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Biofeedback treatment in patients with refractory epilepsy: Changes in depression and control orientation

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Depression is a common and serious interictal problem in patients with epilepsy. The genesis of depressive disorders is multifactorial. One aetiological aspect focuses on psychosocial factors. It was hypothesized that uncontrollable, unpredictable chronic aversive events (i.e. epileptic seizures) result in cognitive deficits of *external* control orientation. If this is true, biofeedback training could represent a possible treatment strategy to lower depression, because biofeedback is known to mediate success experiences and control. Measures of depression and locus of control were administered to 20 patients with refractory partial epilepsy before and after biofeedback treatment. The biofeedback consisted of slow cortical potentials or breathing parameters in 10 patients each. A clear relationship occurred between depression and locus of control in the subjects. After biofeedback training control orientation moved towards a more internal locus of control. Also, depression scores were significantly reduced six months after training. Results show that in patients with refractory epilepsy depression is highly correlated with locus of control, in a way that external control orientation relates to high depression scores. Biofeedback is able to improve internal control orientation through personal success mediation.

Key words: epilepsy; biofeedback; self-control; depression; control; orientation.

INTRODUCTION

Depression is known to be a frequent and clinically relevant interictal condition in patients with epilepsy[1]. The suicide rate in these patients is also higher in relation to the general population[2]. Aetiological factors for depression include biological, pharmacological and psychosocial variables. It was hypothesized, that epilepsy, like all chronic disorders with episodic, but unpredictable manifestations (e.g. asthma) alters the patients perceived status of control[3]. Control or lack of control therefore possibly represents one risk factor for depression in patients with chronic epilepsy, because epileptic seizures are uncontrollable, unpredictable aversive events[4,5]. In epilepsy research two related concepts have been discussed with depression rates in epileptic patients: Seligman's concept of learned helplessness[6,7] and Rotter's locus of control construct[8]. Seligman hypothesized that exposure to uncontrollable, unpredictable aversive events result in a generalized pattern of cognitive, emotional and motivational deficits, called 'learned helplessness'. These deficits may result in depression, if the personal attributional style is pessimistic, meaning explanations for good events are attributed to external, acute and specific causes, bad events are attributed to internal, and global causes. Rotter's construct of control orientation comprises an external and internal locus of control. External locus of control is the generalized belief that powerful others, chance or fate determine important life events more than the person himself. Internal locus of control is the generalized belief of personal control over important life events with options to act.

Biofeedback methods on the other hand, mediate control and success through its direct and objective feedback. Meichenbaum[9] stated a cognitive theory of self-control for biofeedback methods. He postulated three steps of cognitive-behavioural modification during biofeedback treatment: In the initial conceptualization phase, the patient must become an observer of his behaviour and physiological reactions. These recognitions then become in a second step a stimulus to restructure cognitions and behaviour in the training phase. After this cognitive change, specific treatment effects become generalized and long-term treatment success in the final transfer-to treatment phase. Biofeedback methods therefore might be superior to other psychological treatment methods in some aspects. First, control is mediated implicitly through success experiences and not verbal cognitive,

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and also feedback is quantitatively scaled and therefore an objective measure for patients. Little steps can be described as a great success and failure can be disguised. Also, the fact that complex equipment is necessary makes the method very 'professional' for patients[10]. If depression and control orientation are related, and control orientation is internalized through biofeedback treatment, biofeedback should result in improved internal control orientation and less depression in epilepsy patients. Figure 1 depicts this model.

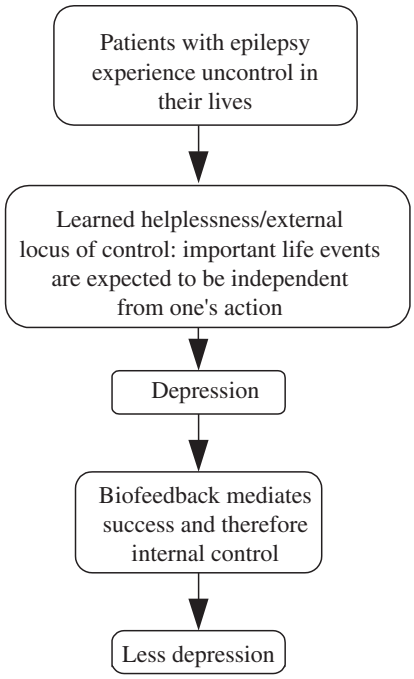

Fig. 1: Model of the relation of depression, control orientation and biofeedback in patients with refractory epilepsy.

