Effect of respiratory feedback on the breathing pattern and on psychophysiological measures of relaxation

Gerhard Strauss-Blasche, Herbert Redtenbacher, Christian Zniva, & Wolfgang Marktl

In K.W. Kallus & N. Posthumus (Eds.), Current psychological research in Austria (pp. 27-30). Graz: Akademische Druck- u. Verlagsanstalt, 2001.

Der Effekt von Atembiofeedback auf das Atemmuster und auf psychophysiologische Entspannungsindikatoren

Das Ziel der Arbeit war zu prüfen, inwieweit Atembiofeedback ein wirksames Instrument zur Veränderung des Atemmusters und der Entspannung darstellt. Dazu wurde bei 10 Versuchspersonen 4 Sitzungen bestehend aus einer Baseline, einer Einatemfeedback (EF)- und einer Ausatemfeedbackphase (AF) in wöchentlichem Abstand durchgeführt. Das Feedback war ein angenehmer Ton, der jeweils während des Ein- oder Ausatmens vorgegeben wurde. In der ersten Sitzung war das AF von einer geringeren Atemfrequenz, einer längeren Ausatemdauer und einer höheren subjektiven Entspannung begleitet als das EF. In der 4 Sitzung führte das AF zu einem höheren Atemzeitverhältnis (E/A) und einem geringen Hautleitwert, jedoch zu einer geringeren subjektiven Entspannung. In der ersten Sitzung wurde überdies die eigene Atmung beim AF als angenehmer erlebt als beim EF. In Summe zeigen die Ergebnisse, daß Atemfeedback zu einer erwartungsgemäßen, aber über mehrere Sitzungen nur mäßig stabile Veränderung des Atemmusters und der Entspannungslage führt.

Introduction

Respiratory phases are closely related to different modes of activation. Physiologically, inspiration is associated with muscular tension, vagal blockade and sympathetic arousal, whereas expiration is associated with muscular relaxation and vagal activation (Strauss-Blasche, Moser, Voica, McLeod et al., 2000). There is evidence that during states of relaxation the expiration time and the end expiration pause tend to be lengthened (Boiten, Frijda & Wientjes, 1994). Also, prolonged expiration as compared to prolonged inspiration has been found to reduce physiological and psychological arousal during a stressful task (Cappo & Holmes, 1984). On the other hand, voluntary control of breathing has been found to increase sympathetic arousal and decrease vagal outflow compared to spontaneous breathing (Patwardhan, Vallurupalli, Evans, Bruce et al., 1995), indicating that a method indirectly altering respiration might be advantageous.

The aim of the present study was to evaluate whether the respiratory pattern, especially expiration and inspiration times, could be manipulated indirectly using respiratory biofeedback selectively reinforcing the expiration phase.

Additionally, possible effects of the feedback procedure on physiological and psychological measures of relaxation were to be tested.

Method

Ten healthy subjects (3 females, 7 males, mean age 25.2 ± 1.8 years) participated in the study. They underwent 4 experimental sessions within a time span of several weeks. A session consisted of a 10 minute baseline and two 15 minute respiratory feedback trials. During the feedback trials, a pleasant triad was presented by loudspeaker either during inspiration or during expiration while subjects were sitting in a comfortable recliner. The sequence of the trials was alternated form session to session. The equipment used was a SOFT biofeedback system from Insight Instruments, Vienna. Feedback was generated by the RELAX software application. The respiratory measures take were inspiration time, expiration time (including the expiration pause), respiration rate, respiratory time ratio (expiration time/inspiration time = E/I), skin conductance level (= SCL), heart rate, and finger temperature. All measures were generated by the SOFT biofeedback equipment. Trial averages were used for further analysis after eliminating artefacts. Subjects scaled subjective relaxation and evaluated the feedback mode on 10 point Likert scales after each trial. Additionally, they described their breathing during the trial with 10 adjective pairs. Differences between trials were calculated for the first and fourth trial using paired t-tests.

Results

As can be seen in table 1, differences did occur between the two forms of respiratory feedback. In the first session, respiration rate was lower and expiration time longer when expiration was reinforced by a pleasant tone than in the trials where inspiration was accompanied by this sound. In the fourth session, these differences had vanished, but the respiratory time ratio (expiration / inspiration) was significantly larger in the expiration tone trial than in the inspiration tone trial, primarily due to differences in the inspiration time. Reinforcing expiration did not change the breathing pattern in comparison to baseline, whereas reinforcing inspiration did, at least numerically, as can be seen in a decrease of expiration time and an increase in respiration rate in trial 1. In trial 4 differences to baseline were even less pronounced. This indicates that especially the reinforcement of inspiration was successful in altering the breathing pattern but this effect was only partially stable over repeated sessions. A decrease of respiration rate or an increase of expiratory time in comparison to baseline could not be achieved.

In regard to the measures of relaxation, reinforcing expiration was found to induce more subjective relaxation than reinforcing inspiration in the first session. Subjects in the prior trial also felt more relaxed than during baseline (table 1). This difference changed to the opposite in the forth session, subjects whose expiration was reinforce feeling less relaxed. Based on the physiological measures, subjects showed a tendency to be more relaxed during the reinforcement of expiration than inspiration, the skin conductance level in the inspiration condition being higher than in the expiration condition in session 4 (table 1). But again, except for the initial subjective level, reinforcing expiration was not superior to baseline in inducing relaxation.

