Psychological Reports, 2007, 101, 237-249.

DYNAMICS OF EMOTIONAL EXPRESSION IN AUTOBIOGRAPHIC SPEECH OF PATIENTS WITH ANOREXIA NERVOSA[1,2,3]

KARYN DOBA

Laboratoire URECA (Equipe FASE), Université Lille 3

LAURENT PEZARD

Laboratoire de Neurosciences Intégratives et Adaptatives, Université de Provence

ANNICK LESNE

Laboratoire de Physique Théorique des Liquides, Université Paris 6

JEAN VIGNAU

Service d'addictologie, CHRU de Lille

VÉRONIQUE CHRISTOPHE AND JEAN-LOUIS NANDRINO

Laboratoire URECA (Equipe FASE), Université Lille 3

Summary.—Emotional disturbances in persons with anorexia nervosa have mainly been documented using static descriptions. This study presents the temporal organisation of emotional expression in autobiographical speech of anorexic patients and thereby provides a first attempt to quantify the dynamics of emotions in patients' speech. The temporal pattern of emotional expression for persons with anorexia nervosa was studied after transforming the autobiographical narratives of 14 patients and 13 matched controls into symbolic sequences of positive, negative, and neutral emotional expressions. These symbolic sequences of emotional states and silences were analyzed using static and dynamic indices. Static indices showed that patients with anorexia nervosa expressed more negative emotions and fewer neutral states than control participants. Dynamic indices showed in patients' speech a cycle of negative emotions and silence. These results showed specific dynamics of emotional expression in persons with anorexia nervosa characterised by the presence of negative emotional perseveration. The possible clinical implications of these findings are discussed.

Autobiographic narratives are fundamental components of the therapeutic relationship. They correspond to summaries of long-term and recent

[1]Address correspondence to Karyn Doba, Université Lille 3, Department of Psychology, Domaine Universitaire, du Pont de Bois 59654 Villeneuve d'Ascq or e-mail (karyn.doba@univ-lille3.fr).

[2]Present address for L. Pezard, Laboratoire de Neurosciences Intégratives et Adaptatives (CNRS UMR 6149), Université de Provence, Marseille, France.

[3]This study benefits from the financial support of the French Ministry of Research and CNRS through the "Action Concertée Incitative: Systèmes Complexes en Sciences Humaines et Sociales". The authors thank David Papo for his comments and his help with translation.

DOI 10.2466/PR0.101.1.237-249

events in the social situations (Nelson, 1988; McAdams, 1993; Welch-Ross, 1995) and emotional experiences (Wahler & Castlebury, 2002) of the narrator's life story. They also have an important effect in the production and the maintenance of personal coherence (Hanninen & Koski, 1999; Burch, Austin, & Bauer, 2004). From the therapists' point of view, the emotional dimension of patients' speech and the temporal evolution of emotions are important indicators for determining therapeutic interventions (de Groot, Rodin, & Olmsted, 1995; Becker-Stoll & Gerlinghoff, 2004).

Nevertheless, although a person's emotional expression clearly unfolds over time, most studies of emotional processing in psychopathology have usually neglected this temporal aspect. In these cases, the emotional expression is mainly measured as a global and static phenomena by scales of alexithymia, mood disorder, or anxiety (Taylor, Parker, Bagby, & Bourke, 1996; Rastam, Gillberg, Gillberg, & Johansson, 1997; Bydlowski, Corcos, Jeammet, Paterniti, Berthoz, & Laurier, 2005). It was hypothesized that the description and quantification of the temporal succession of emotional expression in patients' narratives would provide further information on their emotional disturbances. To test whether the temporal succession of the emotional states varies with emotional disturbances, the particular case of anorexia nervosa was studied, for whom emotional disturbances have already been described (Schmidt, Jiwany, & Treasure, 1993; Kucharska-Pietura, Nikolaou, Masiak, & Treasure, 2004; Nandrino, Doba, Lesne, Christophe, & Pezard, 2006).

