A Study of the Effect of Respiratory Biofeedback
on Respiratory Resistance in Asthmatic Patients

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I. INTRODUCTION

In Japan, biofeedback technique (hereinafter referred to as BF techniques) have recently come to be commonly used in the treatment of various psychosomatic disorders. Especially, BF techniques utilizing electromyograms and electro encephalograms are being widely used in clinical applications.

In the United States, Feldman and Vachon reported in 1976 that a BF technique utilizing respiratory resistance was tested on patient with bronchial asthma to obtain a significant improvement in respiratory resistance value. Since then, this previously unexplored field of BF usage has been attracting increasing attention.

On the basis of the idea that relaxation resulting from autogenic training might alleviate expectation anxiety for asthmatic attacks and the fear of death, we previously tried autogenic training on asthmatic patients and achieved benefical clinical effects such as the disappearance of stridor, a reduction in steroid dependence, etc. For the past several years, we have been testing two types of respiratory resistance BF techniques on 12 patients with bronchial asthma over a period of 3 years in order

to determine whether the self-control of symptoms of bronchial asthma by BF training is feasible or not.

II. EXPERIMENTAL METHOD

We tested two types of respiratory resistance BF techniques, one of them using an unpleasant sound which was intended to mean punishment and the other using a pleasant sound which was intended to mean reward. I will explaine each technique with regard to subject selection, experimental method, apparatus construction and test results. (slide please!)

First, we will discuss the Punishment Type Respiratory Resistance BF technique or Negative Reinforcement technique.

a. Subject selection --- The subjects selected for this purpose were 6 female outpatient seen at the Division of Allergy, Tokyo Kyosai Hospital. (next slide please!)

b. Experimental method --- As illustrated in this slide, the subjects were trained in the following manner: On the day 1, the respiratory resistance of each subject was measured for a period of 5 minutes without giving BF information, and this procedure was repeated five times to determine the respiratory resistance value of the control session which was subsequently compared with those of BF sessions.

On days 2 to 5, the respiratory resistance of the subject was first measured for a period of 5 minutes

without giving BF information to determine the control value, and a value which was 15% higher than this control value was set as the operant level. Then, the BF training for a period of 5 minutes, and this procedure was repeated five times.

The control values obtained in the BF sessions were utilized for the purpose of correction to the standards set on day 1   when comparing   the results of the control session and those of the BF sessions.

Thereafter, 3 subjects who could attend the hospital training sessions once a week were submitted to the BF training of the punishment type for a period three years.

The method of giving BF information was such that the subject ceased to hear an unpleasant alarm sound when her respiratory resistance fell below the operant level preset for each session and began to hear the sound when her respiratory resistance rose above the operant level.

The instructions given to the subject were as follows: "If the sound produced from this apparatus becomes louder, it means that your breathing passages are more closed. Try to suppress this sound and breathe more easily." Thus, the disappearance of an unpleasant alarm sound was employed as the reinforcing factor.

Neither special instructions for autogenic training, meditation, image formation or the like, nor monetary rewards were given at all. That is, our method was based

exclusively on the subject's wishes for recovery.

As a rule, the use of bronchodilators or steroids was forbidden within a period of 6 hours before the start of each session. The results thus obtained were examined by comparing the average values among trials and among sessions and statiscally analyzing the differences observed in individual cases and on the whole. (next slide please!)

c. Construction of punishment type respiratory resistance BF system --- The punishment type respiratory resistance BF system consisted of a repiratory resistometer and a signal sound generator designed so that an unpleasant alarm sound is produced when the respiratory resistance rises above the preset alram level and disappears when the respiratory resistance falls below the alarm level.

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d. Results :

1). Results of short-term training --- This table summarizes the results obtained at the beginning of the BF training of the 6 subjects accoridng to the negative reinforcement technique. Subject F showed a significant decrease in total respiratory resistance (-1.27 cmH$_2$O/l/sec). On the whole, the change in total respiratory resistance was -0.08cmH$_2$O/l/sec. and not statistically significant.

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2). Results of long-term training -- This table summarizes the results of the 3 subjects who underwent weekly BF traning for a period of 3 years according to the negative reinforcement technique. Subject B showed a significant decrease in respiratory resistance at the ends of years 1 and 3. Subject F showed a significant decrease in

respiratory resistance at the beginning.

On the whole, the changes in respiratory reistance were not statistically significant. Nevertheless, there was a tendency for the decrements in respiratory resistance to become larger as the years passed by.

Next, we will discuss the Reward type respiratory resistance BF technique or positive reinforcement technique.

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a. Subject selection --- The subjects selected for this purpose were 6 outpatients with bronchial asthma who were seen at the Division of Allergy. Department of Psychosomatic Medicine, Tokyo University Branch Hospital.

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b. Experimental method --- As illustrated in this slide, the experimental method was identical to that used in the negative reinforcement technique.

The method of giving BF information was such that the subjects began to hear a pleasant chime sound when his respiratory resistance fell below the operant level and ceased to hear it when his respiratory resistance rose above the operant level.

The instructions given to the subject were as follows: "If you continue to hear the chime sound produced by this apparatus, it means that your bronchial passages are more open. Try to maintain this sound and breathe more easily." Thus, the maintenance of a pleasant chime sound was employed as the reinforcing factor.

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    c. <u>Construction of reward type repiratory resistance</u>

       <u>BF system</u>

As illustrated in this slide, the same repiratory resistometer and sound generator were used in both techniques, the only difference being that in the positive technique the sound generator was equipped to produce the chime sound rather than the alarm sound.

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    d. <u>Results</u> :

    1. Results of short-term training --- This table summarizes the results obtained at the beginning of the BF training of the 6 subjects according to the positive reinforcement technique. Subjects <u>a</u> and <u>b</u> showed a signigicant decrease in total respiratory resistance (-0.63cmH_2O/l/sec and -0.32cmH_2O/l/sec, respectively). On the whole, the change in total respiratory resistance was -0.07cmH_2O/l/sec and not statistically significant.

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    2. Results of long-term training --- This table summarizes the results of the 3 subjects who underwent weekly BF training for a period of one year according to the positive reinforcement technique.

At the beginning of the BF training, subject <u>a</u> showed a signigicant decrease, while at the end of one year, none of the subjects showed a significnat decrease. On the whole, however, a significant decrease in totoal respiratory resistance (-0.27cmH_2O/l/sec) was observed.

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DISCUSSION and SUMMARY

We will first compare the results of both groups for short-term training. The number of subjects who showed a significant decrease in total respiratory resistance was 1 for the negative reinforcement group and 2 for the positive reinforcement group.

As for the result of Long-term training, the positive reinforcement group as a whole showed a signigicant decrease in total respiratory resistance at the end of one year, but the negative reinforcement group failed to show a significant decrease even at the end of 3 years, although, the decreaments became larger as the years passed by.

From the above results, we can conclude that the positive reinforcement technique is easier to learn than the negative reinforcement technique. (Light please!)

On considering the clinical application of respiratory resistance BF training in the future, we suppose that better results may be obtained by developing a two-step therapentic program combining an introductory step using the easy to learn positive technique with a subsequent step using the negative technique which seems to challenge and motivate the subjects.

Thank you very much