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MODELING THE DYNAMICS OF PSYCHOSIS BY KINETIC LOGIC

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Modeling the Dynamics of Psychosis by Kinetic Logic

ABSTRACT

There is a growing recognition of dynamical systems approaches and process oriented studies in clinical psychology and psychiatry. The new enthusiasm however risks turning into dissatisfaction when facing methodological obstacles in empirical research and mathematical modeling. Therefore graspable tools allowing a translation of current knowledge into meaningful dynamical models could be helpful as a stepping stone. In this paper a Boolean modeling approach and its application to the dynamics of psychosis is presented: Kinetic Logic, originating from R. Thomas, describes systems on an intermediate level between a purely verbal description and a description using nonlinear differential equations. A model is introduced that describes dynamical patterns of chronic psychosis in the context of vocational rehabilitation. Two attractor-like dynamics of chronicity are presented. The Boolean model also proves useful in formulating and exploring possible treatment strategies. A hypothesis about the modus operandi of family intervention is presented.

INTRODUCTION

Dynamical systems approaches and process oriented studies begin to create new enthusiasm in psychology (Levine & Fitzgerald, 1992; Tschacher, Schiepek & Brunner, 1992; Vallacher & Novak, 1994) and psychiatry (Freeman, 1992; Globus & Arpaia, 1994). Although there have been systems approaches in these fields for some decades the potential of such an orientation has not been fully acknowledged by the main stream. In the case of schizophrenia newer approaches point out a systemic, interactive and developmental view of the disorder. A dynamical, more comprehensive view of the phenomena as being interdependent and evolving in time has been proposed (Strauss, Hafez, Lieberman & Harding, 1985; Ciompi, 1989; Strauss 1989). Advancing from theory to empirical research and application enthusiasm risks dissatisfaction when facing severe methodological limitations. This can be observed in the search for chaotic dynamic in time series (Rapp, 1993). The quality of quantitative data as well as the theoretical knowledge might often not be sufficient for precise mathematical modeling. Accordingly, psychological theories and applications inspired from nonlinear dynamics (e.g. Bütz, 1993) are in danger of remaining purely metaphorical.

In this paper, we will introduce Kinetic Logic (Thomas, 1979; Thomas & D'Ari, 1990), a logical, Boolean approach, and apply this view to the dynamics of chronic psychosis. Kinetic Logic has been developed for modeling in biology and describes systems on an intermediate level between a purely verbal description and a description using nonlinear differential equations. Thus, it might help to bring the qualitative verbal descriptions of well known theories to a more formal mathematical level while still keeping and using the knowledge that is contained in the verbal descriptions. Having done this, it is possible to model impact, feedback, and the temporal evolution of the variables. As the system evolves in time, one is able to detect resulting attractors and to explore the effect that changes in the model might have on the dynamics. This relatively simple approach might be a valuable tool in integrating current theories and systems thinking into meaningful dynamical models.

We first give a short informal introduction to Kinetic Logic. The method is covered both in its basic 'naive' and advanced 'generalized' form. The main part of the paper focuses on an application of 'Generalized Kinetic Logic' (Snoussi, Thomas & D'Ari, 1990). We propose a model of the dynamics of chronic psychosis and apply this model to two types of interventions in the vocational rehabilitation of the chronically mentally ill.

The 'naive' form of Kinetic Logic

In essence, Kinetic Logic is a logical representation of a class of differential equations. The method states that elements in a system interact positively or negatively with a strength of impact depending on the levels of the elements. The crucial assumptions of Kinetic Logic are: (1) The system elements have little effect on each other until they reach a certain threshold. (2) At high levels the effect tends to reach a plateau.

Supposing this is true, we can say that an element is *'absent'* when it is under the threshold level and *'present'*, when above the threshold level. In this way, Kinetic Logic approximates a sigmoid curve of interaction with a step function (Thomas & D'Ari 1990). Thus a variable can have two *logical values*, 0 for absent, or 1 for present. *Logical values* are denoted by small letters: x, y, z. On the other hand, *logical functions* reflect the *evolution* of variables and are symbolized by capital letters (X, Y, Z). Logical functions describe towards which states the variables in the systems tend. However they are not the derivatives. In a typical genetic application, x=0 means for example 'gene product is absent,' x=1 means 'gene product is present', while X=0 means 'gene is off' and X=1 means 'gene is on' (Thomas & D'Ari 1990). In psychology, X could be for instance a tendency or readiness to show a certain behavior, while x would be the behavior itself.