The purpose of this study was to confirm the relationship of depression and control orientation in medically intractable patients with epilepsy, and to examine changes in depression and control orientation obtained through biofeedback treatment.

METHODS

Twenty patients with refractory epilepsy were examined. Mean duration of epilepsy was 25.5 years (standard deviation (SD) 11.9 years). Patients mean age was 38.5 years (SD 10.1), 70% currently take, or had taken, at least one of the new AEDs, and only 30% had a regular full-time job. Fifty-five per cent had a higher education level, and mean full-scale IQ was 96.7 (SD 12.7).

Two different biofeedback methods were administered to the epilepsy patients, with 10 patients in each biofeedback method: respiration feedback, a methodology first described as a useful methodology in seizure reduction by Fried *et al.*[11] and feedback of slow cortical potentials (SCP), developed by Birbaumer *et al.*[12] and Rockstroh *et al.*[13] Biofeedback treatment with each method consisted of the study of 35 feedback sessions within 3 months. In respiration feedback each training session lasts 10 minutes. Patients have a respiration gas analyzer in front of their seat as demonstrated in Fig. 2. A sample tube is below the nostrils, and connected to the gas analyzer. An online readout of the actual end-tidal carbon dioxide ($ETCO_2$) and respiration rate is shown on the gas analyzer. Patients are asked to produce a specific respiratory pattern with an $ETCO_2$ higher than 5%, and a respiration rate lower than 15 breaths per minute. A complete description of our application of the method has been published elsewhere[14].

In the feedback of slow cortical potentials, each training session consists of 145 trials, with one trial lasting 8 seconds. A letter (A or B) is presented with a stylised rocket ship, whose movements indicate the actual amplitude of slow cortical potentials (see Fig. 3). The letter A indicates the task to produce negative shifts, the letter B indicates positive shifts. Rocket movements to the right show potential shifts in the required direction. A change of $+10\ \mu$V represents the goal of the task in positive shifts, a change of $-15\ \mu$V is the goal in negative shifts. One session lasts about 1 hour. For a detailed application protocol in our department see Uhlmann and Fröscher[15].

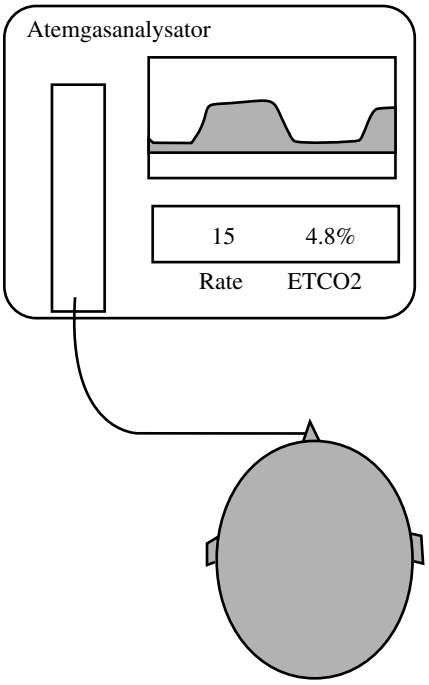

Fig. 2: Feedback of respiration rate and End-Tidal-CO_2. Respiration gas analyzer in front of patient with online readout. A sample tube below the patient's nostrils is connected to the analyzer.

