may cause a loss of stability in some other subsystem. A similar position is held within the framework of Natural Morphology (see Wurzel 1989). The existence of cross-linguistic universals and the phenomenon of chain change further suggests that something along these lines is correct.

3. *Linguistic bifurcations*

Until this point I have discussed the phenomenon of self-organisation in language in rather general terms without much specification of how it actually takes place. Provided that language is a self-organising system, it is reasonable to hypothesise that linguistic changes follow the same bifurcative pattern as changes in other self-organising systems.

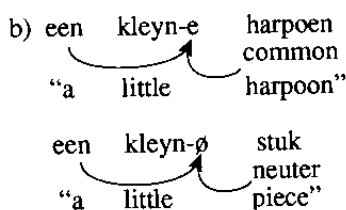
Lass (1990) presents a case study of an exaptative change in Afrikaans. I will use his case to illustrate bifurcations; the concept of exaptation, which is not of primary interest here, will not be discussed (though, as one can see, it is consistent with the principles of self-organisation).

The 17th-century Dutch which was the mother language for Afrikaans had a gender system based on the opposition of two genders — common and neuter — which were marked primarily by the form of the definite article *de* – *het*. The adjective declension system, based on the distinction Adj- \emptyset vs. Adj-*e*, was morphosyntactically conditioned, so that the presence or absence of the suffix -*e* was determined by the gender of the head noun, grammatical number,

and the type of determiner. The rules of adjective declension are outlined in (1a); the illustration for these rules in (1b) is quoted from Lass (1990:91).

(1)

- a) Adj- \emptyset occurred with neuter heads
 Adj-*e* occurred with common heads
 Adj-*e* occurred with plural heads
 Adj-*e* was favoured by indefinite heads
 Definites were variable.



In early Afrikaans, the common / neuter opposition was lost. After that the distribution of the adjective marker become close to random (see (2)):

(2)

$$\text{een kleyn}\emptyset \sim \text{kleyn-}e \quad \left\{ \begin{array}{l} \text{harpoen} \\ \text{stuk} \end{array} \right.$$

Next I will try to interpret this development with reference to the bifurcation diagram in Fig.2 (above). Let us call the system of adjective declension *X*, and the system of gender the control parameter λ . In the initial stage, the system of adjective declension is in a steady state. The stability of this system is controlled by the parameter of gender where the value of λ is equal to the number of grammatical genders. If the number of genders decreases (or increases) then the adjective declension system loses its stability and the occurrence of the marker *-e* becomes close to random (see (2)). This is the bifurcation point for the adjective declension system. At this point three possible developments are open: 1) the loss of the \emptyset/e distinction by overgeneralising \emptyset , 2) the loss of the \emptyset/e distinction by overgeneralising *-e*, 3) the reinterpretation of the \emptyset/e distinction.

Afrikaans chose the last option and adopted a new steady state where the \emptyset/e distinction was reinterpreted on the morpho(phono)logical level. I will give a brief description of this new steady state based on Lass (1990). Morphologically complex adjectives (compounds, derivatives) take the suffix *-e* (see (3a-c)). Monomorphemic adjectives take the suffix *-e* only if they have stem allo-

morphy (see (3d, e)). Morphophonologically simple adjectives, and all adjectives in predicative position, do not take the suffix *-e*.

- | | | | | | |
|-----|----|-----------|---|------------|----------|
| (3) | a) | ge-heim | → | geheim-e | "secret" |
| | b) | stad-ig | → | stadig-e | "slow" |
| | c) | open-baar | → | openbaar-e | "public" |
| | d) | goed | → | goei-e | "good" |
| | e) | vas | → | vast-e | "fast" |

On the basis of this example we could now formulate the first principle of this model of change:

(4) *Principle I: Causality*

A change in language only happens when the given subsystem loses its stability. The system loses its stability when the control parameter of the system reaches its critical value.

This means that whatever change we are dealing with, it must have a cause. The principle states that we can explain a change if we are able to find the control parameter for the given system and to show how the change of its value to a critical point led the system out of stability. In some cases (like the one discussed above) we are able to specify the critical values for a given control parameter and to make a weak prediction that if such a change happens the system will be led out of stability, and a change is expected in order to reach a new stable state. In many cases of language change, perhaps in most cases, it is likely that we are able to specify the control parameter and its critical value only *post hoc*. However, this is not due to the inherent weakness of the model but rather to our inability to obtain all the necessary information for such a prediction. It should be mentioned that even in cases where we are able to specify the control parameter and its critical value, we cannot make a prediction about the direction of change as there are several options available at the bifurcation point.

The model of linguistic changes outlined so far is concerned with the macro-linguistic level of language. No device has been specified yet to explain what happens on the micro-linguistic level when the system loses its stability. To clarify this point, the notion of fluctuation should be introduced. Generally, fluctuations can be defined as random deviations from the system's average state, and they are characteristic of all self-organising systems. For example, in biology fluctuations are manifested as mutations from the dominant genetic pattern in a given population.