As a basic example of Kinetic Logic reasoning, consider the following loop structures (Thomas & d'Ari, 1990) and the resulting attractors in Table 1. The first example shows a *negative feedback loop,* where X=1 if y=0 and Y=1 if x=1, expressing that X is 'on' when y is not present, while Y is 'on' when x is present.

Example 1:	Example 2:
Negative feedback loop	***Positive feedback loop***

graph of interactions:

$x \underset{-}{\overset{+}{\rightleftarrows}} y$	$x \underset{-}{\overset{-}{\rightleftarrows}} y$

logical relations:

$X = \bar{y}$	$X = \bar{y}$
$Y = x$	$Y = \bar{x}$

state table:

Example 1:

x	y	X	Y
$\overset{+}{0}$	0	1	0
0	$\overset{-}{1}$	0	0
$\overset{-}{1}$	1	0	1
1	$\overset{+}{0}$	1	1

Example 2:

x	y	X	Y
$\overset{+}{0}$	$\overset{+}{0}$	1	1
(0	1)	0	1
$\overset{-}{1}$	$\overset{-}{1}$	0	0
(1	0)	1	0

graph of the sequence of states:

Example 1:

$$\begin{array}{ccc} \overset{+}{0}0 & \rightarrow & 1\overset{+}{0} \\ \uparrow & & \downarrow \\ 0\overset{-}{1} & \leftarrow & \overset{-}{1}1 \end{array}$$

Example 2:

$$\begin{array}{ccc} \textcircled{10} & \leftarrow & \overset{++}{00} \\ \uparrow & & \downarrow \\ \overset{--}{11} & \rightarrow & \textcircled{01} \end{array}$$

periodic attractor	*multistationarity*

Table 1: Description of two examples of basic attractor types by Kinetic Logic

The *graph* of positive and negative interactions can be rewritten in the form of logical relations. The *logical relations* describe the possible evolution (X, Y) of the system as a function of its actual state (x, y). $Y=x$ states for instance that y has the tendency to stay or become present, if x is present. Variables that have the same value in the *state* (x, y) as well as in the *logical function* (X, Y) will not change in the next step, while variables which have logical functions different from the actual state, are about to change. In the state table, 'about to change' is expressed by a '+ 'or '-' sign above that state $\left(\overset{+}{x} \quad or \quad \overset{-}{x}\right)$, depending on the direction of change (Thomas 1991). Distinguish the '-' in this notation from the dash above a variable in the logical functions (e.g. $X = \bar{y}$) where it means 'not'. From the state table one can obtain the temporal evolution of the system, called the *graph of the sequence of states*. Consider that Kinetic Logic, unlike Kauffman's approach (Kauffman, 1993) - assumes an asynchronous evolution which means that only one variable is allowed to change at a time. In this first example (see Table 1 left side, bottom), the graph of the sequence shows the pattern of a *periodic attractor* which is typical for a negative feedback loop.

The second example in Table 1 is a positive feedback loop, where the logical function is 'on' for both variables, if the other variable is not present. The states marked in the state table (e.g. (1 0)) are stable, as both variables have the same value as the corresponding evolution functions. As to be expected in a positive feedback loop we find *multistationarity*, i.e. two stable states.

When thinking about applying this method to psychology, such a Boolean reduction of the levels of variables may seem simplistic at first glance. How could such a model be able to reflect the richness of psychological phenomena? Theoretical and clinical reasoning, however, often seem to be similar to threshold models. Many theories, when defining the interactions between variables, treat the variables as having two different states or levels. Family atmosphere in schizophrenia for instance is discussed in terms of high expressed emotion (critiques or overinvolvement) versus low expressed emotion (Vaughn & Leff, 1976). When describing the state of a schizophrenic patient, a clinician may observe that the patient is 'no longer psychotic' or 'psychotic again'. These thoughts both imply a two state model, just as 'Naive Kinetic Logic' does.

'Generalized Kinetic Logic', an advanced form of Kinetic Logic

In 'Generalized Kinetic Logic' (Snoussi et al., 1990), a variable can have more than two levels. The number of 'qualitative' levels of a variable, is derived from the number of elements *n* that a variable influences in the graph of interactions, *n+1* gives then a intuitively convincing estimate of the number of qualitative levels of a variable.

