**BEHAVIORAL ENGINEERING: POSTURAL CONTROL
BY A PORTABLE OPERANT APPARATUS¹**

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Recent studies suggested a general behavioral engineering approach to behavioral disorders by portable operant treatment instruments. The approach was applied to the problem of poor posture, specifically rounding of the back or slouching. An apparatus was developed that provided a warning stimulus followed by an aversive tone for the duration of slouching. Slouching was thereby punished by onset of the tone, and non-slouching was reinforced by tone termination and postponement. Twenty-five adults wore the apparatus during their normal working day during alternate periods in which the aversive tone was connected and disconnected experimentally. A miniature time-meter recorded the duration of slouching. The results showed that slouching decreased for each subject during each period in which slouching produced the aversive tone. For two subjects, a second control procedure was applied in which slouching terminated the tone. The result was an increase of slouching, demonstrating that the postural changes were controlled by the scheduled relation between the aversive tone and the response, and not by other factors such as simple response feedback. The substantial changes in posture indicate that the present procedure may prove to be an effective treatment alternative and suggests the general value of the behavioral engineering approach.

Psychological treatment of behavioral problems usually is given in a restricted locale, such as an office or hospital, and for restricted periods; the hope is that the desired behavioral changes will occur in the patient's normal environment. Recently, operant conditioning procedures have been used in this same manner to modify behavior problems (see examples, summaries, and reviews in Bijou and Baer, 1967; Ulrich, Stachnik, and Mabry, 1966; Ullmann and Krasner, 1965; Ayllon and Azrin, in press). An alternative to this brief treatment approach is to have the treatment continuously operative in the patient's natural setting by apparatus that can be worn and which provides the stimuli

known to be needed for the behavioral change. Several continuous treatment devices have been developed for behavior problems that can be treated by a simple rearrangement or introduction of sensory inputs such as eyeglasses, hearing aids, the cardiac Pacemaker, and watches. If this continuous approach is to be extended to treatment by operant conditioning procedures, something more than simple sensory inputs are needed. Since reinforcement (Holland and Skinner, 1961) and punishment (Azrin and Holz, 1966) are defined procedurally as a stimulus consequence of a response, an operant conditioning treatment device must also discriminate physically when responses occur and only then deliver the stimuli. Only one example of this approach seems to have been developed and proven. In treating bedwetting, Mowrer and Mowrer (1938) developed a special bed pad that sounded an annoying tone when urine caused an electrical current to flow through wires imbedded in the pad. The result was that bedwetting decreased. This technique has not resulted in the emergence of any general principles that suggested similar applications to other behavioral problems. Rather, the bedwetting device seems to be considered as an isolated technique for

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treating a very specific problem. The possible generality of this technique was suggested very recently in the course of developing an apparatus to eliminate cigarette-smoking behavior (Powell and Azrin, 1968). The apparatus was originally described by Whaley (personal communication) and later reported by Whaley, Rosenkranz, and Knowles (in press). A painful electric shock was delivered to the smoker when he opened a specially designed cigarette case. Analysis of the many behavior modification studies, especially those of bedwetting and smoking, revealed several common factors that in combination suggested a general rationale for treating undesired behaviors.

This general approach is designated here as behavioral engineering and seemed to involve the following requirements. (1) *Behavioral definition*: define the undesired behavior in specific behavioral terms; (2) *Apparatus definition*: isolate some essential aspect of that behavior that can be physically sensed by an apparatus; (3) *Response precision*: the response output of the apparatus must be made selective so that it is activated by all instances of the undesired behavior (no false negatives) but by no instance of normal behaviors; (no false positives) (4) *Effective stimulus consequence*: discover some stimulus event that is reinforcing or aversive and that can be delivered physically; (5) *Programming the stimulus consequence*: program that stimulus as a consequence for the undesired response; and (6) *Portable device*: construct a portable device that performs the response definition and stimulus delivery and which allows the patient to engage in his normal activities.

The present study attempted to apply this method of operant treatment aids to remedy poor posture, specifically "slouching". Slouching was selected because it is apparently socially undesirable and because many medical authorities consider it detrimental to health. Goldthwait, Brown, Swaim, and Kuhns (1945) are perhaps the strongest proponents of the causative relationship between good posture and good health, and their views are accepted in varying degrees by other medical authorities (see for example Burt, 1950) as well as physical therapists (Williams and Worthingham, 1957) and individuals interested in maximizing the performance of athletes (see Lowman, 1958). However, this

view is not shared by all (see excellent review by Hellebrandt and Franseen, 1943).

