JOURNAL OF APPLIED BEHAVIOR ANALYSIS 1970, 3, 235-240 NUMBER 4 (WINTER 1970)

# BEHAVIORAL ENGINEERING: CONTROL OF POSTURE BY INFORMATIONAL FEEDBACK[1]

F. O'BRIEN AND N. H. AZRIN

ANNA STATE HOSPITAL AND SOUTHERN ILLINOIS UNIVERSITY

The effects of informational feedback on a socially undesirable behavior were studied. The feedback was a mild vibrotactile stimulus and the response was slouching. When subjects slouched, a behavioral engineering apparatus provided vibrotactile stimulation to the shoulder. All subjects slouched less when stimulation was provided. A procedural control revealed that slouching will decrease because of the informational aspect of the stimulus consequence and not because of its aversive properties. When the subjects were instructed to slouch, the effects of feedback were reversed: feedback increased, rather than decreased, slouching. These results indicate that the effect of feedback for a response depends on the subject's motivation to perform that response. It is suggested that informational feedback could be used more widely as a therapeutic procedure to modify human behaviors, but only those behaviors that a patient is strongly motivated to change.

When a reinforcing stimulus is given to a patient for performing desired behaviors, two processes may be operating. The first process is the strengthening of the response because of the reinforcing properties of the stimulus; this process constitutes the principal basis of behavior modification through operant conditioning, examples of which are the delivery of food for correct verbalizations (Lovaas, Berberich, Perloff, and Schaeffer, 1966; Risley and Wolf, 1967), tokens for constructive work, (Ayllon and Azrin, 1965, 1968; Schaeffer and Martin, 1969), and social approval for studying (Hall, Lund, and Jackson, 1968; Thomas, Becker, and Armstrong, 1968). The second process is informational feedback, which may also be provided as a consequence for a response and be procedurally indistinguishable from operant reinforcement. Some examples are: (1) telling a subject how long a drawn line is after he had been instructed to draw a 3-in. line (Trowbridge and Cason, 1932), (2) providing an auditory feedback when a subject is on-target in a tracking task (Reynolds and Adams, 1953), and (3) providing an auditory click for each lever press by rats during avoidance conditioning (Bolles and Popp, 1964). In practical applications of operant conditioning, only slight evidence exists that informational feedback may be sufficient to deal with problem behaviors. For example, Leitenberg, Agras, Thompson, and Wright (1968), found that a knife phobia and claustrophobia were improved simply by providing the patient with a timer that displayed to him how long he remained in the presence of the phobic environment. Also, Kaess and Zeaman (1960) showed that programmed instruction is more effective when the student is given informational feedback for correct answers.

If simple feedback is an effective method of eliminating problem behaviors, major practical and theoretical implications follow. From the theoretical point of view, such a finding would indicate that operant reinforcement may not be as necessary as it had seemed to be. From the practical point of view, it is far simpler to discover and arrange a response-produced stimulus that is purely informational than one that has strong reinforcing or aversive properties. This practical advantage is especially relevant to behavioral engineering (Azrin, Rubin, O'Brien, Ayllon, and Roll, 1968) because the requirements of portability and convenience are often difficult to reconcile with the need to schedule an effective reinforcer or aversive stimulus. The present study attempted to examine whether a strictly informational feedback stimulus was effective in reducing problem behavior, and if so, to use

[1]This research was supported by the State of Illinois Department of Mental Health and NIMH Grants MH04926-08 and MH17981-01. The assistance of K. Henson, RN, is appreciated. Reprints may be obtained from Floyd O'Brien, Behavior Research Laboratory, Anna State Hospital, Anna, Illinois 62906.

this finding by substituting such a stimulus for the aversive tone that had been previously used in a behavioral engineering apparatus to decrease slouching (Azrin *et al.,* 1968). An informational stimulus was selected that was private and seemed so apparently nonaversive as to be judged as bland by the experimenters, namely a vibrotactile stimulus to the skin. Previous reports have summarized the evidence for the medical undesirability of slouching (Burt, 1950; Goldthwait, Brown, Swaim, and Kuhns, 1945) and the major rationale and implications of the behavioral engineering approach for many areas of applied psychology (Azrin, Jones, and Flye, 1968; Azrin and Powell, 1969; Azrin *et al.,* 1968; Jones and Azrin, 1969; Powell and Azrin, 1968; Schwitzgebel, 1968, 1970).