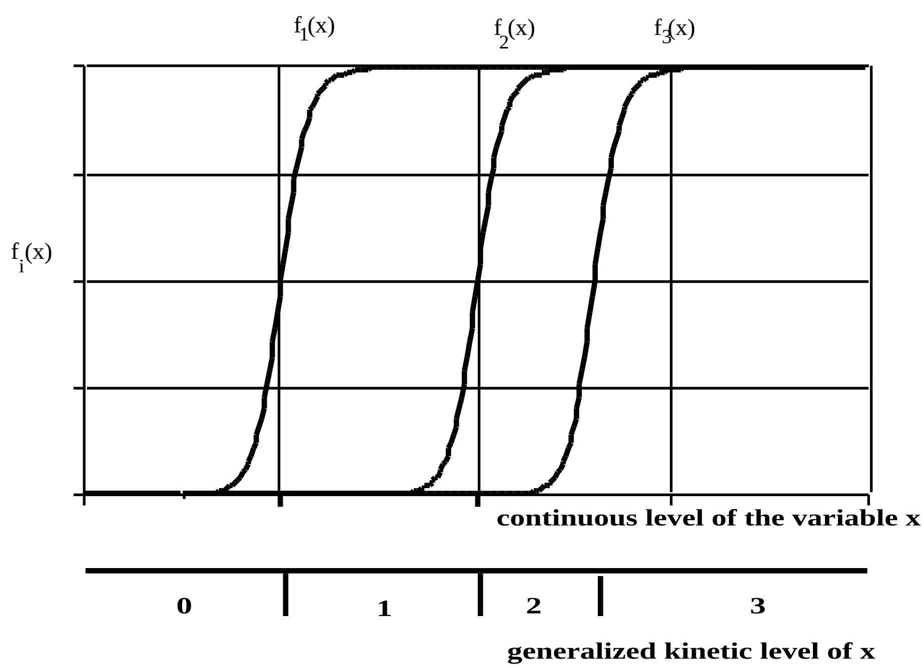

Figure 1: Step functions in 'Generalized Kinetic Logic'

Consider a variable that interacts at three locations in the graph of interactions. For this variable, level '0' implies that the level of the variable is so low that it has no impact at all. Level '1' denotes a level beyond the first threshold, and an impact on one variable, whereas level '2' implies an impact upon two variables. At level '3', the variable has reached its qualitative maximum, where it influences three variables in the system (see Figure 1)

APPLICATION OF KINETIC LOGIC TO THE DYNAMICS OF PSYCHOSIS

General and more specific models - levels of application

In psychology and psychiatry the use of Kinetic Logic has begun only recently (Dauwalder & Hoffmann 1992, Ciompi, Ambühl & Dünki, 1992, Dauwalder & Kupper 1993; Kupper, Hoffmann & Dauwalder, 1994). Our main interest has been in the application of the method to the dynamics of psychotic disorders, especially of schizophrenia. Schizophrenic psychosis can be modeled on different levels with different theoretical backgrounds and on different level of formalization (e.g. Scheflen, 1981; Schmolling, 1983; Nuechterlein & Dawson, 1984; Brenner, 1989; Schmid, 1991; Aebi, Ackermann & Revenstorf, 1993; Kupper & Hoffmann, 1995). One can take a more general or a more individual perspective and start from a biological psychological, or a social frame of reference. In previous research the so called 'naive form' of Kinetic Logic has been applied to the general dynamics of schizophrenia (Ciompi et al. 1992) or to a personalized model of chronicity and rehabilitation in psychosis, exploring the successful rehabilitation of a given patient (Dauwalder & Hoffmann 1992). In this paper we focus on the psychosocial dynamics of chronic psychosis.

A model for chronic psychosis

In the following an application of 'Generalized Kinetic Logic' is presented, describing the dynamics of chronic psychosis in the context of vocational rehabilitation.