A psychological or social need seems to exist for postural treatment aside from any medical need. Patients that have been hospitalized in institutions for the retarded or mentally ill frequently present a postural appearance that discourages social acceptability and discharge to the community. Similar socialaesthetic reasons seem to lead some non-institutionalized individuals to exercise and to use postural braces.

METHOD

Subjects

Twenty-five adults, 18 to 49 years of age, participated; 11 were male, 14 female. All were employees of the Anna State Hospital except for one mental patient and one chiropractor in private practice. All were selected on the basis of their availability and willingness to participate and without regard to their normal posture. Of the hospital employees, seven were attendants, three were speech therapists, one was a clerical worker, two were administrators, one was a psychologist, and the others were general assistants. All were studied at their place of employment and while they were engaged in their usual job activities. The patient was studied while she was engaged in her usual activities on the token-system ward environment described elsewhere (Ayllon and Azrin, 1965; Ayllon and Azrin, in press).

Instructions. The subjects were asked to participate in a study of posture. None declined, although several spontaneously stated that they felt no great need for posture improvement. Three subjects stated without being asked that they desired to improve their posture and actively inquired about participating before being approached (S-10, S-22, S-23). The subjects were shown how the apparatus functioned and were told they would be wearing it for several hours. They were instructed to engage in all of their normal activities while wearing the apparatus and to report afterward on any problems, or inconveniences, resulting from its usage. They were informed of the developmental status of the apparatus, the experimenter's lack of knowledge regarding its possible efficacy, and the possibility that no change in posture might

result. The instructions were in written form for six subjects.

Apparatus and Procedure

The procedure and apparatus will be described in terms of the six requirements listed above.

1. *Behavioral definition.* Slouching was behaviorally defined as a sustained rounding of the shoulders or upper back while in a standing position. Medically, this condition is called "round shoulders" and is defined as a "faulty posture in which dropping of the shoulders and increased convexity of the thoracic spine are conspicuous" (Hoerr and Osol, 1956, p. 1053).

2. *Apparatus definition of response.* The apparatus defined slouching as an increased distance between two points on the back. A miniature snap action switch (Model 11SM1, Microswitch) was modified to operate upon being pulled rather than pushed. This posture switch was mounted on the back at about the level of the second thoracic vertebra (see Fig. 1). The switch was connected to an elastic cord and attached to the back such that rounding of the back caused the switch contacts to close. Two methods of attachment to the back were used: adhesive tape was used for most subjects to provide the more exact measure of the response for purposes of experimental evaluation (see Fig. 1). A second method was a harness (see Fig. 2) which allowed a slight error due to movement of the straps but was more convenient for the subject: it could be removed and attached by the subject himself once adjusted properly, whereas the adhesive mounting required assistance and readjustment for each wearing. Fifteen subjects used the adhesive mounting and 10 the harness. A small strip of tape was used to hold the harness strap in a fixed position on the shoulders for some of the subjects who wore the harness.

The amount of slouching needed to activate the switch was determined by the subject's own judgment. The subject was asked to assume a shoulder posture which he felt bordered on, but did not constitute, slouching and which he would like to maintain. The switch was adjusted via the adhesive tape or straps to be on the point of activation at that posture. The subject then returned to his usual activities for about 5 min after which

Fig. 1. Front and rear view of a subject wearing the posture switch. The front view in the upper sketch shows the signal component worn around the neck. A wire runs from the component, under the arm, to the posture switch on the back which is shown in the lower sketch. The posture switch is attached to the back by two strips of adhesive tape. The subjects wore their outer garments over the assembly which was thereby concealed from view.

the adhesive tape or straps were readjusted in compliance with the subject's request. These 5-min trial periods were repeated until satisfactory adjustment was found. All subjects achieved a satisfactory adjustment within three trial periods except for Subject 7. Measurement of Subject 7 revealed relatively little increase in distance between the shoulders when asked to slouch but a relatively large increase in spinal curvature. Accordingly, for Subject 7, the switch was taped along the spinal cord at its maximum convex

Fig. 2. Front and rear view of a subject wearing the posture switch. The front view in the upper sketch shows the signal component worn around the neck. A wire runs from the component, under the arm, and to the posture switch on the back which is shown in the lower sketch. The posture switch is attached by the shoulder straps which are adjusted for the desired posture for the individual subject. Outer garments are worn over the assembly and thereby conceal it from view.

dorsal curvature such that increased spinal curvature rather than the rounding of the back activated the posture switch. For other subjects, the switch was adjusted vertically after the first 5-min trial to the first or third thoracic vertebra if that location provided a greater distance change during slouching.