Fluctuations also constitute a natural phenomenon in language. Usually, deviations from norms in language are called mistakes or slips of the tongue,

but not all fluctuations could be classified as mistakes or slips of the tongue if these terms mean only ungrammaticalities in speech. Fluctuations in language cover a considerably larger set of phenomena than simple ungrammaticalities. If a speaker uses a feature s/he does not normally use, this would be a mistake from the point of view of his/her own idiolect. Within the community this is just a case of variation, and probably nobody would regard it as a mistake. Thus, using an inappropriate variant for one's social class or for a particular context would not be a mistake in a strict sense, but a fluctuation nevertheless. The same applies for the figurative usage of language — in many cases creative innovations (such as reanalyses and analogies) may not be perceived as mistakes, though from the point of view of the system, they certainly are fluctuations.

According to this model, fluctuations are microlinguistic phenomena which can be observed only at the individual (single speaker) level. On the macro-linguistic level (as far as the system is stable), fluctuations are small deviations from the average state which do not influence this state in any way. The situation, however, changes radically at the points of bifurcation — fluctuations do not cancel each other out, but one of them increases enormously and leads the system into a new steady state. Prigogine & Stengers (1984) call this phenomenon 'order through fluctuations'. From this point of view, the principle suggested by Hermann Paul that every change was once a mistake exactly hits the bull's-eye. I reformulate it below as Principle II:

(5) *Principle II: Expansion of Fluctuations*

Every change starts from a fluctuation. When the system is in a stable state, fluctuations cancel each other out; when the stability is lost, one of them expands and introduces the new stable state.

It is a basic property of all self-organising systems that they tend to maintain the structure necessary for their functioning. Due to this property, self-organising systems tend to suppress innovations, and this is the reason why fluctuations die out if the system is in a stable state. Only when the control parameter has led the system out of stability, does a change become unavoidable. In this case, the most successful innovation will be incorporated into the system as a new unit. This kind of change in language I will call free innovation. The most characteristic property of free innovations is that they have a language-external cause, as is the case with the emergence of prestige features and borrowing, for example.

On the other hand, free innovations may lead to subsequent changes in the other subsystems. These changes are caused by the structural reorganisation of a system when incorporating free innovations. I call them structurally condi-

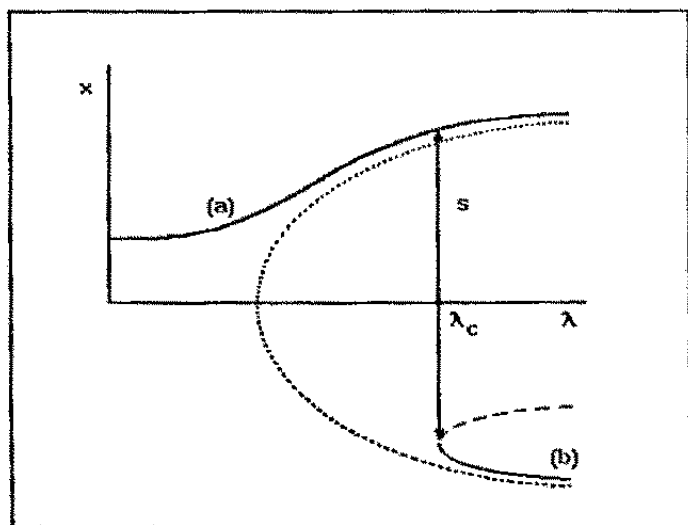
tioned changes. Unlike free innovations, structurally conditioned changes always have language-internal causes.

Thus, it is possible that a change in one subsystem leads to a loss of stability in another subsystem, in which case a chain of changes happens. And it is also possible that a subsystem becomes unstable for purely nonlinguistic reasons (such as social prestige, etc.) which is often the case with sound changes. To be able to accommodate all these possibilities, the basic bifurcative pattern of change has 1) to allow non-linguistic control parameters to account for free innovations; 2) to be in some sense recursive or cyclic, operating interactively at various levels of language, so that certain properties of some subsystems could act as control parameters for other subsystems.

It is obvious that the model of linguistic change as outlined here is somewhat oversimplified as in reality some options seem to be preferred at bifurcation points (see also Aitchison 1989). For example, in instances of grammatical interference, changes are often directed towards greater structural similarity with the influencing language. They have thus a higher probability than chance. The same is the case with so-called natural changes. How are we to explain that?

According to Prigogine & Stengers (1984) nonequilibrium states are sensitive to the forces which operate in their environment. These forces are viewed as external fields that can influence the choice of the path of evolution at the point of bifurcation. In the case of the presence of an external field, the symmetrical pattern of bifurcation presented in Fig.2 is replaced by an 'assisted' bifurcation. In the case of assisted bifurcation, one state is preferred and emerges continuously as the control parameter increases. A diagram featuring assisted bifurcation is presented (according to Prigogine & Stengers 1984:164) — see Fig.3 overleaf.

It seems that in language, free innovations usually arise through assisted bifurcations. Even neologisms and loanwords, not to mention grammatical interference, can be seen to be assisted by corresponding fields. So, if speakers have something in their environment they want to talk about, but have no name for it, they have to borrow or to invent one. (The first option would correspond to an assisted bifurcation, and the second to a symmetrical one.) If this name is accepted and comes into use, then it is what might be called the "system's spontaneous 'adaptive organization' to its environment" (Prigogine & Stengers 1984:165).