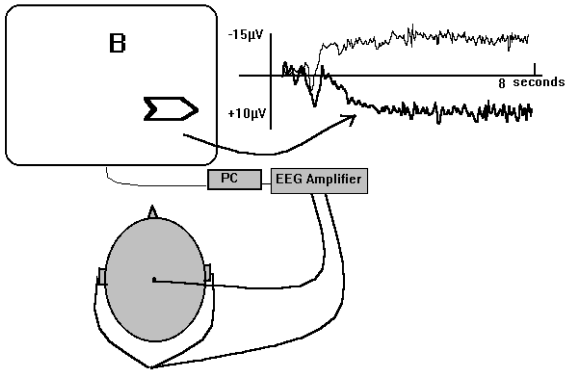

Fig. 3: Biofeedback of Slow Cortical Potentials. A letter (A or B) is presented with a stylized rocket ship, whose movements indicate the actual amplitude of slow cortical potentials. The letter A indicates the task to produce negative shifts, the letter B indicates positive shifts. Rocket movements to the right show potential shifts in the required direction.

The Beck Depression Inventory (BDI)[16] was given to the patients before biofeedback treatment and 6 months after the end of biofeedback training. The Fragebogen zu Kompetenz- und Kontrollüberzeugung, FKK[17]—an advanced German version of Levenson's IPC scales[18]—was administered before biofeedback treatment, immediately after 3 months of biofeedback and at 6 months follow up. Primary scales in the FKK on the external dimension are personal others control and chance control. The secondary scale 'external control orientation' is defined as the generalized belief that powerful others, chance or fate determines important life events more than the person himself. The other secondary scale 'internal control orientation' or self-efficacy, is measured by the two primary scales internality and self-concept, and is defined as the generalized belief of personal control over important life events with options to act. The full scale of the FKK then is defined as the generalized internal versus external control orientation.

RESULTS

1. Relation of depression and control orientation

Spearman rank correlations (R) were calculated between BDI and FKK scores before biofeedback therapy. As indicated in Table 1, there existed a strong relationship between depression and control orientation in the 20 patients. High depression scores were positively related to high external control ($R + 0.49$), i.e. powerful others control ($R + 0.35$) and chance control ($R + 0.40$) in the primary scales, whereas high scores in self-concept ($R - 0.44$), and therefore internal control orientation ($R - 0.40$) were negatively connected to depression.

Table 1: Spearman rank correlations of depression scores and control orientation scores. FKK = Fragebogen zu Kompetenz- und Kontrollüberzeugung, a German version of Levenson's IPC scales.

FKK scales	Spearman rank correlations with BDI
Primary scales	
Self-concept (SC)	$-$ **0.44**[a]
Internality (I)	-0.12
Powerful others control (P)	$+0.35$
Chance control (C)	$+0.40$
Secondary scales	
Internal control orientation (SCI)	-0.40
External control orientation (PC)	$+$**0.49**[a]
Full scale	
Control orientation	$-$**0.50**[a]

[a] Significant at $P < 0.05$, $n = 20$.

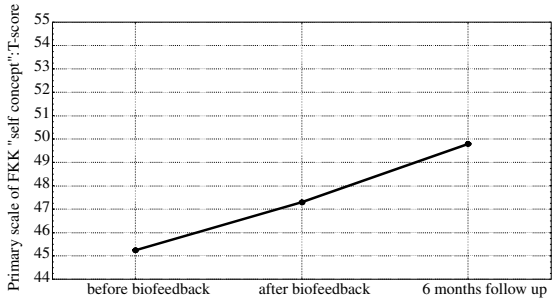

Fig. 4: Changes in the FKK primary scale 'self-concept' after biofeedback. Improved self-concept after biofeedback treatment.

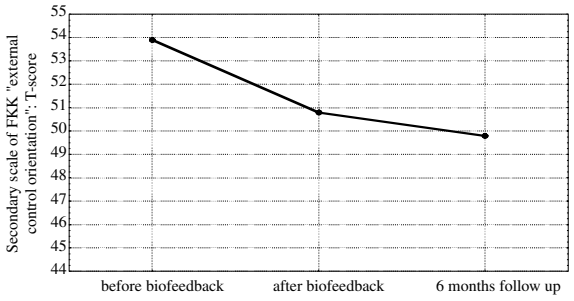

Fig. 5: Changes in the FKK secondary scale 'external control orientation' after biofeedback. Reduction of external locus of control.