Indeed, anorexia nervosa has been associated with a range of emotional deficits, including inhibition of negative feelings (Pierrehumbert, Bader, Miljkovitch, Mazet, Amar, & Halfon, 2002), decreased emotional awareness of self (Bydlowski, *et al.*, 2005), avoidance of communication involving negative affect (Strober, 1991; Sohlberg & Strober, 1994; Geller, Cockell, & Goldner, 2000; Dalgleish, Tchanturia, Serpell, Hems, Yend, & De Silva, 2003), and avoidance of conflict situations (Kog & Vandereycken, 1989; Latzer & Gaber, 1998; Lattimore, Wagner, & Gowers, 2000; Casper & Troiani, 2001). Patients with anorexia nervosa also show impaired recognition of negative facial expressions (Kucharska-Pietura, *et al.*, 2004), and of speech prosody (Zonnevijlle-Bender, Van Goozen, Cohen-Kettenis, Van Elburg, & Van Engeland, 2002; Kucharska-Pietura, *et al.*, 2004), as well as deficits in accessing positive autobiographical memories (Nandrino, *et al.*, 2006). Their results suggest that these deficits are not specific to a particular emotion but rather affect the whole emotional spectrum (Kucharska-Pietura, *et al.*, 2004; Nandrino, *et al.*, 2006), as supported by the high rate of alexithymia observed in people with anorexia nervosa (Bourke, Taylor, Parker, & Bagby, 1992; Cochrane, Brewerton, Wilson, & Hodges, 1993; Schmidt, *et al.*, 1993).

Moreover in addition to these emotional disturbances, anorexia nervosa has been associated with cognitive disturbances for a wide range of perceptual, visuospatial, and attentional processes (Maxwell, Tucker, & Townes, 1984; Yellowless, Roe, Walker, & Ben-Towim, 1988; Kingston, Szmukler, Andrewes, Tress, & Desmond, 1996; Rieger, Schotte, Touyz, Beaumont, Griffiths, & Russel, 1998). A bias toward an analytic and controlled information-processing mode (Green, Elliman, Wakeling, & Rogers, 1996; Dodin & Nandrino, 2003) has also been observed together with cognitive perseverations (Tchanturia, Morris, Brecelj Anderluh, Collier, Nikolaou, & Treasure, 2004; Tchanturia, Campbell, Morris, & Treasure, 2005). These perseverations corresponded to a deficit related to inhibition functions, difficulties in set shifting ability, and an inability to change past patterns of thinking (Dodin & Nandrino, 2003; Tchanturia, *et al.*, 2004). Since autobiographical narratives are based on both emotional and language processes, it was hypothesized that the hallmark of cognitive disturbance, in particular perseveration, would appear in the temporal succession of the emotional states expressed in the speech of patients with anorexia nervosa. This temporal succession was measured by the symbolic (Badii & Politi, 1997) and stochastic methods (Gardiner, 2004). Indeed, this study aimed to access for the first time an emotional perseveration in autobiographical speech of patients with anorexia nervosa.

The study of emotional expression in autobiographical narratives of patients with anorexia nervosa quantifies both the static, i.e., frequency distribution, and dynamic, i.e., temporal succession, characteristics of linguistic indicators. Language was considered as a dynamic process (Elman, 1995; Zellner Keller & Keller, 2000), and nonlinear dynamic methods were used (Kaplan & Glass, 1995; Badii & Politi, 1997) to obtain both local and global quantifiers of emotional dynamics. Such a dynamic framework has been considered a valuable tool for studying mental illness (Ehlers, 1995; Pezard & Nandrino, 2001), and in the case of language, it has been used to quantify deficits in discourse planning in schizophrenic speech (Leroy, Pezard, Nandrino, & Beaune, 2005). The study thus both evaluated the linguistic expression of emotion of patients with anorexia nervosa and quantified its temporal succession. It was hypothesized that autobiographic speech of patients with anorexia nervosa would depict a modification in the emotional expression. The autobiographic speech of these patients should be characterized by a decrease in frequency of the linguistic indicators of emotions in comparison with control participants. It was hypothesized that the patients' autobiographic speech would depict a specific temporal succession characterised by emotional perseverations. Unlike the control participants, the autobiographical speech of patients with anorexia nervosa should be characterized by a decrease in the probability of shifting from one emotional state to another.

Method

Participants

Fourteen young women (M age = 19.2 yr., SD = 2.0) meeting the DSM-IV criteria for anorexia nervosa of restrictive type (American Psychiatric Association, 1994) volunteered. All participants with anorexia nervosa were inpatients and were recruited in the same Eating Disorders Unit. The patients were informed of the research by a psychologist. Semistructure interviews were used to obtain details of the patients' clinical history. The anorexia group had a Body Mass Index which ranged from 12 to 15.5 (M = 13.9, SD = 1.14), and duration of illness ranged from 1 to 4 years (M = 2.5, SD = 1.0).