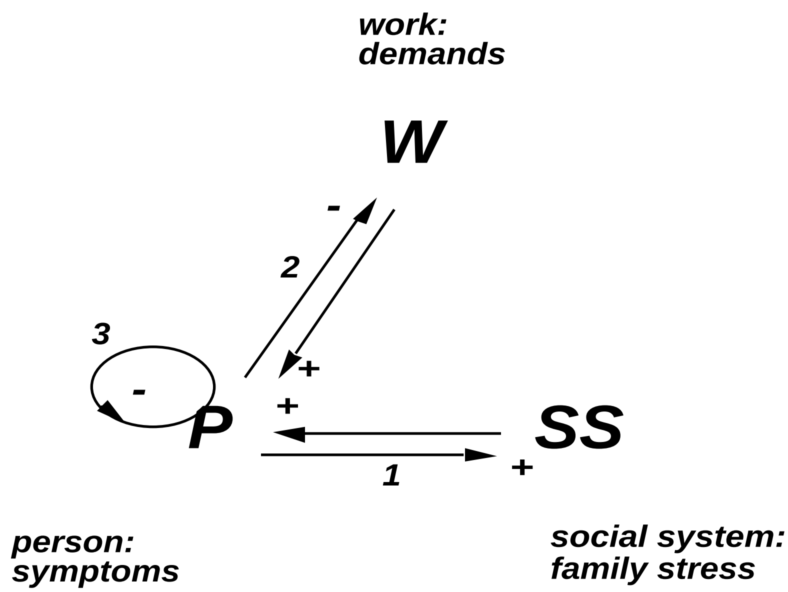

Figure 2: A model of chronic psychosis (for explanations see text).

In this model (see Figure 2), variable *P* stands for psychopathological symptoms and behavioral disturbances of a patient. The numbers 1, 2, 3 in Figure 2 indicate, that the symptoms have different threshold levels regarding the different possible interactions and the levels of symptoms. In chronically mentally ill persons we find heterogeneous patterns of symptomatology where so called 'positive symptoms' (e.g. hallucinations, delusions) and 'negative symptoms' (e.g. emotional withdrawal, motor retardation) as well as coping strategies are present at the same time. Both primary symptoms and coping efforts are often sources of distress for patients and others. This symptomatic behavior might exert stress on the *S*ocial *S*ystem (e.g. the family, or other relevant people), and foster considerable concern or criticism. If this takes the form of an enduring attitude of families it is termed as 'high-expressed-emotion'.

It is known that this can worsen the problems of the patients, specifically promoting relapse (Vaughn & Leff, 1976; Nuechterlein, Snyder and Mintz, 1992). Given these findings, we assume positive feedback between the patient's problems and the stressful reactions of his social environment (see Figure 2).

Work demands are another form of psycho-social stress. Wing, Bennet & Denham (1964) studied the effect of intense vocational training efforts on chronic long-stay patients. Since that study it is known that excessive work demands have the potential to bring about symptoms that had been absent for years. In older studies symptoms had rather been undervalued in their effect on work performance (see the review of Anthony & Jansen, 1984). Recent studies point to a higher importance of symptomatic behavior for future vocational functioning (Anthony, Rogers, Cohen & Davies, 1995; Lysaker & Bell, 1995). Accordingly we propose to model interaction of symptoms and the demands of *W*ork as a negative feedback loop. An increase in symptoms results in a reduction of work demands (often in the form of a dismissal). In return this causes a decrease in the symptoms, considered in medium-term, probably over a period of weeks or months.

The model refers primarily to chronic mentally ill patients, living in the community, showing less symptoms than long-term hospitalized patients. However, to get a comprehensive idea of the possible developments, we also included extreme peaks of the symptoms in our model (level '3' of symptoms). We assume that those peaks are reduced relatively fast in our population by different factors (such as withdrawal, increase of medication, short-term hospitalization). For reasons of clarity and frugality of the model, we formalize this process as a negative feedback loop on the symptoms. At the lowest level (level 1, which stands for 'mild symptoms') symptoms increase the social stress (e.g. negative emotional responses from relatives), at level 2 (= 'moderate symptoms') they have an additional reducing impact upon the demands at work (e.g. in form of a dismissal), where at the highest level (level 3 = 'severe symptoms') corrective negative feedback becomes active on symptoms.

