A multivariate time-series approach to marital interaction

Analyse ehelicher Interaktionen - Annäherungen mit Hilfe multivariater Zeitreihenmodelle

Abstract

Time-series analysis (TSA) is frequently used in order to clarify complex structures of mutually interacting panel data. The method helps in understanding how the course of a dependent variable is predicted by independent time-series with no time lag, as well as by previous observations of that dependent variable (autocorrelation) and of independent variables (cross-correlation).

The study analyzes the marital interaction of a married couple under clinical conditions over a period of 144 days by means of TSA. The data were collected within a course of couple therapy. The male partner was affected by a severe condition of atopic dermatitis and the woman suffered from bulimia nervosa.

Each of the partners completed a mood questionnaire and a body symptom checklist. After the determination of auto- and cross-correlations between and within the parallel data sets, multivariate time-series models were specified. Mutual and individual patterns of emotional reactions explained 14% (skin) and 33% (bulimia) of the total variance in both dependent variables (adj. R², p<0.0001 for the multivariate models).

The question was discussed whether multivariate TSA-models represent a suitable approach to the empirical exploration of clinical marital interaction.

Keywords: marital interaction, atopic dermatitis, bulimia, time-series analysis, couple therapy

Zusammenfassung

Zeitreihenanalysen werden häufig zur Klärung komplexer Strukturen von wechselseitig interagierender Längsschnittdaten eingesetzt. Diese Methodik kann helfen zu verstehen, wie der Verlauf einer abhängigen Variablen aus den früheren Werten dieser Variablen (Autokorrelation) oder aus zeitgleichen oder vorhergehenden Werten der unabhängigen Variablen (Kreuzkorrelationen) vorhergesagt werden kann.

Die vorliegende Studie analysiert die Interaktionen von Zeitreihenvariablen eines Ehepaares. Beide Ehepartner füllten täglich über einen Zeitraum von 144 Tagen einen Stimmungsfragebogen und einen Körperbeschwerdenbogen aus. Das Ehepaar befand sich im gesamten Erhebungszeitraum in einer Paartherapie. Der Ehemann litt an einer atopischen Dermatitis, während die Ehefrau eine Bulimia nervosa hatte.

Nach der Berechnung von Auto- und Kreuzkorrelationen zwischen und innerhalb der Zeitreihendaten wurden außerdem multivariate Zeitreihenmodelle bestimmt. Durch die eigene Gestimmtheit und die Gestimmtheit des Partners konnten 14% der Gesamtvarianz der Veränderungen der Hautbeschwerden des Mannes und 33% der Symptome der Bulimie der Frau erklärt werden (adj. R², p<0.0001 für die multivariaten Modellbildungen).

Die Diskussion greift insbesondere die Frage auf, ob multivariate Zeitreihenanalysen eine brauchbare Methode darstellen, um eheliche Interaktionen adäquat darstellen zu können.
Introduction

According to an old Italian proverb, a watermelon satisfies three needs: it serves as a drink, refreshes, and cleans the hands. In parallel, this study involves three seemingly different, but clinically interacting aspects of investigation: it argues in favor of time-series analysis in the study of social (in this case: marital) interaction, illustrates a reciprocal psychodynamic pattern of psychosomatic symptomatology in the sense of a couple collusion by means of a clinical single-case-study and, by combining the initial two aspects, may illustrate how quantitative single subject research enriches the purely clinical qualitative approaches to a pathological marital interaction.

First, we present multivariate models of time-series analysis (TSA) as a methodological approach, which clarify by means of mathematical model building the structure of marital interaction [1]. Time-series analyses, originally developed by economists for empirical "case studies" of economies and business companies, provide an appropriate framework for the intensive study of complex multivariate interacting panel data, which were observed over a substantial period of time (say, at least 100 days). The "modeling" of these empirical data set, which may require interactions between variables as well as within a series of data points (a time-series) was first described by Box & Jenkins in 1976 as time series analysis [2]; first applications in the psychological realm, discussing alternative strategies of data analyses were presented by Chassan [3], McCleary & Hay [4], Gottman [5] or Kazdin [6, 7]. Studies involving time-series analyses as research tools in a psychosomatic or psychiatric field have been published subsequently [8], [9], [10], [11], [12], [13], [14], [15], [16], [17]. Here, time-dependent structural models of interaction between social or psychological events and bodily reactions or symptoms could be developed. We therefore have some reason to assume that time series analyses of parallel sets of timely organized data are a suitable approach to the registration of dynamic exchanges in a couple (cf. in this context [18], [19]). These patterns of mutual influences have to date not been described in terms of multivariate time series ARIMA models.