The phenomenon of assisted bifurcation in the presence of an external field. x is plotted as a function of parameter λ . The symmetrical bifurcation that would occur in the absence of the field is indicated by the dotted line. The bifurcation value is λ_c ; the stable branch (b) is at a finite distance from branch (a).

Fig.3: Assisted bifurcation

In the case of language the set of possible fields is likely to be very large. Some fields are very common and seem to influence linguistic evolution in many languages. Their presence is manifested by similar changes (the so-called natural changes) across many languages. The fields responsible for these changes are likely to be rooted in the mental and physiological properties of humans — otherwise it would be hard to explain their universality. The other fields are more idiosyncratic being imposed by the immediate environment. Good examples are foreign language or social class influences which differ in their nature as well as their spatio-temporal manifestations across languages. The arguments above can be summarised in the following principle:

(6) *Principle III: Distribution of Fluctuations*

When a field is present, the random nature of fluctuations is statistically biased towards the field, and following Principle II, the probability of the emergence of a particular new stable state at the point of bifurcation is correlated to the statistical distribution of fluctuations.

This principle makes an explicit prediction about the correlation of certain types of speech errors and corresponding types of changes. By psycholinguistically specifying why certain fluctuations are more frequent than others allows us to explain why the corresponding changes are recurrent in languages.

This principle makes another important prediction. Irrespective of whether a field is present, certain types of fluctuation may be absent. This means that the corresponding state is unstable and cannot emerge in a given subsystem. This prediction is particularly important in typological studies. It is well known that there exist typological gaps that in the present framework could be called unstable states. If it were possible psycholinguistically to specify why the fluctuations that might initiate the changes that could lead to the emergence of such states, are absent, we could explain the corresponding typological gaps.

Once more, it should be noted that fields do not cause changes, but only influence the actual outcome when stability is lost. In the case of natural changes this pattern seems to work: natural changes are frequent, but they by no means occur in all times and all contexts where they could. This strongly supports the existence of the notion of control parameters that cause changes (see Principle I), though the actual outcomes are (partly) determined by fields.

Things are more complicated with foreign language influence. It seems that such influence acts both as a control parameter and a field, both causing changes and influencing the outcome. This is a complicated matter, but as I intend to show later, at least in some cases foreign influence itself is insufficient to cause a change if the system is in a stable state.

4. Stability and gradualness of change

As stability and instability are properties of states, their analysis should start with the analysis of the concept of state. Often the notion of state is regarded as so fundamental that it is left without definition. Intuitively, what is meant by state is a record of information that unequivocally characterises a given system. Thus, each state of a particular system is a collection of observables that characterise the conditions at a certain point of time. These observables are called state variables.

It should be noted that the notion of state seems to be an abstraction, a way of organising knowledge about the object of our investigation. This is best characterised by the possibility of different choices for state variables for a given system. As the state variables for particular systems are specified by researchers, the set of variables chosen can be influenced by the researcher's point of view. As the main reason for postulating states is to make the reality more comprehensible by eliminating redundant factors, the selection of state

variables from the total of available observables is inevitable. However, most systems are complex enough to make the choice of the suitable set of observables difficult, even if the researcher is theoretically unbiased (see Kampis 1991).

This criticism may have a fair amount of truth in it. However, as no viable alternatives seem to have been proposed to it, we should not abandon the notion, but rather try to specify its limitations and to use it where it works. At first glance it seems that in the description of discrete phenomena, such as, for example, word order and other syntactic and morphological features, the notion of state is well justified. Less abstract systems, such as perhaps the sound system, are more likely to show gradual behaviour. Similarly, the phenomenon of loss of stability is more likely to be salient in the first type of systems. Let us first concentrate on the notion of loss of stability in domains where the concept of state is productive.

In Section 2 (above) I illustrated the idea of bifurcations in the case of a change in Afrikaans. I argued that when the gender distinction was lost the system of adjective markers became unstable, and the system had to find a new stable state. What is meant here by the loss of stability? The simplest answer is that by the loss of stability I mean the process of something that was determined in a language becoming undetermined. Or to say it in other words, the loss of stability is the process of a rule or distinction fading away. If defined in this manner, the loss of stability does not necessarily imply chaos or functional instability, though the latter may well be present in some cases. Let us illustrate this idea.

When the category of gender faded away in Afrikaans, the rule that referred to it became meaningless. As a result, the distribution of adjective markers became random with respect to the type of heads of adjectives. This is the point of instability. As it stands, it does not imply an explosive emergence of chaos or any great loss of functionality. Nevertheless, since the basis for the stability of the previous state had disappeared, this state could not have been maintained.

Further evidence for such bifurcations is not hard to find. The cases of the losses of word final /s/ in French, discussed in section 3, exhibit a similar type of loss of stability in a system's state. When the word final /s/ was lost in French, the distinction between second and third person singular become undetermined. This was an unstable state for the person marking system, since some crucial information was left obscure. The system had to change and it did so: marking of the distinction between 2nd and 3rd person singular shifted to the pronoun, as French optional subjects became obligatory clitics. I summarise this argument as Principle IV:

(7) *Principle IV: Loss of Stability*

A state of a subsystem of language loses its stability when a formal or conceptual distinction that separates one of its state variables from others is lost.