## EXPERIMENT I

### METHOD

*Subjects*

Eight employees of Anna State Hospital served, two of whom had previously worn the posture apparatus with the auditory stimulus. Five were female and three were male. All were chosen on the basis of their ready availability and without regard to their normal posture. They were studied in their place of employment and while engaged in their normal work routines.

*Apparatus*

The apparatus shown in Fig. 1 was functionally identical to the earlier posture apparatus (Azrin *et al.,* 1968) except that slouching caused a vibrotactile stimulation to the shoulder, rather than the sounding of an auditory stimulus. The vibrotactile stimulus was produced by energizing a Bone Conductor such as is used to compensate for hearing loss. The Bone Conductor (Model B 70A, Bone Receiver from Radioear Hearing Devices, Canonsburg, Pennsylvania) was attached to the underside of one of the shoulder straps of the harness so that the Bone Conductor rested on the clavicle (shoulder blade), which was relatively sensitive to tactile stimulation. The remainder of the harness consisted of two shoulder straps, a mechanical switch across the back, and a circuit packet on the chest, all of which was designed to detect slouching and to energize the vibrotactile stimulator for the duration of the slouching. No auditory signal was detectable from the stimulator when it was energized, thereby ensuring the privacy of the feedback. The entire harness arrangement was not detectable by others because it was concealed by outer clothing. As in the previous study, the duration of slouching was recorded by a miniature elapsed-time meter (Model 120-PC, Curtis Instrument Co.) contained in the circuit packet.

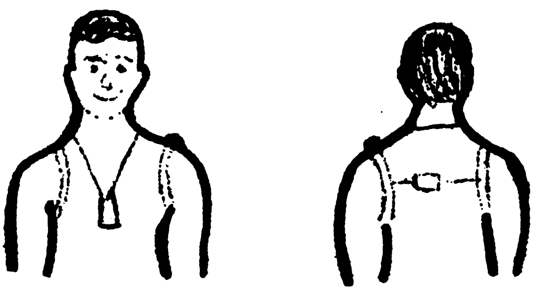

Fig. 1. Front and rear schematic view of the vibrotactile posture apparatus. The normal outer clothing is not shown here for the clarity of presentation. In the front view, the packet suspended from the necklace contains the electrical circuit. In the rear view, the mechanical switch is shown in the middle of the back and connected to both shoulder straps. In both views, the object on the left shoulder is the vibrotactile stimulator.

The method of fitting the harness to the subject was identical to that used previously and relied on the subject's own definition of slouching. Briefly, the strap across the back was shortened to the approximate point where the subject stated that the vibrotactile stimulation occurred only when he slouched. After 5 min of wearing the harness, it was readjusted if necessary in the direction requested by the subject.

*Procedure*

The tactile posture apparatus was worn for 4 hr. The first and last hours were control periods during which the tactile vibrator component was inoperative. Recordings were taken each hour of the 4-hr period by removing the concealed time-meter that timed the duration of slouching and replacing it with a new meter. The meter readings were not known to the subject or the research assistant who removed it. The experimental design was A-B-B-A within subjects: control-feedback-feedback-control. This design provided a control for individual differences and for placebo effects related to instructions and the apparatus. Several days later, each subject was given the tactile posture apparatus and also the previously described posture apparatus that had the auditory feedback and asked, after listening to the auditory stimulus and touching the tactile stimulus, which of them he preferred to wear.

### Results

Table 1 presents the per cent of time each subject spent slouching during feedback and no-feedback conditions. The algebraic sign shows the direction of change in slouching relative to the no-feedback condition. Table 1 shows that the tactile feedback decreased the percentage of time spent slouching for each of the eight subjects for a mean reduction of 35%.