Second, as clinical background, we report some aspects of a one-year lasting couple therapy, in which the male partner was affected by atopic dermatitis, whereas the female partner was affected by bulimia nervosa. For the unconscious aspects concerning the complementary defensive patterns in couples, Willi [20] has coined the term of couple collusion. He argues in favor of a widely unconscious pattern of mutual interaction of psychosocial defenses, which stabilizes neurotic relationships. Aggressive and libidinous impulses are mostly projected into the partner; as a result, a gradual stabilization of the individual neurotic function is made possible by a designation of contrasting family roles to family members, as described by Richter and co-workers [21], [22], [23].

Literature on the personal characteristics of patients with atopic dermatitis (overviews [24], [25], [26]) and bulimia (cf. [27], [28], [29], [30], [31]) has pictured clinically a temporal sequence of complementary interacting psychosocial profiles with low aggression and high anxiety (and/or activation) and subsequent depressive reactions in allergy-prone patients with psychosomatic defenses, whereas bulimia-prone subjects were depicted as overtly struggling with strong aggressive impulses, paralleled by binge eating and followed by depressive symptoms.

From clinical observation and psychodynamic conceptualization, a specific, similarly complementary patterns of object relations in these conditions has been deduced: atopy-prone patients were seen in their object-relations as distant and schizoid [33], whereas bulimics are believed to oscillate between narcissistic react and, psychodynamically spoken, object-hunger in close relationships. The bulimic subject is tempted, metaphorically, to "devour" her partner, resulting in close but highly ambivalent relationships.

Although these "specific" atopic or bulimic dynamics were not encountered in all cases with the studied psychosomatic conditions, these clinical descriptions as typologies were clinically useful in characterizing "typical constellations" and permit a literature-based formulation of clinical hypotheses in this context of a couple collusion.

Using the above-cited concept of a partner-collusion and of psychosocial defenses through projectively assigned social roles, the following can be assumed: On a conscious level, both partners are expected to display reciprocal patterns of affective expression, i.e., to be openly active and aggressive in times of conflict on the part of the female partner and to be affectively inhibited, especially in a context of active and/or aggressive stimulation on the part of the male subject. Her symptoms should be accompanied by shame and guilt [34], feelings further associated with depressive moods, whereas his itching as sign of his atopic dermatitis should be tied to aggressive or anxious moods.

The common factor linking both partners, on the unconscious level, and constituting the very essence of their collusive interplay, can be seen as an underlying wish to avoid impulses of merger in their object-relationship: By developing symptoms of bulimia, following a line of psychodynamic interpretation, the wife tried to find a compromise between "devouring" and "vomiting" the object, whereas the husband's skin-inflammation seems to serve, again metaphorically speaking, as a protective armor against the object and, ironically, locus of intense care of the object. The resulting ambivalence results in a waxing and waning of symptoms along with varying degrees of intimacy between both partners.

Schlüsselwörter: Paarinteraktion, Neurodermitis, Bulimie, Zeitreihenanalyse, Paartherapie
Addressing the third point, empirical research on marital interaction in a single case may prototypically add some new facets to the understanding of the different aspects of partner dynamics by developing empirically sound methods in studying individual and/or couple dynamics, even though both realms of investigation, the clinical and the empirical, are so different from each other. Modern sociological research, however, has developed a concept of “triangulation”, which mediates between qualitative and quantitative data. The process of triangulation, a metaphor not unknown to psychoanalysis, shows how both approaches may enrich each other in intensive case studies, thereby providing a more effective alternative to the "novelistic", purely descriptive, clinical investigation [35], [36].