3. *Response precision.* The posture switch arrangement across the back was found to be effective in avoiding "false negatives"; *i.e.*, the switch contacts closed whenever rounding of the back occurred. "False positives" did oc-

cur in the early development of this method; the switch contacts closed because of an incidental rounding of the back that was a part of normal activity. One type of false positive was a short-term rounding of the back such as occurred when the subject looked over his shoulder. This type of problem was solved by defining slouching as a sustained response. Therefore, slouching was defined as uninterrupted closure of the switch for at least 3 sec. A second type of false positive resulted from normal reaching movements that caused the switch contacts to close as a result of the associated shoulder blade movements. As described above, this problem was solved by mounting the switch at a level above the shoulder blades which for different subjects was the first, second, or third thoracic vertebra. A third type of false positive resulted when the torso was bent sharply forward as occurs during close reading while seated and when picking up an object from the floor. This problem was eliminated by a mercury tilt switch (Model: Gordo 1-220-L2) that blocked the output from the posture switch when the torso was tilted forward more than 10° .

4. *Effective stimulus consequence.* A 500-cps tone at an intensity of 55 db was used as the stimulus consequence for slouching. The intensity was measured at a distance of 15 in. which was the approximate distance of the apparatus from the subject's ear when the apparatus was worn. Preliminary evidence indicated that this tone was aversive when it sounded while the subject was in his natural and usually social environment. (Experimental evidence regarding the aversiveness is presented below.) The tone was generated by a transistor circuit (see Fig. 15.9 in G. E. Transistor Manual, 1964) which included a hearing aid speaker (Audivox Model 8AA).

5. *Programming the stimulus consequences.* Since slouching could occur at any time, it constituted a free operant response that should be amenable to treatment by free operant conditioning procedures. The present procedure programmed the onset of the tone as a punisher for the onset of slouching and the termination of the tone as escape reinforcement for the termination of slouching. A warning stimulus, consisting of a momentary click, occurred whenever the posture switch contact closed. The click sound was produced by the built-in snap action of the microswitch

when the contacts opened or closed. The aversive stimulus tone sounded 3 sec later if the switch contacts remained closed. The termination of slouching opened the posture switch contacts and immediately terminated the tone.

6. *Portable apparatus.* If the procedure was to operate in the subject's natural environment, the device had to be sufficiently small, light, and unobtrusive to be worn easily. The present study did not attempt to develop the ultimate in miniaturization but only to satisfy the requirements of portability to the extent needed to make this study possible. The posture switch arrangement described above was connected by a thin lead that passed loosely under the shirt to the programming device that was suspended by a necklace on the chest (see Fig. 1 and 2). Females usually wore the apparatus in their brassiere and males wore it under their shirt. The apparatus weighed 60 g, measured about 2 by 4 by 6 cm, and contained the mercury switch for measuring vertical tilt and the circuit and speaker for the tone.

Recording response duration in a portable apparatus. A major problem existed in objectively measuring the duration of slouching while the subject was in his natural environment. Previous studies had not developed such a method. The present use of a switch attached to the back offered an objective method but the problem remained as to how a record could be obtained of the posture switch output, since no fixed connection could be made from the posture switch to a stationary recording instrument. Even telemetry was impractical since the subjects could travel over a distance of several miles in their autos. A method was developed for recording the cumulative duration of slouching by arranging a miniature (2.8 by 0.5 by 0.5 cm) elapsed time meter (Curtis Instrument Co., Model 120-PC) in series with the posture switch. The measuring element of the meter consisted of a capillary tube filled with two columns of mercury separated by a gap of electrolyte. When current passed through the meter, the electrolyte gap moved at a rate determined by the amount of current flow. The speed of the timer was determined beforehand by the value of the fixed resistor in series with the time meter. Since slouching was defined as a maintained response, the current was allowed to

pass through the time meter only after the posture switch was closed for 3 sec. The meter provided a silent, accurate method of recording the duration of slouching. It was necessary to magnify the timer in order to read the elapsed duration. A photograph was taken of the timer to provide a permanent and enlarged photographic record that could be measured at a later time. The time could be read with an accuracy of about one-fifth of 1% (about 30 sec) at the 4-hr time range used for almost all subjects.