It is undoubtedly possible to find a large number of changes that will support the notion of loss of stability as defined above, particularly from morphology and syntax where the categories and constructions are discrete (one detailed description of such a bifurcative change in the Estonian adpositional system is discussed in Ehala 1994). However, the crucial question for model is the problem of gradual change, such as for example grammaticalisation and grammatical interference.

4.1 *Accounting for gradualness of change*

Traditionally the process of grammaticalisation is characterised as a simultaneous process of semantic bleaching and phonetic reduction. As all sorts of erosion are gradual, these properties strongly argue for the gradual nature of the processes of grammaticalisation. Heine & Reh (1984:15) state explicitly that "[g]rammaticalization is an evolutionary continuum. Any attempt at segmenting it into discrete units must remain arbitrary to some extent". This is clearly contradictory to the bifurcative model of change. In order to solve this problem, it is reasonable to hypothesise that the phenomenon of aggregation of language change (which, in the case of grammaticalisation, involves everything that happens after the process has started) is not a single atomic phenomenon, but a complex process, something of a cascade of smaller changes. Let us attempt to break it down to basic atomic units of change.

Language change is traditionally viewed as a process of replacement of an old form by a new one. I represent it schematically as in Hopper & Traugott (1993:36):

(8)

$$\begin{array}{ccc} & B & \\ A > & & > B \\ & A & \end{array}$$

This schema expresses the view that new forms can hardly replace the old ones without a stage where the two coexist (see also the notion of doubling in Hawkins 1983). This doubling phase can last for several centuries (as was the case with English *be* and *be going to*), or it may go to completion quickly. It may even be that change never goes to completion as A never disappears. This

means that the emergence of B and the loss of A are two distinct changes, but not parts of a single change.

This seems to be the case with grammaticalisation as well. The fact that grammaticalisation starts from a lexical item, does not mean that this lexical item must disappear from language as it grammaticalises. While this possibility cannot be ruled out, it seems to be also possible that a lexical item grammaticalises in certain contexts, but retains its meaning and form in the rest of the contexts. This happens when this lexical item is reanalysed in certain contexts as a grammatical marker. For example, the case of grammaticalisation of French *pas* to the marker of negation was

accompanied as usual, by a shift of meaning, in this case from the lexical meaning 'step, pace' to the grammatical meaning of negation. There is in this instance no phonological change peculiar to the grammaticalized form, and no fusion with neighboring words. The original noun *pas* lives on in its earlier meaning of 'step, pace' and it remains completely homophonous with the negative particle. (Hopper & Traugott 1993:116)

Such an evolution argues for a semantic shift in the early stages of grammaticalisation due to the reanalysis, rather than for simple infinitesimally gradual semantic bleaching. This case of grammaticalisation also gives evidence for the notion of loss of stability and bifurcation. It is known that the grammaticalisation of *pas* occurred when the old negative marker was realised as [n] in certain contexts and zero as others. The word *pas* itself occurred as a reinforcing form in Old French with a variety of other forms, such as *point*, *miette*, *gout*, etc. The variability of the negation marker /n/ created a number of cases where the intended negation could not have been detected. The loss of this distinction in certain cases manifested the loss of stability which demanded a change in the system's state. The reanalysis of *pas* out of a variety of other forms is a response to this loss of stability. That *pas* was chosen out of a number of other similar words is a result of random fluctuations or perhaps a social field (considering it was the favoured form in the Ile-de-France area). Thus, in this case again we can see an initial loss of stability. The case suggests that for the appearance of B (see (8)), the distinction expressed by A, or rule referring to A must have become obscure. This happened when the negative marker started to be variably deleted.

However, some other cases of grammaticalisation seem not to show a similar initial loss of stability. For example, Estonian has developed an adposition *koos* 'together' to express the same meaning that could already be expressed by the comitative case. This change gives no apparent evidence for loss of stability, as Estonian had and still has the old synthetic comitative, and there is

no evidence that it was lost in some contexts before the emergence of the adposition *koos*.

A solution for this problem can only be hypothesised: it is generally agreed that the first step in grammaticalisation is a reanalysis whereby a lexical item acquires a grammatical meaning. Reanalysis is an instantaneous and individual phenomenon — it is a manifestation of human creativity. Thus, the first instances of grammaticalisation are individual phenomena, not collective. However, a single case of reanalysis is not yet a grammaticalisation. As Hopper & Traugott (1993:38) note, "a novel construction that does not reappear or spread is taken to be a 'scribal error', or a 'nonce-formation', and not an example of change or even precursor to change". Thus, such an occurrence is a fluctuation. According to Principle II, fluctuations die out under normal conditions when the system is in a stable state. If every fluctuation led to a change, language would cease to exist as a communicative system. Thus, there must be something that determines when a fluctuation leads to a change, and when it remains a singular error. Whatever the properties of this something might be in cases like the grammaticalisation of *koos*, I will call it the control parameter.