The duration of the states and the time needed for a given transition can be left unspecified in a Kinetic Logic model. It is also possible that these times are different in the same model depending on the relevant transition. Nevertheless, all possible transitions can be studied in this way. However, one always has to bear in mind that interactions might depend considerably on the time scale. This is also known from empirical time series research, where time lagged cross-correlations are studied between variables. Therefore in developing a Kinetic Logic model its time frame should be specified. As mentioned above, the model presented here applies to the development on a time scale of weeks or months. If the model should focus on the dynamics in time scales of hours or days, other interactions would eventually be relevant. Furthermore the interactions could change with the age of patients (Hoffmann, Wyler and Kupper, 1995). Our model applies to young psychotic patients.

Kinetic Logic analysis of the model of chronic psychosis

The assumptions of our model for chronic psychosis can be formalized first in the simple form of 'naive' logical equations:

$$P = \bar{p} + ss + w$$
$$W = \bar{p}$$
$$SS = p$$

This means: P has a reducing effect on itself and is increased by SS and W. In these 'naive logic' equations, the threshold levels are missing. The postulated effects, their directions, and the threshold levels for effects can be summarized in a interaction matrix as follows:

$$\begin{array}{c} \\ P \\ W \\ SS \end{array} \begin{array}{c} \quad p \quad w \quad ss \\ \begin{pmatrix} -3 & 1 & 1 \\ -2 & 0 & 0 \\ 1 & 0 & 0 \end{pmatrix} \end{array}$$

The first row represents the impact on the symptoms (*P*), the second row on the work demand (*W*) and the third one stands for the impact on stress in the social system (*SS*); e.g. the first column vector states: '*P* has a reducing effect on itself on level 3', '*P* has a reducing effect on *W*, beginning on level 2' and '*P* has an increasing effect on *SS*, beginning on level 1'.

The description of generalized kinetic systems is completed by defining the so called 'K-values'. A K-value describes the level towards which a given variable tends, if a certain combination of interactions are effective on that variable. K-values can therefore be higher than 1 only for variables which can reach levels higher than 1. In Table 2 two possible sets of K-values are presented.

The K-values in the left part of Table 2 imply a high impact on symptoms by family stress and work demands. We assume that this is given in the group of severely impaired patients. The right part of Table 2 shows an example of lower impact on the symptoms as it might be given in less impaired chronic outpatients. These patients occasionally apply for vocational rehabilitation.

high impact on symptoms
(severely impaired patients)

p	w	ss	K_P	K_W	K_{SS}
0	0	0	.	.	.
0	0	1	1	.	.
0	1	0	2	.	.
0	1	1	2	.	.
1	0	0	0	1	1
1	0	1	2	.	.
1	1	0	3	.	.
1	1	1	3	.	.

lower impact on symptoms
(less impaired patients)

p	w	ss	K_P	K_W	K_{SS}
0	0	0	.	.	.
0	0	1	1	.	.
0	1	0	1	.	.
0	1	1	1	.	.
1	0	0	0	1	1
1	0	1	1	.	.
1	1	0	1	.	.
1	1	1	2	.	.

Table 2.: Two different set of K-values (Note that not all combinations of impact need to be meaningful for all variables. Such K-values are left out and denoted by dots.)

The numbers below the small letters (*p, w, ss*) represent all possible combinations of influences by the variables *P, W, SS,* where 1 stands for a positive influence. The numbers under K_P, K_W and K_{SS} are K-values. As example for the meaning of K-values see the last row left in

Table 2. The vector (1 1 1 | 3 . .) states that if all three variables (*p, w, ss*) have a positive influence on the symptoms, the K-value of the symptoms K_p is 3, i.e. the symptoms will tend to level 3 (= 'severe symptoms'). In other words: if the symptoms are below the level, where they have negative feedback on itself *and* both work demands/having a job and family stress are given, the symptoms will tend to become severe.