Table 1

Effect of informational feedback by a tactile stimulus presented contingent on slouching ($N = 8$).

| | *Per Cent of Time Slouching* | | | | |
|---|---|---|---|---|---|
| *Subject* | *No Feedback* | *Feedback* | *Feedback* | *No Feedback* | *Difference* |
| 1 | 57% | 2% | 2% | 23% | −38% |
| 2 | 70 | 2 | 2 | 30 | −48 |
| 3 | 58 | 2 | 2 | 42 | −48 |
| 4 | 49 | 2 | 3 | 4 | −24 |
| 5 | 30 | 2 | 10 | 44 | −31 |
| 6 | 47 | 10 | 4 | 33 | −33 |
| 7 | 77 | 26 | 35 | 60 | −38 |
| 8 | 44% | 21% | 29% | 49% | −21% |
| Mean | 54% | 8% | 11% | 36% | −35% |

For each subject, the per cent of time spent slouching was less during either of the 1-hr feedback periods than during either of the 1-hr no-feedback periods. This decrease of slouching during the tactile feedback period was statistically significant ($P < 0.01$) according to the Wilcoxin Matched-Pairs Signed-Ranks Test (Siegel, 1956). The results for the two subjects who had previously worn the apparatus with the auditory stimulus (S-3 and S-6) did not differ from the other subjects. When offered a choice between wearing the apparatus with the tactile stimulus or with the aversive tone, each subject chose the tactile stimulus.

### Discussion

The results showed that the vibrotactile stimulus presented contingent on slouching reduced slouching. The reduction with the vibrotactile stimulus was almost as great as the reduction found previously (Azrin *et al.*, 1968) when an aversive tone was used as the response consequence.

Two major problems of interpretation prevent one from stating that the present results demonstrate that simple informational feedback is an effective method of reducing problem behavior, even when the feedback has no inherent motivational properties. First, the vibrotactile stimulus may indeed have been slightly aversive in spite of its apparent mildness. Secondly, one need ask why the feedback decreased, rather than increased, the response of slouching.

## EXPERIMENT II: MOTIVATIONAL *vs* INFORMATIONAL EFFECT OF FEEDBACK FOR SLOUCHING

The present experiment examined in a different manner the informational *vs* the motivational basis for the reduction of undesired behavior by vibrotactile feedback. The general procedure of Exp. I was repeated but with a procedural control for aversiveness. When the subject slouched, the vibrotactile stimulator was energized on one shoulder; when he did not slouch, the stimulus was energized on the other shoulder. Since the subject was stimulated at all times, the overall level of stimulation was constant; only the locus of stimulation differed, thereby providing information regarding slouching with no corresponding change in energy level of stimulation. If the slouching should be reduced by this balanced-stimulus technique, one could conclude that a purely informational event could improve posture.

Assuming that simple informational feedback does improve performance, can this effect be reconciled or integrated with the process of reinforcement? Theorists (Spence, 1947; Skinner, 1953) have proposed a reconciliation that states that if reinforcement has been given for a behavior, stimulus feedback for that behavior should become a conditioned reinforcer. Conversely, it has been found that if a response is associated with an aversive stimulus or with the absence of reinforcement, a feedback event for that response should become a conditioned punisher and should decrease that response (Hake and Azrin, 1965). This analysis suggests that improvement in performance by feedback should result to the extent that the subject is motivated to change the response. The direction of change should be determined by the direction of the motivation. With respect to slouching, this analysis predicts that feedback will decrease slouching for normal subjects whose non-slouching behavior has presumably been reinforced; this result was obtained in Exp. I. The analysis also predicts that feedback will increase slouching for subjects who are motivated to slouch. The present study evaluated this latter prediction by instructing subjects to slouch (presumably creating a temporary motivation to do so) and then evaluating the effects of feedback on such artificially motivated subjects.

## Method

### *Subjects*

Six employees of Anna State Hospital served under the same circumstances as in Exp. I. Three were male and three were female. Two of these subjects had also previously worn the posture apparatus with the auditory stimulus.

### *Apparatus*

The apparatus was identical to that of Exp. I except that an additional Bone Conductor was sewn on the other shoulder strap, and the circuit was modified to activate this Bone Conductor when the subject was not slouching. As in Exp. I, the other conductor was activated when the subject was slouching.