In any case, the reanalysis can be said to be complete when a rule could be formulated which specifies under which conditions the new form occurs. Then we would say that the fluctuation has led the system to a new state, and the bifurcation is completed. However, it is well known that the frequency of grammatical morphemes is higher than that of grammatical words, which in turn are more frequent than lexical words. Thus, one of the effects of the reanalysis is that the frequency of the new construction in usage rises. As the segmental length of grammatical morphemes is smaller than that of grammatical words which in turn are generally shorter than lexical words, this suggests that the more frequent an item is the shorter it tends to be (see Zipf 1949). From this it follows that frequency acts in some sense as a control parameter for the system of segmental length of language items. If there is an increase in frequency of a particular item, it becomes more salient and consequently does not need to be lengthy to be recognised. Thus, its length becomes to a certain degree counter-functional, and will be reduced.

The process of grammaticalisation may well end with one reanalysis and possibly a following phonetic reduction, i.e., after one or two bifurcations, but there may follow further bifurcations which will take the process of grammaticalisation further. The question now arises as to why the following bifurcations deepen the very same process, but do not lead it along a different path, if the new state is chosen by random fluctuations.

This phenomenon is connected with the notion of field. It is reasonable to assume that each grammatical construction or linguistic subsystem has its own

field which has some influence on neighbouring systems. The more frequent a construction is the stronger is the field, because it is psycholinguistically more dominant. After the completion of a reanalysis, the newly emerged construction establishes a field that starts to influence related constructions, and if a change happens in these constructions the outcome is likely to be influenced by this field.

Let us consider now a case of grammatical interference which shows an apparently gradual nature, and further seems also to be caused by a field. It was argued in Section 3. that fields do not cause changes, but only influence the distribution of fluctuations, as stated in Principle III. The question now arises whether the theoretical distinction between control parameters and fields is necessary. Perhaps it would be possible to merge them into a single category which both imposes a force to a system, and by doing so causes changes. However, this unitary category would miss an important generalisation: not every control parameter causes the system to change in a predetermined direction. This we have seen from the analysis of the change in the adjective marker system in Afrikaans (see Section 3.). If we were to merge control parameters and fields into one category we would have to explain why the direction of the change some times is predetermined, but some times not. And this would necessitate a distinction of some kind between these different causal forces anyway.

However, if we agree that fields can in some instances also cause changes, this would question the validity of the notion of loss of stability: if a field can gradually force the system into a new state, we may ask what is the point of instability which should be a prerequisite for every change. Basically, this is the question whether change is genuinely a gradual phenomenon or whether it presupposes a qualitative break, the emergence of a new structure.

Consider an example of an apparently gradual change caused by field influence. In Estonian, negation is traditionally expressed by negative verb forms (see 9a; ILL stands for the illative case). Unlike in English and other Indo-European languages, in Estonian it has not been possible to negate some NP of the sentence while retaining the verb in affirmative mood (9b). However, due to the influence of Indo-European languages, this property is now being occasionally attested in certain contexts (9c).

- (9) a) *Kõik lapsed ei lähe kooli*
 All children NEG go school&ILL
 "Not all children go to school"
- b) **Mitte kõik lapsed lähevad kooli*
 Not all children go school&ILL
 "Not all children go to school"

- c) ?*Kooli lähevad mitte poisid, vaid tüdrukud*
 School&ILL go not boys, but girls
 "Not boys go to school, but girls"

It seems then that there is a field of Indo-European influence that causes the emergence of a new negation construction in Estonian apparently without any loss of stability in the Estonian negation system. However, if we look more closely at the emergence of the new negation system we can see that it is not a unitary gradual shift, but involves the emergence of two new distinctions.

As was seen in (9b) and (9c), in contemporary Estonian the subject NP can be negated by means of a lexical unit *mitte*. This word has not emerged together with the new negation, but has long been present in Estonian. It is important to note that in standard Estonian, *mitte* is not a negation marker in a strict sense, but an optional emphatic word that is used to reinforce the negation that must be obligatorily expressed by the verb negator *ei*. Below I provide some examples of the usage of *mitte* in standard Estonian.

- (10) *Kooli ei lähe lapsed, vaid vanemad*
 School&ILL NEG go children, but parents
 "Not children will go to school, but parents"
Kooli ei lähe mitte lapsed, vaid vanemad
 School&ILL NEG go not children, but parents
 "Not children will go to school, but parents"

The examples in (10) indicate that *mitte* can be used optionally to emphasise the fact that not the children, but parents will go to school. However, the difference between these two sentences is very slight, and they could even be considered identical. There is one variation of this sentence where *mitte* is obligatory:

- (11) *Kooli lähevad vanemad, mitte lapsed*
 School&ILL go parents, not children
 "Parents will go to school, not the children"

The emphatic character of *mitte* can also be seen from its property of reinforcing the negativeness of a negative sentence, while it is unable to give negative meaning to positive sentences as shown in (12).

