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Beneficial Effects of Accurate and False Brief Biofeedback on Relaxation

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Summary

Much research has focused on the efficacy of biofeedback therapy; however, previous studies only compared biofeedback treatment with no-treatment conditions or using pre- and post-test data. Examination of biofeedback relaxation therapy with a false-feedback condition could produce data on physiological changes suitable to clarify findings. Sixty-three participants were randomly assigned to either an accurate or a false feedback condition for a five-minute period. Analysis of the measures yielded significant differences in both groups between pre- and post-tests, but not between-groups, suggesting a potential placebo effect of biofeedback induced relaxation. Implications and limitations are discussed.

The use of biofeedback methods in psychotherapy has become increasingly widespread since the development of the technology. Researchers have reported beneficial effects of biofeedback in treating people with some forms of epilepsy (Lubar, 1998), anxiety disorders (Wenck, Leu & D'Amato, 1996), panic disorder (Meuret, Wilhelm, & Roth, 2004), temporomandibular disorders (Mishra, Gatchel, & Gardea, 2000), and hypertension (Overhaus, Ruddell, Curio, Mussgay, & Sholz, 2003). Although these studies included comparison or control conditions, few studies examined the possibility of a placebo effect, so in this study a pretest-posttest design was used to compare the effects of accurate and false biofeedback on relaxation.

Despite the effectiveness of biofeedback, some researchers have not reported higher efficacy for biofeedback. Eppley, Abrams, and Shear (1989) reported similar effect sizes for relaxation training regardless of whether biofeedback or other relaxation methods were utilized. Niemann, Pratt, and Maughan (1993) stated that biofeedback and music induced relaxation were equally efficacious in a treatment of performance-related anxiety. Watson, Tuorila, Vickers, Gearhart, and Mendez (1997) found simple progressive relaxation training while sitting in a comfortable chair as effective as biofeedback for treating Vietnam-era PTSD veterans.

In summarizing the very broad psychotherapy literature in this area, Joyce and Piper (1998) estimated that expectancy or a placebo effect probably accounts for approximately 15% of the treatment outcomes. Few researchers have actually compared biofeedback with a clear placebo. Gatchel (1979) found that accurate heart rate biofeedback was more effective than false heart rate biofeedback when treating speech anxiety, but the false feedback group still experienced less anxiety than a control group. Given the paucity of literature on expectancy

effects in biofeedback studies, a comparison of accurate with false biofeedback on relaxation seemed worth exploration. The hypothesis was specified as accurate and false biofeedback would be equally effective in producing a relaxation response. Participants were expected to be more relaxed following brief biofeedback but accurate feedback would be no more effective on measures than false feedback.

Method

Participants

Participants were volunteers from psychology classes at a small midwestern university. Their ages ranged from 18 to 34 years ($M = 19.3$, $SD = 2.4$). The sample included 63 participants, 10 men and 53 women. The ratio of men to women was not atypical for the population of the university. Many participants received extra credit in undergraduate courses for their participation.

Apparatus

Two laptop computers were used, one for recording the actual biofeedback information, the other for playing back prerecorded false biofeedback information. The Thought Flex ProComp+ biofeedback equipment was used, using the surface electromyography (EMG), electrodermal response (GSR), blood volume pulse, and surface temperature sensors. These methods were selected because previous research indicated they are indicative of relaxation (e.g., Lee & Olness, 1996). Manufacturer's instructions were followed to place the EMG: positive and negative leads were placed above the right eye and the ground lead was placed on the left earlobe. Electrodermal leads were placed on the index and middle fingers of the participant's self-reported dominant hand. The surface temperature sensor was placed on the middle finger of the nondominant hand. The blood volume pulse sensor was placed on the thumb of the

nondominant hand. The Stens MultiTrace biofeedback software suite was used to present the visual stimulus, which was the Stress Profile preset screen layout that simultaneously displayed all four readings.

Materials

In addition to demographic information, self-report ratings were collected using three one-item measures before and after the procedure. The items asked participants to rate their current stress, physical relaxation, and mental relaxation. All three items were rated on an analogue scale of 0 to -10, with -10: Most Relaxed and 0: Most Stressed.

Procedure

One of two investigators met each participant on entering the campus counseling lab. The participants were randomly assigned to receive either accurate or false biofeedback. In a small room, which contained the biofeedback equipment, a monitor, and a comfortable chair, the participant gave informed consent. Next, pretest data were collected, which consisted of the analogue scales on current stress, physical relaxation, and mental relaxation. Next, leads and sensors were attached to the participant. The investigator then monitored the data collection from an enclosed area not visible to the participant. Finally, participants were instructed by prerecorded instructions on what the biofeedback display would show. They were asked to relax as best they could, and that as they relaxed, their physiological data would be recorded, and the direction of change for each display during relaxation was explained. Each participant was given five minutes of biofeedback (accurate or false). A five-minute session was selected for several reasons: the economy of time, because participants had to complete the informed consent process, be connected to and calibrate the equipment, fill out the pretest measures and posttest measures, and the actual session. The session took around 30 minutes per person including the

five-minute relaxation session. Although a full relaxation response might well take most people longer than five minutes, the goal of this experiment did not require eliciting a full relaxation response, nor was the intention of this experiment to determine whether biofeedback relaxation would lead to a fully relaxed state. Rather, the interest was in the relaxation during the five-minutes was different when accurate and false feedback was given. At the end of the session, the investigator removed the leads and sensors and collected the posttest ratings. Following the collection of all data, the experimenter provided a debriefing. The Institutional Review Board approved these procedures, and all participants were treated in accordance with APA ethical standards.