Having defined all necessary elements of the model, we transform the interaction matrix into a state table, including all possible states and the corresponding evolution functions, or 'images' as Thomas (1991) calls it. As shown in the simple examples in Table 1, we can derive the resulting dynamics from such a table. State tables are suppressed in this and all following examples. For models with few variables calculations can be done manually. However help from computers is preferable[i]. Figure 4 shows the dynamics in our model of chronicity using the K-values for 'high impact on symptoms' (see Table 2 left part). It is a three-dimensional table with symptoms on y-axis, work and family stress on combined x- and z-axis. Hence the table includes all possible states of the system, the 'state space'. The figure can also be imagined as a landscape on which a ball is moving. The arrows represent the direction of the ball's movement, i.e. the transition between different combinations of symptoms (*P*), work situation (*W*) and family stress (*SS*) which have to be expected according the assumptions. As demonstrated, the presented transitions are no arbitrary settings but they are the *clear consequence* of the variables' interactions and of a certain setting of their power (K-values). In this form of the model bifurcation can occur, i.e. certain states can develop in more than one pathway. If it is known which transitions are faster, these separations of pathways can be dissolved by the setting of so-called t-values. Otherwise we imply that all of them are equally probable. Most realistic is to see these transition times *t* as stochastic variables with given means and variations (see Thomas & D'Ari, 1990). Thus, attractors emerging out of the analysis, are in fact the dominating dynamical structures in the system.

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[i] An algorithm performing the basic calculations using SAS/IML (1989) matrix language is available from the first author. For its use, the SAS/IML software is prerequisite.

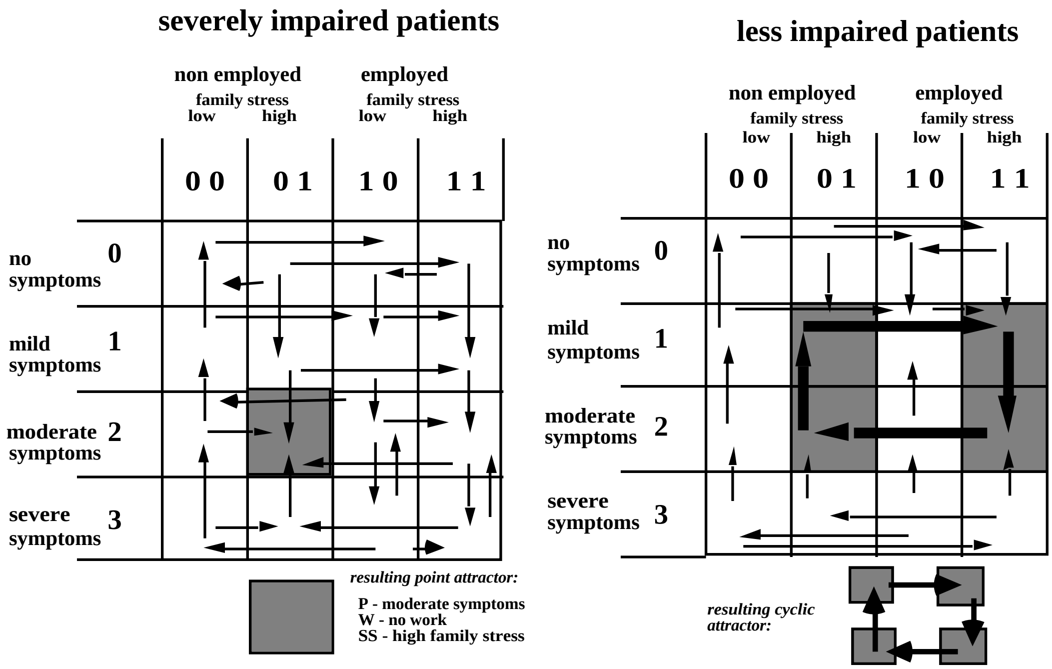

Figure 3: Chronicity as a point attractor and a cyclic attractor

The most important result of our application is, as shown in Figure 3, left panel, that under the assumptions of the presented model, only one *stable state* is possible: the combination of moderate symptoms, together with no work and high family stress. In this case, chronicity has the dynamical pattern of a *point attractor*, as the system has the tendency to return always to the one unfavorable state. Even if external factors, as e.g. therapeutic interventions with only short-term effect, move the system to another, more desired state, this tendency persists. This corresponds in the landscape analogy to a ball which always returns to the hollow after being pushed. The improvement of the working capacity in a vocational rehabilitation program followed by an employment but without additional interventions on *P*, *W* or *SS*, would be doomed to failure.