Experimental design. Two experimental conditions were imposed on each subject: (A) the normal condition in which the tone was disconnected but the timer continued to record slouching and the posture switch continued to click each time the switch contacts were opened or closed, and (B) the punishment of slouching condition in which the tone sounded during slouching. The change from one condition to the other required less than a minute and was made by disconnecting or connecting the speaker by a switch inside the programming apparatus. The sequence of conditions within each day was ABA for some subjects and BAB for the others; three subjects were BABA. The time spent in each period was 1 to 3 hr, with most subjects spending approximately equal durations in the two conditions. For three subjects, however, the conditions were changed between days in an ABA or BABA sequence; they wore the apparatus about 7 hr on each of the days. This design permitted a within-subjects and (except for three subjects) a within-session determination of whether the punishment of slouching by the tone reduced the duration of slouching. All features of the two conditions were comparable including the wearing of the apparatus, the presence of a warning stimulus click, the nature of the subject's activities, and the instructions to the subjects; the sole difference was the response contingency of sounding the tone during slouching.

Two subjects were given a second session during which the above procedure was changed in order to obtain additional evidence regarding the aversive properties of the tone. If the tone were simply providing information or feedback, slouching should be affected in the same way when the tone sounded only during slouching as when it sounded only during non-slouching. On the

other hand, if the tone were aversive, slouching should be decreased when the tone was produced by slouching but increased when the tone was eliminated by slouching. The two subjects were given a second session about two weeks after the first, during which the same ABA design was used but in which slouching terminated, rather than produced, the tone. The tone sounded only when the subjects were not slouching. The same instructions were given as in the first session.

RESULTS

Table 1 shows the percentage of time spent slouching for each subject when slouching produced the tone and when the tone was disconnected. All subjects slouched less when the slouch produced the tone than when the tone was disconnected. Slouching increased each time the tone was disconnected and decreased each time it was connected. For a given subject no overlap between conditions can be seen: more slouching occurred during each period without the tone than during

any period with the tone. The reduction of slouching occurred for the subjects who had the conditions alternated within each day as well as those who had it alternated between days (S-8, S-19, S-22). Similarly, the reduction occurred for the subjects who wore the tape-mounted posture switch as well as those who wore the harness-mounted switch (S-3, S-6, S-9, S-11, S-12, S-13, S-14, S-15, S-20, S-21); for the normals as well as the mental patient (S-20); for the females as well as males; for those who slouched a high percentage of the time as well as those who slouched only rarely; for those who wore the posture switch across the back as well as the one subject who wore it along the spine (S-7).

The extent of the reduction for each subject can be described by the fraction B-A/B in which A is the percentage of time spent slouching when the slouch did not produce the tone and B when it did produce the tone. This fraction is expressed as a percentage in the column on the right of Table 1. This percentage change of slouching varied between -62% and -97% for different subjects

Table 1
Effect of a Tone Punishment for Slouching for 25 Subjects

Subject	Percentage of Time Spent Slouching					Per Cent Change of Slouching by Punishment
	No Punishment	Punishment of Slouching	No Punishment	Punishment of Slouching	No Punishment	
1	34.4%	1.1%	51.1%	%	%	-97%
2	57.8	1.1	10.8			-97
3	25.8	0.9	18.1			-96
4	35.0	0.8	5.0			-96
5		0.4	7.8	0.4		-95
6	17.0	0.9	16.0			-95
7		0.5	8.1	0.5		-94
8		5.3	77.0	1.9	33.1	-94
9	93.1	4.4	57.7			-94
10		1.7	17.5	1.7		-90
11	8.0	0.9	9.8			-90
12	6.2	0.4	1.7			-90
13	32.2	4.4	49.8			-89
14	26.1	2.7	10.7			-86
15	57.3	8.0	30.6			-82
16	59.2	9.2	37.5			-81
17		2.1	6.2	0.4		-81
18	26.7	4.4	16.7			-80
19	2.9	1.4	10.8			-80
20		4.7	24.8	10.7	52.0	-80
21		6.3	16.3	1.2	21.3	-80
22	4.0	2.4	15.7			-76
23		4.2	20.0	6.7		-72
24		1.1	5.6	2.2		-71
25	2.5	0.8	1.7			-62

with a mean reduction of 86% for all of the subjects.