- (12) *Ta ei lähe*
 He NEG go
 "He does not go"
Ta ei lähe mitte
 He NEG go not
 "He goes not" / "He does not go"

**Ta läheb mitte*
 "He goes not"

All this suggests that syntactically *mitte* does not behave as a negative marker in standard Estonian, but rather as an independent adverb which can reinforce and pinpoint the negative meaning of a negative sentence. In this respect it is qualitatively different from the Estonian negative particle *ei* which is the only productive grammatical means of expressing negation. In this respect Estonian is different from English where both *no* and *not* behave syntactically as negative markers. Therefore, in English it is sufficient when either the verb or an appropriate NP is negated, both constructions (NP – negV and negNP – V) are grammatical English sentences. In standard Estonian only NP – negV is allowed whereas *negNP – V is ungrammatical. The reason for this is that the negation particle *ei* specifies only verbs, and *mitte*, which can specify NPs, is not a true negation marker. On this basis it can be argued that the stability of this system is lost when the conceptual distinction between these two constructions is lost. This happens when *mitte* is reanalysed as a true grammatical negation marker such as *ei*. At this point the negNP – V construction becomes a grammatical means of expressing negation in Estonian and the whole negation system is reorganised to allow both NP – negV and negNP – V constructions. What the new distinction between these two possibilities will be is impossible to predict, but after *mitte* is reanalysed, it is likely that there will be a rapid expansion of the new construction over several contexts.

Now, according to this analysis, the English type negation pattern is not possible in Estonian unless Estonian has a similar negation marker. Thus, as long as *mitte* is not reanalysed, the new constructions cannot emerge. This means that a field cannot directly cause a new structural construction to emerge if the system is in a stable state, i.e., when the distinction between grammatical NP – negV and ungrammatical negNP – V is categorical. However, a field can influence the frequency of already grammatical means of a particular construction, and to bias the distribution of fluctuations. In this case, the increase in frequency of *mitte* in usage, caused by the field, may lead to its reanalysis as a grammatical marker of negation. If this happens, it would be just a (first) step in the process of grammaticalisation, similar to those that were already discussed above. It was argued that the main prerequisite of grammaticalisation is reanalysis, and that this can happen when the frequency of a lexical item reaches a certain threshold. In other words, the control parameter for the grammaticalisation is frequency.

A similar pattern is also operating in the case of the emergence of the new negative in Estonian. Due to the influence of the Indo-European languages, the

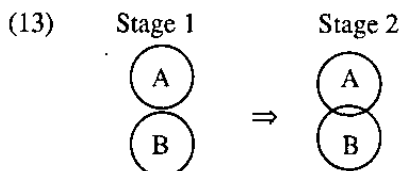
usage of *mitte* in discourse has arisen. It should be mentioned that this rise has been caused by the increase of usages of *mitte* in contexts where it is allowed in Estonian. This may cause *mitte* to be reanalysed as a grammatical marker which will lead the negation system out of stability.

It should be mentioned that the field itself will not cause the system to lose its stability as it would also have been possible that Estonian had developed an alternative negation marker without the presence of a field, but with the same consequences. In the present case, field is the most likely cause for the change of the control parameter to its critical value (the reanalysis of *mitte* as a negation marker), but such a change might possibly also be caused by other reasons. Thus, the separation of the control parameter from the field allows us to specify the general conditions for the loss of stability in the negation system (the emergence of a new marker), while still leaving the possibility open for explaining the predetermined direction of change in certain circumstances with the field influence. This can also explain why fields can sometimes have no influence on the systems' state (see Ehala 1994).

It must be noted that analogy, like reanalysis, is an instantaneous individual creative act. Unless it is repeated by other speakers, the single occurrence of analogy remains a fluctuation. The problem why fluctuations start to grow at the point of instability, but not under normal circumstances, still remains.

4.2 Accounting for loss of stability

All the cases discussed so far suggest that change happens when a rule or distinction which was categorical, has become obscure or lost. When this happens the distribution of forms associated with this rule becomes undetermined (random). This can be represented as (13):



Stage 1 is a stable state. A and B are kept separate by a formal or conceptual distinction. Occurrences of A are not mixed with the occurrences of B. They are just two separate constructions that nobody has any problems keeping apart. All three changes discussed above fit this initial situation: in Afrikaans *e* and \emptyset were kept separate, in French 2nd and 3rd person were kept distinct, and in Estonian, the syntactic and lexical means of expressing negation are kept separate.

In stage 2 something happens and the distinction is lost. This is the point of bifurcation. A and B coexist, but their domains may mix, because there is no clear distinction between them.

We know that this kind of situation happened when the gender distinction was lost in Afrikaans, when the /s/ indicating the 3rd person singular was lost in French and when *mitte* is reanalysed as a negation marker. When this happened, A and B became in some sense one phenomenon, either conceptually or formally, or to say it in other terms — they become variants of one variable, at least in some contexts.

Let us hypothesise that this emergence of variation between A and B in these overlapping contexts is the loss of stability. However, it should be noted that patterns of stable variation are well known in the history of many languages (*h*-dropping, for example is a classic case in the evolution of English). In order to claim that loss of stability consists of the loss of a distinction and emergence of unstable variability, we have to be able to explain why certain cases of variability manifest loss of stability and lead to changes while some other types seem to be stable for long periods. An answer to this problem lies in the phenomenon of probability matching.