In the second example, the assumed effects of the system (the matrix of interactions) are kept constant, but the power of the unwelcome effects on *P* (the K-values) are reduced, as shown in Table 2 right part ('lower impact on symptoms'). Given these K-values, the dynamics presented in Figure 3, right panel, will result: The person circles within four states: the state 'no work, mild symptoms, high family stress' is followed by the state 'work, mild symptoms, high family stress', i.e. with mild symptoms, the person looks for a job and gets it. As a next step, however, the symptoms increase, then the job will be lost, which finally results in a reduction of the symptoms. Thus the patient is back at the first state of the circle. In this model chronicity is not a single state but equals a periodic attractor. If external factors (such as therapeutic interventions with only short-term effects) are included, the system can also develop other states for a short period of time (e.g. work, no symptoms, low family stress), but there is a strong tendency to return to the attractor of chronicity.

Implications for vocational rehabilitation: a systemic perspective

This approach can stimulate a new view of chronicity and new intervention strategies in rehabilitation. Chronicity has to be seen not as a state but as a pattern resulting from a system's dynamic. The same is true for rehabilitation and its goals. It is not the primary and only goal in rehabilitation, to reach a desirable state (e.g. to get a job), but to create conditions which always let the system return to a desired state (e.g. not to loose the job in a crisis). Dauwalder & Hoffmann (1992) have described this in a single case with Kinetic Logic. Finally, many intervention strategies result from the interactions postulated in Figure 2. Crucial in this view is that the patient's symptoms (*P*) are one, but not the only variable that could be addressed by interventions. As the system's 'chronic' behavior results from the interaction of all elements, attempts for change should be tried either on the social stress (*SS*) or the work situation (*W*). If for example the increase of symptoms caused a dismissal in former times, the question arises whether the patient can develop a different approach to his symptoms. On the other hand one should consider if the vocational context can react more helpfully on symptomatic behavior. According to this approach, in our rehabilitation program we include interventions on the level of the patient as well as at work and in the social system.

Exploring treatment strategies

After having built a model, one generally has to evaluate it, using specific criteria or 'tests'. Levine et al. (1992) outlined tests for the validity of models as being either (1) 'structural tests', (2) 'behavioral tests' or (3) 'policy tests'. One could label the corresponding criteria (1) theoretical consistency, (2) empirical consistency and (3) consistency with changes from interventions. In the following two examples we explore the reactions of our model to two interventions. This type of test can be called test of *behavior sensitivity*: 'Do plausible changes in parameters values only lead to changes observed in the real system?' (Levine et al. 1992, p. 217). We first introduce an intervention on the work site and go then to family intervention.

First type of intervention: sheltered job

As a starting point we take our model of chronicity (Figure 2) with the K-values denoting a lower impact on the symptoms (Table 2), which results in chronicity as cyclic attractor (Figure 3, right panel). As mentioned above, this seems realistic for many patients applying for vocational rehabilitation. An increased tolerance for symptoms, or problematic behavior at the workplace in generally is an essential part of a sheltered job intervention. Formalizing this in the language of the model, the thresholds have been changed (see Figure 4, left panel).

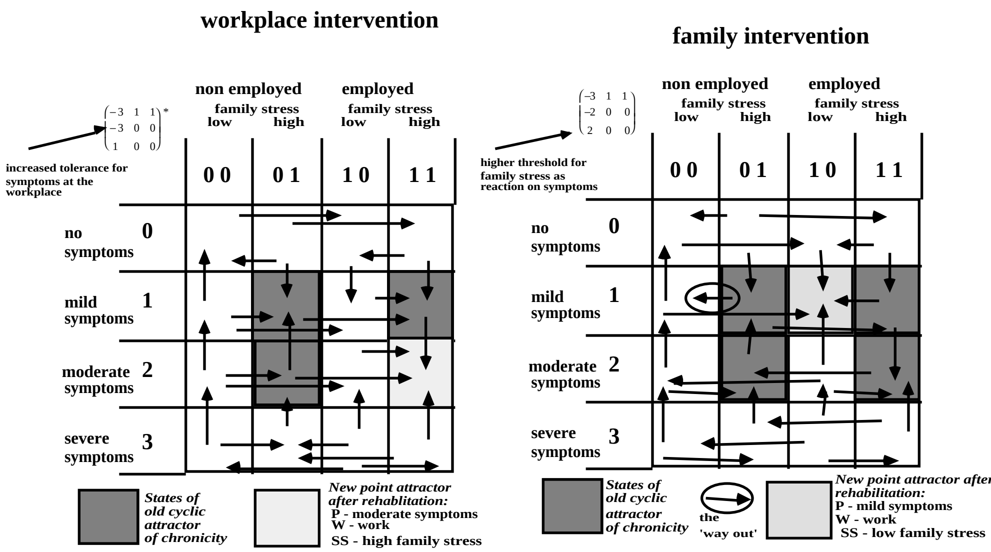

Figure 4: Workplace intervention (sheltered job) and family intervention: Dynamical impact