Semistructured interviews were used to evaluate the presence of depression and anxiety comorbidity or other psychopathology from Axis I of the DSM-IV (American Psychiatric Association, 1994). Diagnostic assignment was based on consensual judgment of three professionals, one psychiatrist and two clinical psychologists. None of the patients with anorexia nervosa presented depression or anxiety comorbidity or other psychopathology. Nine patients were treated with serotoninergic agonists to decrease the eating obsessions.

The control group was composed of 13 young women (M age = 20.5 yr., SD = 1.9) recruited in the university or in nursing schools and matched for education with patients. Participants in the control group had no direct and hierarchical link with the researcher. The control group was assessed with a semistructured interview by a senior clinician. None of the control participants had any previous history of psychiatric, eating or personality disorders, or drug abuse (American Psychiatric Association, 1994). The control group had a Body Mass Index ranging from 20 to 23 (M = 21.9, SD = 1.1). The anorexia group and control group participants were all single. Mean age did not significantly differ between the anorexia group and the control group (Mann-Whitney U = 54.5, p = .08). All subjects were asked to participate in a study concerning their life stories. They all gave informed consent and agreed to have the story recorded using a tape recorder.

Data Acquisition

Autobiographical narratives were obtained from patients with anorexia and control participants by asking them "Can you tell me the story of your life?" (Hanninen & Koski, 1999; Von Wyl, 2000). The interviewer intervened only to resume speech after periods of silence of at least 10 sec. To avoid orienting a patient's speech, the interviewer's questions always repeated the theme which preceded silence in the narrative. The interview stopped when participants reported they had nothing more to say. Each autobiographical interview was audio-taped on-line and transcribed off-line for further analysis by a human operator on a text editor.

Data Encoding

To perform a quantitative analysis on the autobiographical speech, the stories were encoded according to the linguistic indicators of emotions (Ortony, Clore, & Collins, 1988; Messina, Morais, & Cantraine, 1989). To optimize the length of the symbolic sequences, each autobiographic speech was divided into fixed temporal intervals. An interval based upon speech divisions generated too short sequences with a high heterogeneity among participants. Temporal intervals of 2, 5, and 10 sec. were tested and 5-sec. intervals were chosen. Indeed, the 2-sec. intervals led to possible ambiguity semantically, and the 10-sec. intervals led to an information loss given the observed presence of discordant linguistic indicators of emotions in the same interval. Each autobiographical speech was divided into 5-sec. segments to which was assigned either a Speech or a Silence value (Rapp, Jimenez-Montano, Langs, Thomson, & Mees, 1991; Schiepek, Kowalik, Schutz, Kohler, Richter, Strunk, Muhlnickel, & Elbert, 1997).

In a second step, all segments with Speech value were attributed an emotional code according to the linguistic content. Emotional autobiographical indicators were encoded according to three categories: Negative Emotion, Positive Emotion, and Neutral Condition. Each emotional category was defined by precise criteria: Negative Emotion corresponded to emotional indicators of sadness, psychological grief, physical and mental suffering, fear, aggressiveness and anger, anxiety, jealousy, disappointment, discouragement, and guiltiness. Example: "It hurts me" or "I suffer more from it." Positive Emotion corresponded to emotional indicators of happiness, feeling of well-being, tenderness, empathy, satisfaction, gratitude, and love. Example: "I'm very glad to be here" or "His speech comforted me." The Neutral Condition corresponded to the absence of emotional indicators in the speech. Example: "When I was young, I rode a bicycle with my cousin." The procedure encoded each autobiographic story into a sequence of symbols from a set of four possible ones: Silence, Neutral Condition, Positive and Negative emotion.

Analysis of Data

Symbolic sequences obtained for each subject were analyzed using both static and dynamic statistical indices. The Static Index of the symbolic sequences were characterized by the frequency for each of the four symbols, two emotional indicators, neutral condition and silence. Several dynamical indices were computed to quantify the temporal organization of the sequence of four symbols. Those indices belong to information theory (Shannon, 1948), symbolic dynamics (Badii & Politi, 1997), and stochastic methods (Gardiner, 2004).

Two levels of analysis were performed, a global level quantified the tem-

poral organisation of each sequence for every time scale and a local level quantified the probability of transition between two successive symbols.