Probability matching is a psychological phenomenon characteristic of humans as well as other species. It is an ability to replicate the frequency of an observed event in one's behavioural responses. A classic case of probability matching is running the T-maze (see Smith & Dawkins 1971). If the food is distributed between the sides of the maze in 25% and 75%, the test animal tends to match the distribution of food very closely in its choice of path in the maze. Labov (1994) has suggested that linguistic variable patterns are also learned and maintained by the probability matching. He further argues that change in variable patterns happens when, due to misunderstanding, some tokens of a variant are not recognised as such which will cause a deviation in the variable pattern. This is, as he argues, the key factor which facilitates the shift in the process of language acquisition by successive generations. His arguments are well motivated, but I would like to suggest that the role of probability matching in the process of facilitating change is much broader than suggested by Labov.

By using the notion of probability matching it is possible to account for why fluctuations remain fluctuations in stable conditions, but lead the system into a new state when stability is lost. When the rule determining the distribution of adjective markers was lost in Afrikaans, the distribution started to be governed by the mechanism of probability matching. As there was no conceptual distinction which could have kept the variants separated, every single fluctuation might have had a significant effect on the overall development of the

system's state by initiating a cumulative process of its own reproduction. Thus, in situations where two phenomena are separated by a conceptual or formal distinction, a fluctuation remains an error, since it is known to be an error. When the distinction is lost, fluctuations are not felt as errors, but count as genuine cases. This kind of situation is unstable as every disturbance may have unexpectedly large consequences. I further predict that such states where the distribution of A and B are governed solely by probability matching are only very temporary (in fact they are the points of bifurcations), and will be replaced by a new conceptual, formal or social distinction.

As to the process of establishing a new distinction, it is driven by humans' creative abilities. It is likely that humans' ability to systematise leads single individuals subconsciously to seek for underlying principles behind free variation. As nobody knows that there are none, they keep trying to interpret it in some way or another. In a situation of probability matching every case of a re-analysis will disturb the balance, and enforce the same hypothesis. This will lead to a snowball effect and the emergence of a new structure, whatever it might be in the given instance. It should be noted that not every case of variation of A and B must necessarily be reinterpreted as a linguistic distinction. It might be reinterpreted as a social distinction, or one of the variants may simply disappear. The number of possibilities is likely to be large, determined only by humans ability to create associations and use analogy. It is also likely that the actual changes are much more complex than described above, but I hope to have shown that the underlying patterns of language change seem to be in accordance with the model of linguistic bifurcations.

Author's address:

Martin Ehala
Department of Estonian Language
Tallinn Pedagogical University
Narva Road, 25
EE 00 01TALLINN, Estonia
e-mail: ehala@lin.tpu.ee

REFERENCES

- Aitchison, Jean. 1989. "Spaghetti Junctions and Recurrent Routes". *Lingua* 77.151-171.
Anttila, Raimo. 1985. "Dynamics in Morphology". *Acta Linguistica Academiae Scientiarum Hungaricae* 35.3-30.
Ballmer, Thomas T., ed. 1985. *Linguistic Dynamics Discourses: Procedures and evolution*. Berlin: Walter de Gruyter.

- Ballmer, Thomas T. & Wolfgang Wildgen, eds. 1987. *Process Linguistics*. Tübingen: Max Niemeyer.
- Barton, Scott. 1994. "Chaos, Self-organization and Psychology". *American Psychologist* 49.5-14
- Carpenter, Gail A. & Stephen Grossberg. 1987. "Discovering Order in Chaos: Stable self-organization in neural recognition codes". *Annals of the New York Academy of Sciences* No.504.33-51.
- & -----, eds. 1991. *Pattern Recognition by Self-Organizing Neural Networks*. Cambridge, Mass.: MIT Press.
- Coseriu, Eugenio. 1983. "Linguistic Change Does not Exist". *Linguistica Nova ed Antica: Rivista di linguistica classica medioevale e moderna* 1.51-63.
- Ehala, Martin. 1994. "Russian Influence and the Change in Progress in the Estonian Adpositional System". *Linguistica Uralica* 30.177-193.
- Garfinkel, Alan. 1987. "The Slime Mold Dictyostelium as a Model of Self-organisation in Social Systems". *Self-Organizing Systems The emergence of order* ed. by F. Eugene Yates, Alan Garfinkel, Donald O. Walker & Gregory B. Yates, 181-212. New York & London: Plenum Press.
- Hanson, Stephen Josi & Carl R. Olson. 1990. *Connectionist Modelling and Brain Function: The developing interface*. Cambridge, Mass.: MIT Press.
- Hawkins, John A. 1983. *Word Order Universals*. New York: Academic Press.
- Heine, Bernd, Ulrike Claudi & Friederike Hünemeyer. 1991. *Grammaticalization: A conceptual framework*. Chicago: Univ. of Chicago Press.
- & Mechthild Reh. 1984. *Grammaticalization and reanalysis in African languages*. Hamburg: Helmut Buske.
- Hopper, Paul J. 1987. "Emergent Grammar". *Papers from the 13th Annual Meeting of the Berkeley Linguistic Society* ed. by Jon Aske, Natasha Beery, Laura Michaelis & Hana Filip, 139-157. Berkeley, Calif.: Berkeley Linguistic Society.
- & Elizabeth Closs Traugott. 1993. *Grammaticalization*. Cambridge: Cambridge Univ. Press.
- Kampis, George. 1991. *Self-Modifying Systems in Biology and Cognitive Science*. Oxford: Pergamon Press.
- Labov, William. 1994. *Principles of Linguistic Change Volume 1: internal factors*. Oxford & Cambridge, Mass.: Blackwell.
- Lass, Roger. 1974. "Linguistic Orthogenesis? Scots vowel-quantity and the English length conspiracy". *Historical linguistics II* ed. by John M. Anderson & Charles Jones, 311-352. Amsterdam: North-Holland.
- , 1990. "How to Do Things with Junk: Exaptation in language evolution". *Journal of Linguistics* 26.79-102.
- Lindblom, Björn, Peter MacNeilage & Michael Studdert-Kennedy. 1984. "Self-Organizing Processes and the Explanation of Phonological Universals". *Explanations for Language Universals* ed. by Brian Butterworth, Bernard Comrie & Östen Dahl, 181-203. Berlin: Mouton.
- Mohanan, K. P. 1993. "Fields of Attraction in Phonology". *The Last Phonological Rule* ed. by John A. Goldsmith. Chicago: Univ of Chicago Press.