Patients and methods

The couple

The 26-year-old woman had been suffering from bulimia nervosa for an estimated period of two and a half years. After an initial psychodynamic interview in a university policlinic, she decided on psychosomatic in-patient therapy. After six weeks, this therapeutic setting could not be continued due to the patient's pregnancy; ambulant couple therapy with therapeutic constancy followed. Her 22-year-old boyfriend had likewise been suffering since a period of two years, but from atopic dermatitis, parallel to the beginning of their relationship two years ago. Even though he is not considering an individual psychotherapy, both of them opted to participate in outpatient couple therapy with parallel empirical evaluation of the process and video recording of the sessions. The woman became bulimic after breaking up with her former boyfriend. She described her seven-year lasting relationship with him as a very constricting one, isolating both of them from the world outside ("He was my whole world"). Her almost daily binge-eating episodes at the time of the beginning of therapy, followed by violent vomiting, mostly occurred when she felt lonely in her partnership.

In therapy, she spoke about her mother, who had always insisted that she made herself attractive: She remembered that she had to present herself like a "little doll". A similar mother-child discourse reappeared after the birth of her child, when her mother put pressure on her to improve her figure. She also told her not to breastfeed the infant, so that her breasts would not sag. In addition to suffering from feelings of guilt induced by her mother, she felt overburdened whenever she was separated from her boyfriend and later husband: Her partner was regularly away due to his school on weekdays. She then experienced frequent bulimic episodes. Intensified symptoms also appeared during one phase of therapy, in which she had to deal with the issue of emotional separation from her parents. The night before her wedding, she again had a severe binge episode, followed by vomiting. She feels that her wedding was another way of separating herself from her parents.

As the therapy continued, she learnt to distance herself from these ambivalent parental images to an even greater extent in order to do more to serve her own needs. She was also, by the end of the therapy, more able to tolerate temporary separations from her husband. She even learnt to view these phases of marital distance as an opportunity to take more time for herself. The male patient was slow to open up at the start of therapy. He was firmly convinced that his atopic dermatitis symptoms were mainly due to his work as a farmer. His contact with cattle and dirt seemed to him to be the cause of his problem. In the conflicts between his wife and his mother (both, his parents and the couple were living door by door on the same farm) he felt "stuck in the middle", while anger and confrontations intensified his itching. All conflict-loaded situations, in fact, such as discussing their marriage and the birth of their child, intensified his skin complaints, a temporal relation he was largely unaware of.

Only at a later point in the therapy process did some problems involving his relationship to his father clear up. The patient worked now, after finishing school, as a farmhand on his parents' farm. Working together with his father became an increasing strain on him. Moreover, instead of confronting issues of conflict, his father tried to suppress them. When the patient had to "swallow" his anger, unable to resolve the conflict, his itching grew worse. Near the end of his therapy, these symptoms were also gradually alleviated.

To sum up, the course of therapy can be characterized as follows:

The female patient's symptoms appeared in various situations involving separation and loneliness. The male patient's symptoms were mainly due to his difficulties in establishing clear borders between self, parents, and wife. The process as a whole was characterized by massive changes in their psychodynamics, initiated and intensified by the birth of their first child, by their wedding, and by his professional qualification.

Four years later, a follow-up could be arranged in form of a last couple-session. The symptoms in both partners had disappeared completely. The couple had moved away from the farm of the husband's parents and had another child. The therapy had initiated decisive steps toward a greater individuation of both partners and had, at the same time, established a firmer bond between them.

Time-series data

The data collection for the empirical analyses was limited to a time frame of 144 days, which happened to be a significant period in their lives [37]. This phase under investigation included 25 days prior to the birth of the couple's first child, the day of birth itself, and 118 days afterwards. Both partners filled out a mood questionnaire MSF (multidimensional mood questionnaire [38]) and a
by a regression coefficient of the independent variables, but also by regression terms given by previous observations of the same variable, a fact termed autocorrelation. In addition, in multivariate cases, the given observation can also be predicted by lagged (previous or subsequent) observations of the independent variables. The multivariate approach, by computing second order correlations with adjustment for concurring intercorrelations, detects the strongest influences on a given dependent variable, thus accounting for its position in this three-dimensional time matrix.