Results

Repeated measures analyses of variance were used to test our primary hypothesis that biofeedback would be effective. See Table 1 for pre- and posttest means and standard deviations on each of the measures recorded pre- and posttest. For the physiological data, EMG readings decreased significantly at posttest ($F(1, 55) = 3.68, p = .03, r^2 = .06$), as did heart rate ($F(1, 60) = 3.91, p = .03, r^2 = .06$), electrodermal/galvanic skin response ($F(1, 60) = 37.15, p < .01, r^2 = .38$), and temperature ($F(1, 60) = 17.60, p < .01, r^2 = .23$). For self-rated relaxation, the overall stress rating did not significantly decrease ($F(1, 60) = 1.24, p = .27, r^2 = .02$), but both the perceived state of physical relaxation ($F(1, 60) = 9.623, p < .01, r^2 = .14$), and the perceived state of mental relaxation ($F(1, 60) = 8.49, p = .01, r^2 = .12$) were significantly higher.

Next, the relative effectiveness of accurate and false biofeedback was compared using a one-way multivariate analysis of covariance to examine the effects of experimental group (accurate, false biofeedback) on physiological measures adjusted by using pretest values as covariates. There were no significant differences for type of feedback (Wilks' $\lambda = .964, F(4, 48)$

$= .45, p = .78, \eta^2 = .04$). Similarly, there were no differences between accurate and false biofeedback on self-rated measures (Wilks' $\lambda = .91, F(3, 55) = 1.74, p = .17, \eta^2 = .09$). The possibility that the omnibus multivariate tests may have masked individual differences on selected measures was checked by inspection of the individual analyses of covariance which yielded no significant differences ($p > .05$) between the accurate and false biofeedback conditions.

Discussion

Overall, the brief five-minute biofeedback was effective in helping participants experience some relaxation. The analyses show beneficial effects on two of three subjective ratings and on all physiological measures for both accurate and false biofeedback. This supports the first hypothesis. The second hypothesis that accurate and false biofeedback would be equally effective was also supported.

It is not clear why participants did not report a change in ratings of perceived stress despite reporting perceived changes in mental and physical relaxation. One explanation could be that self-reported stress was too broad in comparison with more specific questions. The positive changes for self-reported mental and physiological relaxation along with changes in the physiological measures suggest that participants were attuned to their changed physiological state.

These findings are consistent with previous research that under certain conditions, accurate biofeedback might not be superior a placebo-like intervention (e.g., Niemann, et al., 1993; Watson, et al., 1997). The relative efficacy of false biofeedback suggests the possibility of a placebo effect, which must be explored. The few studies on the relative effectiveness of accurate and false feedback suggests that careful study is required.

Although accurate biofeedback was not better than false biofeedback on a five-minute intervention, this study is subject to several limitations including the length and single session of biofeedback and perhaps the use of a nonclinical sample. It is also possible that the participants may not have fully understood the biofeedback measures because of the brief and broad descriptions provided in the prerecorded instructions. Also, it is possible that participant's self-rated measures improved due to a compliance or acquiescence effect, which was not possible to measure or counteract in this study. Researchers should address these limitations along with the inclusion of a no-treatment control group.

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Table 1
Means and Standard Deviations on Pretest and Posttest Scores By Measure (N = 63)

	Measure	Unit of Measure	State	<i>M</i>	<i>SD</i>
Self-Rated Measures	Overall Stress	0 = Most Stressed	Pretest	-5.2	1.9
		-10 = Least Stressed	Posttest	-6.2	2.1
	Physical Relaxation	0 = Least Relaxed	Pretest	-5.5	1.9
		-10 = Most Relaxed	Posttest	-6.7	2.2
	Mental Relaxation	0 = Least Relaxed	Pretest	-5.0	1.9
		-10 = Most Relaxed	Posttest	-6.4	2.0
Physiological Measures	Electromyography	Hertz	Pretest	5.37	8.29
			Posttest	3.39	3.35
	Electrodermal Data	Ohms	Pretest	3.10	1.35
			Posttest	2.52	1.29
	Heart Rate	Beats Per Minute	Pretest	75.07	11.82
			Posttest	77.78	13.96
	Temperature	Degrees Fahrenheit	Pretest	81.00	8.03
			Posttest	83.27	8.29

Table 2

*Pearson Correlations Among Pretest (Above Diagonal) and Posttest (Below Diagonal)**Measures (N = 63)*

	1	2	3	4	5	6	7
1. Overall Stress	—	.50*	.50*	-.12	-.13	-.04	.11
2. Physical Relaxation	.46**	—	.23	.01	-.01	.13	.16
3. Mental Relaxation	.48**	.62**	—	.07	-.05	-.07	.07
4. Heart Rate	-.09	-.04	-.05	—	.35*	-.04	-.17
5. Electrodermal Data	-.04	-.09	-.001	.42**	—	.01	-.02
6. Temperature	-.06	.13	-.04	.004	-.05	—	-.11
7. Electromyography	-.02	.19	-.02	.12	.29*	-.06	—

* $p < .05$, ** $p < .01$