For the 16 subjects given the ABA design, a comparison of the first and third periods indicated somewhat less slouching after exposure to the tone contingency than before it. Statistical analysis by the Wilcoxin Signed Ranks Test (Siegel, 1956) indicated that this residual effect of the tone contingency was not significant ($P > 0.05$).

Table 2 shows the results of the procedure in which slouching terminated the tone rather than producing it. Both subjects showed an increase of slouching when the tone sounded and a decrease when the tone was again disconnected. The change in slouching was opposite in direction to that seen in Table 1 for the same two subjects.

Difficulties encountered in use of apparatus. Although all subjects indicated the apparatus was usable, some problems were noted that suggest improvements. (1) Subjects in preliminary studies complained of the social distraction caused by the sounding of the tone in the presence of another person, especially in relatively quiet surroundings. The present apparatus partly eliminated this problem by the 3-sec delay between the warning click and the tone; the subjects could correct their posture during this interval and avoid the tone. Several subjects stated that they would have preferred a longer delay or repeated warning clicks. These click sounds were not unusual and did not seem to draw the attention of others even in very quiet surroundings. (2) In a very noisy environment, such as exists near an air conditioner or fan or in some automobiles, some subjects stated that the tone was not loud enough to be heard. This problem seems to be of great importance only if the individual spends much of his time in such a noisy environment. (3) All subjects were asked about any inconvenience caused by the posture switch or the programming device.

The programming switch could not be worn inconspicuously by one subject since it produced a bulge in his form-fitting shirt; his participation was postponed to the next day when he wore the more usual type of shirt. Three subjects stated that the weight of the programming apparatus on the neckline was annoying. This problem had been solved for females by resting the apparatus in the center of the brassiere and for the subjects who wore the posture harness by attaching the necklace to the two harness straps that passed in front of the arms. (4) In response to the question of interference with activities, several subjects stated there was some interference initially but none after they learned to discriminate how much slouching was permitted and how long the delay was between the warning click and the tone. (5) Several instances of apparent false positives were reported. One that permitted no general solution was sounding of the tone while one subject, an attendant, was physically separating two combative patients. A second instance was when the shoulders were rounded while pushing a shopping cart, driving a car, or reading. In each instance the subject could learn to avoid the tone by tilting the torso forward slightly, thereby activating the vertical tilt switch and permitting the rounding of the back that is often normal when engaging in these activities.

DISCUSSION

The present results showed the procedure was effective in reducing slouching for all subjects during every period in which it was worn. The magnitude of the reduction was considerable, averaging 86% for all subjects and almost 100% for some. A slight enduring effect of the procedure was seen from the lower duration of slouching after exposure to the punisher than before it. Possibly longer periods of wearing the apparatus might have

Table 2
Effect of a Tone Punishment for Non-Slouching

Subject	Percentage of Time Spent Slouching			Per Cent Change of Slouching by Punishment
	No Punishment	Punishment of Non-Slouching	No Punishment	
12	36	87	68	+41
13	61	93	61	+53

decreased the slouching to an even greater extent. The large and consistent reduction of slouching by this procedure suggests the usefulness of this behavioral engineering approach for developing similar procedures for other behavior problems in which a body movement or orientation can be used to define the problem.

When slouching produced the tone, slouching decreased; when non-slouching produced the tone, non-slouching decreased. The results satisfy the definition of the tone as a punishing stimulus in that slouching was reduced when slouching produced the tone (Azrin and Holz, 1966). The tone also meets the definition of an aversive stimulus (Holland and Skinner, 1961) in that non-slouching increased in duration when non-slouching terminated the tone and similarly, slouching increased when that response terminated it. The present procedure represents a combination of punishment and escape conditioning of a free operant response. The click sound can be considered as a warning or discriminative stimulus for the tone. Previous findings of discriminated punishment show that a punished response will be suppressed by a warning stimulus that precedes the punisher (Dinsmoor, 1952; Azrin, 1956; Brethower and Reynolds, 1962; Hake and Azrin, 1965; and see review by Azrin and Holz, 1966); and an avoidance response will occur primarily during a warning stimulus that precedes the aversive stimulus in discriminated avoidance (Sidman, 1955; Ulrich, Holz, and Azrin, 1964; Azrin, Holz, Hake, and Ayllon, 1963; and see review by Hoffman, 1966). The click was included in the procedure to increase the control exerted by the tone. Unfortunately, the present method of recording posture did not permit independent evidence of this function, except for the verbal statements of several subjects that the click sound enabled them to correct their posture and to avoid the tone more easily.