Table 1: *Mean values (standard deviation) of respiratory and relaxation measures during baseline, reinforced inspiration and reinforced expiration for session 1 and 4. Significant differences (p<.05) between the three trails are indicated accordingly.*

	session 1				session 4			
	base (1)	insp ! (2)	exp ! (3)	sign	base (1)	insp ! (2)	exp ! (3)	sign
resp. rate	11.6 (4.3)	12.8 (4.8)	11.6 (4.8)	2-3	12.7 (4.3)	12.6 (4.1)	12.8 (4.5)	ns
E/I	2.1 (0.4)	1.9 (0.4)	2.1 (0.3)	ns	2.3 (0.4)	2.1 (0.5)	2.5 (0.5)	2-3
insp. time	1.9 (0.6)	1.9 (0.9)	2.0 (0.9)	ns	1.6 (0.5)	1.8 (0.8)	1.5 (0.4)	ns
exp. time	4.0 (1.6)	3.6 (1.6)	4.1 (1.8)	2-3	3.6 (1.2)	3.6 (1.3)	3.7 (1.3)	ns
SCL	2.2 (1.8)	2.6 (2.2)	2.2 (1.4)	ns	2.0 (2.2)	2.8 (2.3)	2.3 (2.3)	1-2
hand temp.	29.9 (3.6)	29.3 (3.8)	29.9 (3.3)	ns	30.2 (3.8)	30.2 (3.7)	30.4 (3.3)	ns
heart rate	70.9 (16)	68.3 (15)	68.8 (13)	ns	66.8 (12)	65.6 (13)	66.2 (12)	ns
subj. relax.	6.9 (1.4)	7.1 (1.7)	8.2 (1.3)	2-3;1-3	7.1 (1.6)	7.6 (1.6)	6.6 (1.8)	2-3

Additionally to the measures of relaxation, the subjective quality of breathing was assessed with adjective pairs (figure 1). Breathing during reinforced expiration was perceived as more pleasant (p<.01) and slower (p<.07) than during reinforced inspiration in session 1. In session 4, differences between the two biofeedback modes could not be found in regard to breathing quality.

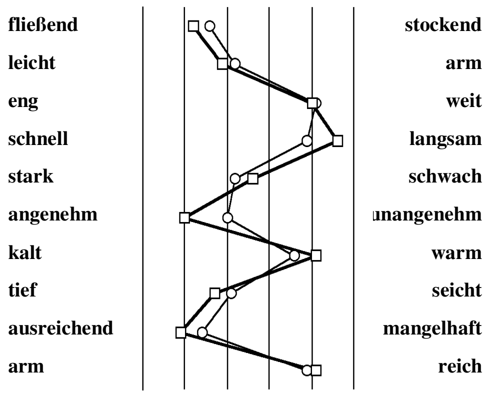

Figure 1: *Subjective evaluation of breathing at session 1 for reinforced inspiration (O) and reinforced expiration (□) always below pictures*

Discussion

The study sought to evaluate the effect of respiratory feedback using the RELAX application from the SOFT biofeedback system as a method for indirectly altering the breathing pattern and thereby the state of relaxation. In the first session, subjects showed lower respiration rates, longer expiratory times and greater subjective relaxation in the expiration feedback trial than in the inspiration feedback trail, but differences to baseline could only be found in subjective relaxation. On the other hand, Zeier (1984) found respiratory feedback to decrease heart and respiration rate compared to a music relaxation trial without feedback. Our failure to find differences to baseline heart and respiration rate remains unclear, but might be due to a less effective respiratory feedback compared to Zeier (1984), or to the relative low resting respiration rate levels.

In the fourth session the results pertaining to respiratory feedback are somewhat conflicting. Although respiration rates are similar for all three trials, expiration feedback is accompanied by a lower E/I ratio and lower SCL but less subjective relaxation than inspiration feedback. This indicates that a repeated application of respiratory feedback does not necessarily lead to comparable effects and that expiratory feedback may loose its relaxing qualities for the individual, at least on a subjective level. This result is again at variance with other research indicating a beneficial effect of repeated sessions of respiratory feedback on mood and blood pressure (Frank, Schafer, Stiels, Wassermann et al., 1994). The reason for this discrepancy may be that we used a more stringent design, comparing two different feedback modes, whereas Frank et al. (1994) compared feedback to a non-treatment control.

In sum, it seems that although respiratory feedback initially changes respiratory patterns in the predicted way, the effects are neither very large nor stable. Therefore, respiratory feedback in the adopted form does not seem to be an alternative to the voluntary control of breathing to alter respiratory patterns. In regard to relaxation, expiration feedback is more beneficial than inspiration feedback but did not seem to have a great advantage compared to a non-feedback control trial.

References

Boiten, F.A., Frijda, N.H. & Wientjes, C.J.E. (1994). Emotions and respiratory patterns: review and critical analysis. International Journal of Psychophysiology, 17, 103-128.

Cappo, B.M. & Holmes, D.S. (1984). The utility of prolonged respiratory exhalation for reducing physiological and psychological arousal in non-threatening and threatening situations. Journal of Psychosomatic Research, 28 (4), 265-273.

Frank, M., Schafer, H., Stiels, W., Wasserman, R., Herrmann, J.M. (1994). Relaxation therapy with respiratory feedback in patients with essential hypertension. Psychotherapie, Psychosomatik, Medizinische Psychologie, 44, 316-322.

Patwardhan, A.R., Vallurupalli, S., Evans, J.M., Bruce, E.H. & Knapp, C.F. (1995). Override of spontaneous respiratory pattern generator reduces cardiovascular parasympathetic influence. Journal of Applied Physiology, 79, 1048-1954.

Strauss-Blasche, G., Moser, M., Voica, M., McLeod, D.R., Klammer, N., Marktl, W. (2000). Relative timing of inspiration and expiration affects respiratory sinus arrhythmia. Clinical and Experimental Pharmacology and Physiology, 27, 601-606.

Zeier, H. (1984). Arousal reduction with biofeedback-supported respiratory meditation.. Biofeedback and Self Regulation, 9, 497-508.