- Nikola'eva, T. M. 1991. "Diakronija ili evolucija? (Ob odnoj tendencii razvitiya jazyka)". *Voprosy jazykoznanija* 40:2.12-26.
- Prigogine, Ilja & Isabelle Stengers. 1984. *Order out of Chaos*. London: Heinemann.
- Radziki, M. J. 1990. "Institutional Dynamics, Deterministic Chaos and Self-Organizing systems". *Journal of Economic Issues* 24.57-102.
- Rapoport, Anatol. 1986. *General System Theory*. Tunbridge Wells, Kent: Abacus Press.
- Rumelhart, David E., James L. McClelland & the PDP Research Group, eds. 1986. *Parallel Distributed Processing: Explorations in the microstructure of cognition*. Vol I. Cambridge, Mass.: MIT Press.
- Sapir, Edward. 1921. *Language: An introduction to the study of speech*. New York: Harcourt, Brace & Co.
- Smith, J. N. M. & E. Dawkins. 1971. "The Hunting Behavior of Individual Great Tits in Relation to Spatial Variation in Their Food Density". *Animal Behaviour* 19.695-706.
- Wurzel, Wolfgang U. 1989. *Inflectional Morphology and Naturalness*. Dordrecht: Kluwer.
- Zipf, George K. 1949. *Human Behavior and the Principle of Least Effort*. Cambridge, Mass.: Addison-Wesley.

SUMMARY

This paper introduces a model of language change based on the theory of self-organisation. It is argued that the structure of language is defined by speech as much as speech is determined by grammar and that the emergence of new grammatical options is a process of mutual interaction of these two sides of language. The main principle of this model of language change is that changes can happen only when the system's stability is lost. At this point, called bifurcation point, random fluctuations choose a new stable state. The stability of the system does not depend on fluctuations, but is a function of its control parameter. When this parameter reaches the critical point, one of the fluctuations starts to expand and leads the system into a new steady state. It is argued that external fields can influence the random nature of fluctuations which makes the corresponding changes ('natural' changes) recurrent crosslinguistically.

RÉSUMÉ

L'article présente un modèle des changements langagiers ayant pour base la théorie de l'autoorganisation. Selon ce modèle la structure d'une langue n'est pas définie par la grammaire, mais par le discours; les nouvelles structures grammaticales, elles, sont créées par l'interaction de la langue et la grammaire. L'idée principale du modèle présenté est le fait que les changements peuvent

avoir lieu dans la langue seulement au cas où le système perd sa stabilité. À un moment donné, appelé 'point de bifurcation', des fluctuations fortuites conduisent le système de nouveau à un état stable. La stabilité du système ne dépend pas de fluctuations, c'est plutôt une fonction d'un paramètre de contrôle. Si le paramètre arrive à sa valeur critique, l'une des fluctuations croît en importance et conduit le système de nouveau à un état stable. L'article avance l'hypothèse que les champs de force peuvent influencer la distribution fortuite des fluctuations qui rend ces changements répétitifs parmi les langues.

ZUSAMMENFASSUNG

Dieser Artikel stellt ein Sprachwandelmodell vor, das sich auf das Prinzip der Selbstorganisation gründet. Nach diesem Modell definiert die Rede, nicht die Grammatik, die Struktur der Sprache, und neue grammatische Strukturen bilden sich durch den gegenseitigen Einfluß von Rede und Grammatik. Das Grundprinzip des vorliegenden Modells ist, daß die Änderungen in einer Sprache nur dann vorkommen, wenn das System seine Stabilität verliert. In diesem Punkt, der als Bifurkationspunkt bezeichnet wird, führen die zufälligen Fluktuationen das System in den neuen stabilen Zustand. Die Stabilität des Systems ist nicht von den Fluktuationen abhängig, sondern ist die Funktion des Kontrollparameters, die das System leitet. Wenn dieser Parameter seinen kritischen Wert erreicht, nimmt eine von den beiden Fluktuationen zu und führt das System zu einem neuen stabilen Zustand. Der Artikel stellt die Hypothese auf, daß die Kräftefelder außer dem System die zufällige Distribution der Fluktuationen beeinflussen können und dadurch die entsprechenden (sog. natürlichen) Änderungen in den Sprachen der Welt häufig vorkommen.