The global quantification was performed using an index of randomness, namely, the Lempel-Ziv complexity, and the procedure of surrogate data testing (Schreiber & Schmitz, 2000). The Lempel-Ziv algorithm enumerates the new substrings appearing as a sequence evolves. The number of new substrings observed in the sequence divided by the number of symbols in the sequence gives an estimate of the sequence complexity, also called the LZ-entropy (Kaspar & Schuster, 1987). In a random sequence, all substrings can be produced so that its LZ-entropy is high although in a "more organized" sequence, the number of new substrings is reduced, leading to a lower LZ-entropy.

As it was of interest to investigate how the temporal structure contributes to this LZ-entropy, a preliminary step was to extract the influence of symbol statistical dispersion by computing LZ-entropy of surrogate data that retained only the dispersion contribution (Schreiber & Schmitz, 2000). The remaining part reflected the temporal organization. Thus, to test the presence of temporal structure in the experimental data, surrogate data testing was used. LZ-entropy values for all the experimental symbolic sequences were compared with those obtained for a set of 999 surrogate data (Schreiber & Schmitz, 2000) obtained by shuffling the experimental data in such a way that experimental and surrogate data shared the same symbol dispersion. Thus, the surrogate data shared the same number of symbols with the experimental data, but they depicted a random temporal structure. The experimental data were considered to depict a significant temporal structure if the number of surrogate data for which LZ-entropy was higher than that of experimental data greater than 950. This procedure corresponded to a one-sided bootstrap test with $p = .05$ statistical threshold.

The local quantification used the probability of transition from one symbol to another. Symbolic sequences were thus described by a matrix of probabilities quantifying transitions between symbols. In this study, a 4×4 matrix (T) was built whose elements were the conditional probabilities of transiting from one state to another.

Statistical Analysis

A Wilcoxon-Mann-Whitney nonparametric test which did not assume the data to be normally distributed was used to test whether the difference between the two groups was statistically significant (Siegel & Castellan, 1988).

Results

Methodological Validation

The encoding procedure was tested for interrater agreement. Five auto-

biographical narratives, out of a total of 27, were independently encoded by three clinical psychologists. Interrater estimates were based on κ-coefficients. The computed κ-coefficients (range from .80 to .88; $Mdn = .81$) were satisfactory by Fliess (1981) criteria.

Furthermore, the length of autobiographic speech did not differ ($U = 86.5$, $p = .83$) between the anorexia group ($M = 576$ symbols, $SD = 37.7$) and the control group ($M = 568$, $SD = 55.9$).

Static Analysis

The results of the static analysis are summarized in Fig. 1 and the results of the corresponding statistical tests are given in Table 1. The anorexia group was characterized by a higher frequency of Negative Emotional indicators and a lower frequency of Neutral ones. The anorexia group and control group did not differ regarding Positive Emotional indicators, while the anorexia group had a tendency to produce more Silences than the control group.

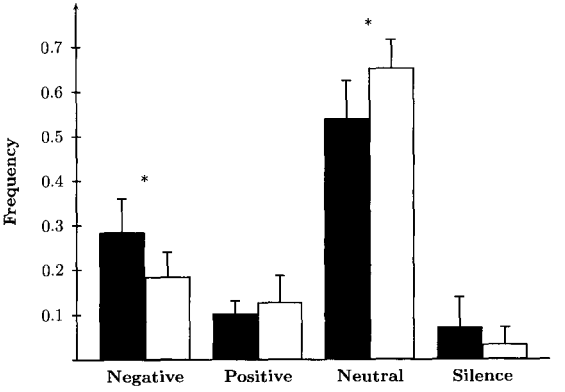

FIG. 1. Group-averaged frequencies of each emotional component for the Anorexia (patient) group (■) and the Control group (□). *SD* are depicted as vertical bars. Stars denote the statistically significant differences between groups.

Dynamic Analysis

Global level.—To examine the presence of a time structure, surrogate data testing was performed for each symbolic sequence on the basis of the Lempel-Ziv entropy. For 10 of 14 patients with anorexia nervosa and 7 of 13 control participants, the surrogate data test allowed rejection of the hypothesis of complete random sequence, i.e., independent and identically distributed symbolic sequences. These results thus suggested the presence of a significant temporal structure in the original data. Nevertheless, the proportion of hypothesis rejection did not differ significantly between the anorexia group and control group ($\chi^2 = 0.32$, $p = .58$).