### *Procedure*

The tactile posture apparatus was worn by each subject under two instructional sets. One instructional set was identical to the instructions of Exp. I (*i.e.,* no particular instruction was offered subjects about slouching, other than that necessary to describe and adjust the apparatus). The second instructional set asked subjects to slouch as much as they possibly could. The presentation of instructional sets was counterbalanced to insure that sessions with one instructional set occurred first equally as often as the other set. Under both instructional sets, each subject experienced both the control condition, during which the apparatus provided no feedback, and the experimental condition, during which the right Bone Conductor operated when subjects slouched and the left Bone Conductor operated when subjects did not slouch. Experimental and control periods were about 45 min in duration and were counterbalanced to insure that the experimental period was scheduled first as often as the control period. Each subject, therefore, served in two sessions, one for each instructional set, and during each session, each subject experienced both the control and experimental procedures.

The procedure described in Exp. I for adjusting the harness was modified to yield a more conservative definition of slouching for those sessions in which the subjects were to be instructed to slouch. Once having set the apparatus in accordance with the subject's requests, the strap across the back was loosened by about $\frac{1}{8}$ in. thereby increasing the amount of rounding of the shoulders necessary to activate the apparatus. This modification prevented the slouching from asymptoting at 100% as a result of the instructions.

Several days later, each subject sampled the posture apparatus with the single Bone Conductor used in Exp. I and the apparatus with the auditory feedback and was asked which they preferred to wear, in the same manner as described for the subjects in Exp. I.

## Results

Table 2 presents the percentage of time spent slouching during the feedback and no-feedback conditions for each subject and under both instructional sets. The algebraic sign indicates the direction of change relative to the no-feedback condition. Table 2 shows that for each of the six subjects, the tactile stimulation decreased the slouching when the subjects were not instructed to slouch. The mean difference in the percentage of time spent slouching was $-45$ ($P < 0.05$). Table 2 shows that when the subjects were instructed to slouch as much as possible, each subject increased slouching during the feedback condition for a mean difference of $+43\%$ ($P < 0.05$). No difference is apparent in the results for the two subjects (S-11 and S-13) who had previously worn the apparatus with the auditory stimulus.

When four of the six subjects were offered a choice between wearing the apparatus with the tactile stimulus or with the aversive tone, each chose the tactile stimulus. The remaining two subjects were unavailable.

Table 2

Effects of informational feedback by an apparatus that presented tactile stimulation on one shoulder for slouching and identical stimulation on the other shoulder for not slouching.

| | *Per Cent of Time Spent Slouching* | | | | | |
|---|---|---|---|---|---|---|
| | *No Instructions* | | | *Instructions to Slouch* | | |
| *Subject* | *No Feedback* | *Feedback* | *Difference* | *No Feedback* | *Feedback* | *Difference* |
| 9 | 98% | 8% | −90% | 92% | 99% | +7% |
| 10 | 91 | 16 | −75 | 26 | 88 | +62 |
| 11 | 31 | 7 | −24 | 19 | 53 | +34 |
| 12 | 75 | 30 | −45 | 22 | 96 | +74 |
| 13 | 47 | 31 | −16 | 9 | 41 | +32 |
| 14 | 53% | 35% | −18% | 16% | 65% | +49% |
| Mean | 66% | 21% | −45% | 31% | 74% | +43% |

## Discussion

Both Exp. I and II showed that slouching was reduced for uninstructed subjects when vibrotactile stimulation was provided for the slouching. As a practical procedure, the vibrotactile stimulus seems more suitable than the auditory, which was used in the previous study (Azrin *et al.,* 1968). First, the private nature of a tactile stimulus should reduce the hesitation to wear the apparatus in public that the auditory stimulus would engender. Secondly, the less-aversive nature of the tactile stimulus should make the wearer less likely to discontinue its use (Powell and Azrin, 1968). These expectations were supported by the present finding that the subjects all stated a preference for the apparatus with the vibrotactile stimulus over the one with the auditory stimulus.

The results of Exp. II demonstrated that the slouching was not reduced because of the aversiveness of the consequence, since the level of tactile stimulation was constant whether or not the subjects slouched. This finding shows that simple informational feedback will reduce an undesired behavior and suggests that feedback procedures could be used more generally as a behavior modification procedure for patients who are known to be motivated toward eliminating their undesired behavior. In the absence of such motivations, simple feedback should not reduce the symptom and might in fact exacerbate the symptom.