Results

As preliminary steps in the analyses of the two corresponding time-series data sets, correlations and cross-correlations as well as vector-autoregression models were computed for the time domain lead/lag 1 to 7. The analyses should clarify which variables were cross-correlated and how the corresponding time-lag could be specified. Based on these preliminary findings, multiple time-series regression equations were developed. These final results can be described as follows:
The male partner's somatic symptoms (see Table 1) were best predicted in terms of his own depressive mood on the same day and of his wife's aggressiveness on the previous day. Moreover, it is connected with own aggressive strivings on the following day. A large, but insignificant autocorrelative parameter could be found on lag 1. The model accounted for 14% of the total variance (adj. $R^2$) with highly significant estimations for the mood predictors. Further statistics, such as Durbin-Watson and Akaike information criterion, indicate the sufficient quality of the model.
The woman's bulimic symptoms (see Table 2) were best predicted by her own aggressiveness on the previous day and by depressive moods on the same day. Her symptomatology was associated with altered activity on the part of her husband on the following day. The more she suffered from bulimia, the less her husband could be active. Her bulimic symptoms autocorrelated significantly with observations on day -1 (AR1) and day -7 (AR7). The last parameter indicates a weekly rhythm as a social structure ("Social Zeitgeber").
The described model accounts for almost 34% of the total variance (adj. $R^2$), with highly significant estimations for the mood predictors.

Looking at cross-interactions between partners, the following predictors are significant: Her symptomatology is not predicted in any way by his lagged mood or symptom variables, but seems to "trigger" mood changes and symptom production on his part. Thus, her progressive, active strivings seem to affect on him, in a way that her emotional variation drives him (see Figure 1) into psychosomatic reactions. His variability has no significant effect on her.
### Table 1: Multiple regression model with the husband’s symptom as a dependent variable

| DEPENDENT VARIABLE: ITCHING |
|-----------------------------|

Included observations: 142 after adjusting endpoints

| Variable     | Coefficient | Std. Error | t-Statistic | P  <  |
|--------------|-------------|------------|-------------|-------|
| AGGR(H)(1)   | 0.041       | 0.011      | 3.657       | 0.0004|
| DEPR(H)      | 0.018       | 0.005      | 3.713       | 0.0003|
| AGGR(W)(-1)  | 0.038       | 0.013      | 3.026       | 0.0030|
| AR(1)        | 0.155       | 0.083      | 1.861       | 0.0648|

**Model**

| Adj. R²      | 0.142       | Mean dependent var | 1.148 |
|--------------|-------------|--------------------|-------|
| S.e. regression | 0.441     | Akaike info criterion | -1.611 |
| Sum sq. resid.  | 26.794     | Schwarz criterion  | -1.528 |
| Log likelihood  | -83.086    | F-statistic        | 8.757 |
| Durbin-Watson  | 1.983      | P (F-statistic)<   | 0.0001|

**Legend:** ACT = Activity, AGGR = Aggressiveness, DEPR = Depression, (H) = Husband’s scores, (W) = Wife’s scores

### Table 2: Multiple regression model with the wife’s symptom as a dependent variable

| DEPENDENT VARIABLE: BULIMIA |
|-----------------------------|

Included observations: 135 after adjusting endpoints

| Variable     | Coefficient | Std. Error | t-Statistic | P  <  |
|--------------|-------------|------------|-------------|-------|
| AGGR(W)(-1)  | 0.089       | 0.017      | 5.328       | 0.0001|
| DEPR(W)      | 0.011       | 0.003      | 3.641       | 0.0004|
| ACTIVITY(H)(1)| -0.010    | 0.002      | -3.889      | 0.0002|
| AR(1)        | 0.255       | 0.089      | 2.884       | 0.049 |
| AR(2)        | 0.067       | 0.089      | 0.762       | 0.4476|
| AR(7)        | 0.316       | 0.087      | 3.641       | 0.0004|

**Model**

| Adj. R²      | 0.338       | Mean dependent var | 0.430 |
|--------------|-------------|--------------------|-------|
| S.e. regression | 0.576     | Akaike info criterion | -1.062 |
| Sum sq. resid.  | 42.727     | Schwarz criterion  | -0.932 |
| Log likelihood  | -113.902    | F-statistic        | 14.706 |
| Durbin-Watson  | 2.015       | Prob (F-statistic) | 0.0001|

**Legend:** ACT = Activity, AGGR = Aggressiveness, DEPR = Depression, (H) = Husband’s scores, (W) = Wife’s scores
Discussion