2. Changes after biofeedback therapy

Mean depression rates before biofeedback in 20 patients were 10.50 (SD 7.9). The depression scores dropped significantly to a BDI score of 7.65 (SD 7.0) 6 months after biofeedback treatment ($T = 2.41$, df $= 19$, $P < 0.026$).

Mean T-scores of the 20 patients in the variable control orientation, as measured by the FKK, also showed changes over time. The primary scale 'self-concept'

increased significantly from a T-score of 45.25 before treatment to 47.30 directly after biofeedback, and was even higher 6 months after feedback training with 49.80, over all 20 patients (see Fig. 4, repeated measures ANOVA, $F(2, 38) = 3.16$, $P < 0.054$).

As shown in Fig. 5, T-scores of external control orientation, a secondary scale of the FKK, consisting of powerful others control and chance control, decreased significantly over time with T-scores from 53.9, over 50.8 to 49.8 over all 20 patients (repeated measures ANOVA, $F(2, 38) = 3.22$, $P < 0.051$).

Finally, Fig. 6 depicts changes in control orientation with the two biofeedback groups considered separately. A oneway repeated measures ANOVA reached statistical significance for the respiration feedback group ($F(2, 18) = 3.88$, $P < 0.04$), but not for the group of slow cortical potentials ($F(2, 18) = 0.37$, $P < 0.69$). In a repeated measures ANOVA with the factor feedback group, there existed no significant interaction between the factors feedback group and time in the full scale of control orientation. At the same time, there existed a significant main effect in the factor feedback group ($F(1, 18) = 6.10$, $P < 0.024$), indicating a difference between the two feedback groups and a marginal significant main effect over time ($F(1, 18) = 2.92$, $P < 0.067$).

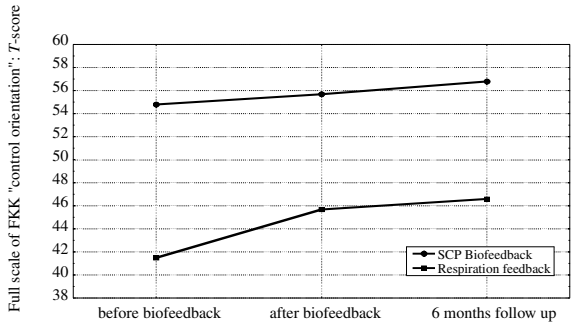

Fig. 6: Changes in the FKK full-scale 'control orientation' after biofeedback. Full-scale control orientation is defined as internal vs. external control orientation. Higher T-score means more internal control. SCP = slow cortical potentials.

DISCUSSION

The relationship between depression and control orientation was confirmed in this study. In patients with refractory epilepsy, depression rates seem to be highly correlated with control orientation. High external control orientation, with the expectation that other people or chance determines one's life, is related with more depressive symptoms, whereas a positive and stable self-concept is connected to less depression. It must be pointed out that the scores represent only a correlational view. This means that there is no proof for determinants, but control orientation serves at least as a stabilizing factor in depression.

Biofeedback was indeed able to reduce depression and also to internalize control orientation in this study. Patients self-concepts improve after biofeedback treatment, meaning they expect generally more options in life, and the belief of external control of powerful others and chance decreases. This might be due to success experienced during the biofeedback treatment which leads to generalized restructured cognitions about the illness.

Therefore biofeedback not only reduces seizures[11, 13, 14, 19, 20], but is a psychotherapeutic method in patients with epilepsy. Respiration feedback might be superior to feedback of slow cortical potentials in initiating internal control. It has to be stressed, however, that T-scores of internal control measures before treatment were significantly lower in the respiration group in comparison with the feedback group of slow cortical potentials. Patients with low internal control orientation might profit the most from biofeedback treatment in terms of depression and locus of control.

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