TABLE 1
MEAN FREQUENCIES OF EMOTIONAL SYMBOLS AND MANN-WHITNEY *U* TESTS FOR COMPARISONS BETWEEN ANOREXIA ($n = 14$) AND CONTROL ($n = 13$) GROUPS

Emotional Symbol	Anorexia		Control		Mann-Whitney	
	M	*SD*	*M*	*SD*	*U*	*p*
Negative Emotion	.285	.076	.185	.056	24	.001
Positive Emotion	.103	.029	.128	.060	75	.437
Neutral Condition	.539	.087	.653	.064	26	.001
Silence	.072	.068	.034	0.39	52	.058

The LZ-entropy obtained for the anorexia group ($M = .726$, $SD = .072$) was significantly higher ($U = 34$, $p < .006$) than that of the control group ($M = .633$, $SD = .08$). This result indicated a higher randomness in the temporal organization of emotional indicators in the life stories of the anorexia group than those of the control group. These results were similar whether the whole group was taken into account or only the subjects for whom the surrogate data test was significant.

Since no difference was found between the LZ-entropy values for the surrogate data of each group (Anorexia group: $M = .941$, $SD = .032$; Control group: $M = .942$, $SD = .031$; $U = 86$, $p = .81$), differences between groups could be attributed to the temporal organization of the speech and not only to the frequency of each symbol.

Local level.—The analysis of the transition matrix showed significant

TABLE 2
TRANSITION MATRIX: GROUP-AVERAGED PROBABILITIES OF TRANSITION FOR ANOREXIA ($n = 14$) AND CONTROL ($n = 13$) GROUPS

Emotional Symbol	Anorexia		Control		Mann-Whitney	
	M	*SD*	*M*	*SD*	*U*	*p*
Negative–Negative	.390	.083	.285	.099	40.0	.01
Negative–Positive	.068	.024	.115	.062	47.0	.03
Negative–Neutral	.479	.080	.577	.083	39.0	.01
Negative–Silence	.054	.053	.016	.020	39.0	.01
Positive–Negative	.213	.069	.175	.064	66.0	.22
Positive–Positive	.257	.094	.262	.119	88.5	.90
Positive–Neutral	.486	.103	.554	.127	59.0	.12
Positive–Silence	.058	.054	.027	.023	56.0	.08
Neutral–Negative	.264	.074	.169	.063	32.5	.01
Neutral–Positive	.086	.016	.115	.062	78.5	.54
Neutral–Neutral	.593	.076	.708	.092	27.0	.001
Neutral–Silence	.050	.050	.023	.016	53.5	.07
Silence–Negative	.162	.095	.070	.092	38.0	.01
Silence–Positive	.107	.260	.048	.087	75.0	.44
Silence–Neutral	.471	.229	.662	.227	48.5	.04
Silence–Silence	.257	.217	.198	.201	76.5	.48

differences in the patterns of dynamic transitions for the anorexia group versus the control group (Table 2 and Fig. 2). Negative Emotions for the anorexia group were significantly more likely to be followed by another Negative Emotion or a Silence, and significantly less likely to be followed by a Positive or a Neutral emotion than in the control group. Moreover, Silence and Neutral indices were more likely to be followed by a Negative Emotion in the anorexia than in the control group. The anorexia group was characterized by recurrent cycles of Negative Emotion and cycles of Negative Emotion and Silence.

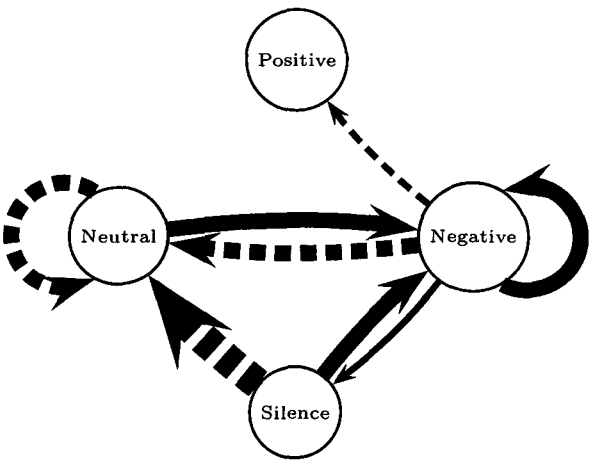

FIG. 2. Transitions which differ significantly between groups: Anorexia group < Control group (– –) and Anorexia group > Control group (—)

DISCUSSION

Static analysis of linguistic indicators of emotion in autobiographical speech of patients with anorexia nervosa showed a higher frequency of negative emotion expression and a lower frequency of neutral expressions than in the autobiographic speech of control participants. Dynamical analysis points at a specific temporal organization of linguistic indicators of emotion in the autobiographical narratives of patients with anorexia nervosa. These results support the idea of an impairment of the emotion expression characterized by a perseveration of negative emotional states in people with anorexia nervosa.