In this empirical time-series study on marital interaction, an attempt has been made to describe a defined time section of a "psychosomatic couple collusion" by means of interacting mood variables (cf. Evans & Wertheim [42]). The data set allowed the simultaneous analyses of timely interactions between subjects as well as within subjects. These analyses of time-series data, undertaken in two different subsets of panel data, provide in condensed form some (conscious) aspects of the couple dynamics previously given clinically. These conscious aspects, however, do not fully explore in depth Willi's concept of a so-called "couple collusion", since only the conscious surface could be explored. The, seen from a psychodynamic point of view, openly ("consciously") accessible data underscore, in line with Willi's concepts, a specific cross-correlating dynamic couple structure, in which the wife's progressive, active impulses dovetail with the husband's regressive, passive strivings. He seems to be driven by her, a partner constellation, which underscores the different role designations both partners have entered in their mutual (supposedly unconscious) scripts [43]: His symptomatology is triggered by her aggressive strivings. After having submitted to itching as his paramount psychosomatic symptom, he is, after all, finally able to experience aggressive moods on his own side.

In addition to its possible function in summarizing and condensing the couple's dynamics in this special clinical case, the empirical study of psychological time-series variables may, in some instances, make utile contributions to the study of the temporal dynamics in psychoneurotic as well as in psychosomatic conditions intraindividually or, interindividually, in terms of couple or group interactions: These data sets may, ideally spoken, explore simultaneously intraindividually the relation between affects, psychosomatic symptoms and resulting changes of mood. By the same token, these analyses could also shed some light on the dynamics of a partner or group member in terms of interindividual investigations. A composite picture of human illness as an individual affliction and, simultaneously, interactional symptom can thus be depicted [10]. The methodological approach presented may therefore contribute to an understanding of the relational, systemic nature of human health and illness [44], [45], [46], [47].

Concerning the shortcomings of this study, future timeseries research in the realm of psychosomatic disorders should address more intensely the following critical points: External, situational influences should also be registered, for instance by applying daily hassles scales [48], [49], [50], [51], [52], [53], [54], [55], [56], [57], [58]. In gathering somatic data, "objective" psychophysiological data should, whenever possible, also be taken into account in order to make the study more valid psychobiologically [59], [60], [61].

Being a first pilot-study, further investigations should expand over a longer period of time in order to study the stability of this interactional pattern. The time frame of this study was, albeit chosen carefully, to limited to make any further inferences e. g. about different phases or changes in interactional styles in couple interaction. Other possible approaches to the research of marital interaction would include multiple time samples of different couples with similar typologies in order to clarify typical partner constellations. In this context, our study may be regarded as a very preliminary attempt to study the time-dependent dynamic of a prototypical couple with this specific psychosomatic interactional pattern.

In sum, the intensive study of individual cases over a significant period of time may, if rooted in empirical research and clinical observation, contribute to a deeper understanding of the individual and interactional dynamics of psychosomatic disorders. The study did not answer questions about changes in marital interaction over time as a result of therapeutic intervention. In longer therapies, interrupted time-series with estimation of multivariate predictors, could be appropriate in investigating changes in marital patterns as an expression of personal growth.

Longer time-series with a different periodicity of data collection (say, on a weekly basis) could be analyzed more easily in terms of the trends revealed, such as variations brought about by holidays and other interventions, since these focus on a larger time-frame.

By using such naturally occurring interventions as weekend rhythms and the absence of the therapist as dummy variables in a non-experimental design, social stimuli and factors obtained within the therapeutic setting itself can be tested for their impact on time-series; the basic condition for this is that at least 100 observations be made. Pooled time-series would investigate a common process in multiple couples with the estimation of common independent parameters for the prediction of changes in dependent markers of marital (dys-)function. Modern econometric software (e.g., Eviews) includes programs for the analysis of pooled data, in which autoregressive and lagged influences of dependent variables can be clarified and a common model can be checked for its power to explain variance in more than one time-series.

Figure 1: Time-series interaction between wife and husband

Legend: ACT = Activity, AGGR = Aggressiveness, DEPR = Depression, (H) = Husband's scores, (W) = Wife's scores
The study would also have been enriched if self-ratings and partner ratings had been combined. These approaches, however, are difficult to accomplish over a longer period in a field setting. Despite the shortcomings of our study, as detailed above, TSA as a tool has a considerable potential for the analysis of marital interaction in clinical as well as in non-clinical couples. They require a data series of at least 50-100 observations if parametric statistics with multivariate influences are to be analyzed effectively. TSA can be applied for testing interventions in individual cases by means of quasi-experimental designs. Trends and rhythms can be analyzed for purposes of quality control in courses of therapy.

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