The effectiveness of the tone as a punisher or aversive stimulus raises the question as to the reason for this aversiveness. One possibility is the inherent aversiveness of the tone because of its intensity, duration, or on-off pattern. Although the intensity of the sound was far below that found to be aversive in other studies with humans (Azrin, 1958), its long duration may have made it aversive (see Church, Raymond, and Beauchamp, 1967). A

second possibility is that the aversiveness was acquired in the manner of a conditioned punisher (Hake and Azrin, 1965) or a conditioned aversive stimulus by association with existing aversive events. One such event was the social distraction or embarrassment that often resulted when the tone sounded in the presence of others. A second event was the aversiveness of the behavior being treated. Slouching was defined for each subject as the degree of rounding of the back that he wished to avoid. If this degree of slouching is considered an aversive event for a given subject, the tone would be a conditioned aversive stimulus because of its pairing with that undesired posture. This explanation seems identical to the description of the tone as response feedback: the tone providing a warning that an undesirable behavior has occurred. As noted above, however, this feedback explanation cannot account for the *increase* in slouching when the tone was scheduled as a punisher for non-slouching. In summary, the present data showed that the tone was a punisher and that these punishing properties did not derive simply from the information that the tone provided about slouching. Mowrer and Mowrer (1938) also found that noise was an effective punisher but apparently because it awakened the enuretic patient. The present results reveal that a fairly mild tone can serve as a punisher for the waking individual and suggest its use in other behavior applications as an easily programmed stimulus consequence that does not cause the apprehension caused by electric shock (Powell and Azrin, 1968).

Although the critical feature of the present procedure seems to have been the presence of the tone and its relation to the response, several other explanations of the results should be examined. A novelty effect of wearing the apparatus could not account for the response changes since the apparatus was worn when the tone was operative as well as when it was disconnected. The click that signaled that the back was rounded could not have caused the reduction simply by providing feedback, since the clicks sounded all of the time that the apparatus was worn. Differences between subjects were not relevant since all comparisons were done within subjects. Variations in the nature of the subjects' activities could not account for the reduction since the subjects' activities were predetermined by the responsi-

bilities of their jobs. The effect of the simple passage of time was made comparable by the alternating sequence of the experimental conditions. The feedback or information function of the tone was not a critical factor, since the information was equivalent when the slouching produced the tone and when it terminated it; yet the slouching decreased in the former procedure and increased in the latter. This same reversal showed that the changes in slouching were not caused by a general suggestion effect of the instructions since they were identical for the two procedures. A simple "alerting" function of the tone also could not account for this reversal because the tone was present during both procedures but decreased slouching only when the slouching produced the tone. Thus, the click sound, the mere sounding of the tone, the wearing of the apparatus, the instructions, the identity of the subjects, and the passage of time were all comparable or controlled for between conditions by the within-subjects and within-sessions design; only the response-tone relation differed and would seem to be the principal reason to account for the postural change.

The practical applicability of the posture apparatus will depend on factors such as the need for treatment, convenience, effectiveness, interference with other activities, and characteristics of the patient. The apparatus seemed to be sufficiently convenient to wear during most everyday activities and did not interfere seriously with them. For long-term use, the harness arrangement would be more convenient than the tape arrangement: the patient would not require assistance each time the posture switch was removed, as in bathing and sleeping. The need for postural treatment is partly a medical question that can only be answered by the clinical practitioner for a given patient. In clinical practice, successive approximation to the desired degree of erect posture has been recommended for the treatment of severe slouchers (Williams and Worthington, 1957), a procedure to which this apparatus is well suited. The present technique appears to have some potential advantages over two of the major alternatives to postural control, which are postural braces and exercise periods. Unlike a fairly rigid back brace, the present apparatus permitted any type of posture or movement without discomfort. Ad-

ditionally, the relevant muscles must be used by this method rather than being passively supported as with the postural support. Unlike the limited periods of exercise, the present apparatus motivated the subjects to use the relevant muscles continuously rather than to hope for possible transfer from the exercise period.

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