## REFERENCES


Ayllon, T. and Azrin, N. H. The measurement and reinforcement of behavior of psychotics. *Journal of the Experimental Analysis of Behavior,* 1965, **8,** 357-383.

Ayllon, T. and Azrin, N. H. *The token economy: a motivational system for therapy and rehabilitation.* New York: Appleton-Century-Crofts, 1968.

Azrin, N., Jones, R. J., and Flye, Barbara. A synchronization effect and its application to stuttering by a portable apparatus. *Journal of Applied Behavior Analysis,* 1968, **1,** 283-295.

Azrin, N. H. and Powell, J. Behavioral engineering: the use of response priming to improve prescribed self-medication. *Journal of Applied Behavior Analysis,* 1969, **2,** 39-42.

Azrin, N., Rubin, H., O'Brien, F., Ayllon, T., and Roll, D. Behavioral engineering: postural control by a portable operant apparatus. *Journal of Applied Behavior Analysis,* 1968, **1,** 99-108.

Bolles, R. C. and Popp, R. J. Parameters affecting the acquisition of Sidman avoidance. *Journal of the Experimental Analysis of Behavior,* 1964, **7,** 315-321.

Burt, H. A. Section of physical medicine. *Proceedings of the Royal Society of Medicine,* 1950, **43,** 187-194.

Goldthwait, J. E., Brown, L. T., Swaim, L. T., and Kuhns, J. G. *Essentials of body mechanics in health and disease.* 4th ed.; Philadelphia: J. B. Lippincott Co., 1945.

Hake, D. F. and Azrin, N. H. Conditioned punishment. *Journal of the Experimental Analysis of Behavior,* 1965, **8,** 279-293.

Hall, R. V., Lund, D., and Jackson, D. Effects of teacher attention on study behavior. *Journal of Applied Behavior Analysis,* 1968, **1,** 1-12.

Jones, R. J. and Azrin, N. H. Behavioral engineering: stuttering as a function of stimulus duration during speech synchronization. *Journal of Applied Behavior Analysis,* 1969, **2,** 223-229.

Kaess, W. and Zeaman, D. Positive and negative knowledge of results on a pressey-type punchboard. *Journal of Experimental Psychology,* 1960, **60,** 12-17.

Leitenberg, H., Agras, W. S., Thompson, L. E., and Wright, D. E. Feedback in behavior modification: an experimental analysis in two phobic cases. *Journal of Applied Behavior Analysis,* 1968, **1,** 131-137.

Lovaas, O. I., Berberich, J. P., Perloff, B. F., and Schaeffer, B. Acquisition of imitative speech in schizophrenic children. *Science,* 1966, **151,** 705-707.

Powell, J. and Azrin, N. The effects of shock as a punisher for cigarette smoking. *Journal of Applied Behavior Analysis,* 1968, **1,** 63-73.

Reynolds, B. and Adams, J. A. Motor performance as a function of a click reinforcement. *Journal of Experimental Psychology,* 1953, **45,** 315-320.

Risley, T. and Wolf, M. Establishing functional speech in echolaic children. *Behavior Research and Therapy,* 1967, **5,** 73-88.

Schaeffer, H. A. and Martin, P. L. *Behavioral therapy.* New York: McGraw-Hill, 1969.

Schwitzgebel, R. L. Survey of electromechanical devices for behavior modification. *Psychological Bulletin,* 1968, **70,** 444-459.

Schwitzgebel, R. L. Behavior instrumentation and social technology. *American Psychologist,* 1970, **25,** 491-499.

Siegel, S. *Nonparametric statistics for the behavioral sciences.* New York: McGraw-Hill, 1956.

Skinner, B. F. *Science and human behavior.* New York: Macmillan, 1953.

Spence, K. W. The role of secondary reinforcement in delayed reward learning. *Psychological Review,* 1947, **54,** 1-8.

Thomas, D. R., Becker, W. C., and Armstrong, M. Production and elimination of disruptive classroom behavior by systematically varying teacher's behavior. *Journal of Applied Behavior Analysis,* 1968, **1,** 35-45.

Trowbridge, M. H. and Cason, H. An experimental study of Thorndike's theory of learning. *Journal of General Psychology,* 1932, **7,** 245-258.

*Received 20 May 1970.*