Facilitation of Expression of Negative Emotion

Analysis showed a higher representation of negative emotions and a lower representation of positive and neutral ones in the autobiographical speech of patients with anorexia nervosa. These results suggested that the distur-

bance of emotional expression in patients with anorexia nervosa did not correspond to a deficit in the expression of negative emotions as suggested by alexithymia studies which have reported an inhibition in the expression of negative emotions (Sohlberg & Strober, 1994; Geller, *et al.*, 2000; Dalgleish, *et al.*, 2003), or a global deficit affecting the whole spectrum of emotional experiences (Taylor, Bagby, & Parker, 1991; Laquatra & Clopton, 1994; Taylor, *et al.*, 1996; Rastam, *et al.*, 1997). Nevertheless, these studies used global quantitative tools which do not allow the assessment of spontaneous emotional expression in ecological situations and analysis of the relation between narration and emotion. These measures can thus be considered static snapshots of the dynamical evolution of emotional states specifically addressed in this study. Considering alexithymia as an adaptive process resulting from earlier negative experiences (Taylor, *et al.*, 1996; Pierrehumbert, *et al.*, 2002), these results suggest that negative experiences are still accessible as observed through an abnormal focalisation on negative affect in autobiographical narratives. Since free autobiographical speech promotes introspection and can facilitate the expression of negative emotions, the findings led to the conclusion that emotional indicators in speech and subjective representation of emotional expression are two complementary and noninterchangeable measures of emotion processing.

Disturbance in Temporal Regulation of Negative Emotional States

The analysis of the LZ-entropy index suggests that the global temporal structure of linguistic indicators of emotion is more random in patients with anorexia nervosa than in control participants. There is then a global disorganization of emotional expression in autobiographical narratives of anorexic patients.

Frequency of transitions to negative emotional states increased and suggest the presence of negative emotional recurrence in the autobiographical speech of patients with anorexia nervosa. Negative emotions were associated with following silences in patients with anorexia nervosa. These observations were concordant with the results of studies on set shifting which indicated the presence of cognitive perseverations in patients with anorexia nervosa (Tchanturia, *et al.*, 2004, 2005). These results support the assumption of difficulties in patients with anorexia in shifting attention from negative emotions. The cognitive perseverations classically observed in anorexia nervosa on attentional and memory tasks could be generalized to emotional expression. Thus, the hallmark of such disturbances appeared in the temporal succession of the linguistic expression of emotion. Perseverations of negative emotions were developed and maintained through recurrent cycles of negative/negative and negative/silence emotional transitions. This impairment in the regulation of negative emotions could contribute to poor interpersonal

communication, to lower adaptability to new contexts (Keltner & Kring, 1998; Gross, 1999), or to change in pattern of response (Dodin & Nandrino, 2003).

These findings may have important implications for psychological treatment of anorexia nervosa. First, the results suggest that therapeutic interventions should deal with both the emotional content of narratives and the temporal succession of the expressed emotions. The interventions of a clinical practitioner could be directed towards a perturbation of the emotional dynamic to develop the self-regulation of negative emotional states. In particular, such intervention should focus on reducing negative emotional perseveration and increasing flexibility. Since the major difference between patients and control groups has been found in the transition between negative emotion and neutral states, the therapeutic interventions could help regulate emotional expression by facilitating the transitions towards neutral states. These suggestions, which are not directly intuitive, indicate the importance of quantitative analysis of the dynamics of emotional expression as a complement of its static description.

This study has shown that the dynamics of emotions expressed in autobiographical narratives can be quantified by nonlinear time-series analysis methods. Thus, the dynamics of emotions were described both on a short-time scale, i.e., a local analysis which corresponded to relations between emotional states, and also for the whole sequence, i.e., a global level which corresponded to the global temporal organisation. Although linguistic indices are only an indirect measure of emotional states, the characterization of their dynamics appears to be a powerful index of healthy and pathological autobiographical narratives. Indeed, it suggests that temporal organization of emotional states can be specific to mental activities and that disturbances in emotional processes can be observed in the temporal organization of linguistic indicators. Directions for research would involve analyzing whether these characteristics of autobiographical narration are permanent or episode-dependent and to study such life stories in anorexic patients after recovery.

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Accepted July 16, 2007.