Workplace situation now only changes if the patient shows severe symptoms (level 3). After having defined all necessary parameters of the system, the resulting dynamical changes can be analyzed in the pathways of Figure 4, left panel: We see that the system shifts from the old cyclic attractor of chronicity to a new point attractor, representing in fact a stable result of the rehabilitation process. This state, however, is not a ideal one, as the patient still suffers from moderate symptoms and family stress is still high.

Second type of intervention: family intervention

In a second example we test the impact of a family intervention on our system of chronicity (Figure 4, right panel). Again we start from the system analyzed in Figure 3 (right panel). Here, the intervention consists in a higher threshold for family stress as reaction on symptoms. This effect might be common in different forms of family therapy, such as systemic (Selvini Palazzoli, 1986) or behavioral (Hahlweg et al. 1989; Falloon, 1990) approaches, but can be introduced and understood from different theoretical backgrounds. On the formal level of the model, family stress is now only increased, if the patient shows at least moderate symptoms.

The dynamical result is again that the cyclic attractor of chronicity changes to a point attractor. In this case, however, the resulting stable state after rehabilitation is more desirable as in the last example. The patient remains employed, symptoms are low and the family stress has been reduced to a low level too. Thus, one could assume a quite successful rehabilitation.

DISCUSSION

Starting from theory and having systematized and formalized the interactions in Kinetic Logic, the resulting models are fundamentally different from purely verbal or graphical models. Formalized models of this type allow clear statements about possible developments of the system.

Having tested two interventions on our model of chronicity, we can conclude that it reacts in a consistent and understandable way on two standard procedures in rehabilitation. From the last dynamical pattern we gained the following new hypothesis about the way recovery by family intervention develops: there might be a typical 'way out' from the cyclic attractor of chronicity. If new demands are not introduced immediately after recovering from psychosis, but are postponed until the family interaction pattern has changed, a new pathway can arise. We could now investigate empirically if this prediction holds for processes of recovery from chronic psychosis. It is obvious that in practice the dynamics will not be deterministic. Accordingly statistical procedures such as sequential analysis (Gottman & Roy, 1990) will be needed to test such a hypothesis.

The appeal of Kinetic Logic is, first of all, that complex dynamic processes, stated by theory or observable in the clinical field, can be transferred into relatively simple models showing distinct dynamical patterns and 'logical' attractors. Secondly, single observations or theoretical statements can be integrated in a consistent model. Thirdly, the predictions which result from the model, can be compared with observations made so far. If the model is comparable with the theoretical assumptions and former results, modified predictions can be compared with empirical time series.

To clarify the benefits and limitations of Kinetic Logic as a modeling tool in psychology and psychiatry, considerable work has to be done. Some steps in this direction have already been taken. Dauwalder (1994) has applied Kinetic Logic to the psychological management of ecological risks while Dauwalder & Kupper (1993) extended Kinetic Logic to health psychology. It might be helpful to compare the possibilities of Kinetic Logic with the features of other methods for modeling. Having done this, one might conclude that modeling in differential equations is superior to Kinetic Logic, because it seems to be more flexible and open for data input from empirical research. On the other hand, Kinetic Logic is more accessible to verbal, qualitative input and gives an *overall picture* of the possible dynamics and attractors which one can never get from many differential systems without testing different starting values and parameters. Compared with methods from qualitative modeling (see Levine, 1992) such as *pulse processes*, Kinetic Logic seems to be far more adequate for modeling nonlinear systems, as its striking simplicity stems from its conception of nonlinearity. As Thomas (1991) points out, the system has all ingredients to produce Rössler chaos (Rössler, 1976). Hence Kinetic Logic has the capabilities to express chaos. The application of this method to a wide variety of psychological and psychiatric models could yield more insight in its possibilities and limitations. To date it seems that in spite and because of its simplicity Kinetic Logic helps to generate new and meaningful dynamical models.

Author Notes

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