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Use of an Avoidance Paradigm in the Treatment of Torticollis

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USE OF AN AVOIDANCE PARADIGM IN THE TREATMENT OF TORTICOLLIS

by

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Faculty of the School of Graduate Studies in partial fulfillment of the
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INTRODUCTION

The Sidman avoidance procedure (Sidman, 1953) has proven to be a useful research technique. With Sidman’s design, an animal is typically given brief electric shocks periodically. If a response specified by the experimenter as an avoidance response is emitted, the shock is postponed for a certain time interval. The fixed time interval between the avoidance response and a shock is called a response-shock (R-S) interval; the fixed time element between the shocks when no avoidance response occurs to postpone shock is called a shock-shock (S-S) interval.

Several studies, utilizing these procedures, have demonstrated the feasibility of avoidance conditioning despite the absence of an exteroceptive warning stimulus to indicate impending shock. Subjects as varied as rats (Sidman, 1953), monkeys (Kelleher and Cook, 1959), dogs (Black and Morse, 1961) and fish (Behrend and Bitterman, 1963) have been used in these studies. Although relatively few in number, some studies have extended the avoidance paradigm into research with human subjects using both noise (Azrin, 1958) and shock (Ader and Tatum, 1961; Ader and Tatum, 1963) as the aversive stimulus. The same basic procedure has been utilized in the treatment and modification of the maladaptive behavior of a self-destructive retarded child (Whaley and Tough, 1968).

Torticollis, more commonly referred to as wryneck, is a musculoskeletal reaction or twisting of the neck resulting in an ab-
normal carriage of the head (Armstrong, Pickrell, Fetter and Pitts, 1965). It is characterized by fibrosis and shortening of the sternocleidomastoid muscle, thus, pulling the head to one side (Horton, Crawford, Adamson and Ashbell, 1966). If left unattended, the muscles on the uninvolved side distend to compensate for the persistent pull to an abnormal position. Although the presenting behavioral symptoms are basically the same, there is a medical distinction between acquired and congenital torticollis (Horton, et al, 1966). Typical congenital muscular torticollis is encountered more frequently than the acquired varieties and is characterized by the growth of a fibrous tissue tumor (Horton, et al, 1966). The etiology of congenital torticollis is as yet unknown, although numerous explanations regarding its cause have been advanced (Horton, et al, 1966; Kidron, 1958). Because of its appearance in infancy or early childhood, early surgery is advocated and, for the most part, is successful in alleviation of the muscular contractions (Armstrong, et al, 1965; Horton, et al, 1966). Some medical authorities advise more conservative methods such as placing the child's crib so that attention is directed away from the affected side and have instructed the mother in manipulations of the child's head to further stretch the sternocleidomastoid muscle (Armstrong, et al, 1965).

Acquired torticollis, on the other hand, typically develops later in life and is vertebral, ocular of psychogenic in origin (Horton, et al, 1966). The behavioral manifestations of acquired torticollis are the same as those found in the congenital disorder. However, unlike the congenital disorders, acquired varieties of
psychogenic origin do not have tumorous growths or any other physiological cause. Modes of treatment range from surgery (Bunts, 1960) to hypnosis (Seeman, 1961), however, because of its acquired nature as compared to the congenital defect, no truly effective cure for acquired torticollis has been found. Unless treated rapidly, permanent facial and neck deformity may result.

Acquired torticollis exhibits basically the same muscular constriction as a massive tic. In those cases of torticollis believed to have a psychogenic origin, the behavior is under discriminative control. For example, the person whose physical activities are limited by the abnormal bodily carriage imposed by the twisted head and neck may be able to engage in rigorous athletic events that are to his liking. When engaged in such activities the person is not handicapped as his head returns to a normal position. Once the activity is over, however, the abnormal carriage of the head returns. It is feasible, therefore, to assume that torticollis, very much like a tic, is a learned response that exists because of previous or present environmental control.

The first study of tics based on a learning theory model was done by Yates (1958). Utilization of negative practice in the tic resulted in extinction of the undesirable behavior. Barrett (1962) using more sophisticated measurement techniques and operant conditioning also demonstrated control of a tic rate. Extension of learning theory principles has been successful in the treatment of other such pathological behaviors as anorexia nervosa (Bachrach, Erwin and Mohr, 1965), hysterical blindness (Brady and Lind, 1961),

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fetishism (Kushner, 1965) and operant stuttering (Flanagan, Goldiamond and Azrin, 1958).

The present study investigated the application of an avoidance procedure to the successful treatment of torticollis, a musculoskeletal disorder typically treated by surgery. It was hypothesized that this procedure would stretch, strengthen, and equalize both constricted and distended neck muscles, and, thus, allow normal carriage of the head. In theory, this procedure differs little from that involved in the treatment of congenital torticollis in early infancy, as previously described, except that it is used with an adult whose disorder is of an acquired nature.

METHOD

Subject

The subject was a 32 year old male with a musculoskeletal reaction medically diagnosed as torticollis. He had received his Ph.D. and had begun a teaching career prior to the onset of torticollis. In the beginning the tic was mild and appeared at bedtime when he would feel muscular twitches in his right shoulder. Within three months the tic was fully developed and debilitating to the extent that he could no longer teach or function in a research position. In the following 18 month period the subject sought help from neurological centers, sanitariums, physicians and private psychiatrists. One source was able to temporarily abolish the tic with the administration of sodium amytal, but the tic reappeared within two weeks. Other sources were not as effective and suggested the need for long term...
psychotherapy.

Behavioral manifestations were muscular spasms of the neck and shoulders with the eventual position of the head tilted over the right shoulder with the face oriented in a plane parallel to the shoulders. With effort, the subject could move his head to a center position or to the left. However, these positions could be sustained for only a few seconds at which time the head involuntarily returned to the right. The behavior in question was variable and reported, by both the subject and his wife, to be under the control of the environmental situation. The subject reported that he could play basketball, shoot pool, swim, smoke and drink with little, if any, difficulty. However, once these activities subsided the spasticity was reinstated. At the time of this study the subject had had this disabling condition for 18 months and was not able to work or engage in any prolonged activity.

Apparatus

Sessions were held daily in a room measuring 12' x 10' x 10' in the home of the subject. Programming circuitry was housed in the same room. The apparatus consisted of a high back chair constructed of 1/2" plywood measuring 58" x 35" x 21". Attached to the high back portion of the chair were four sets of restraining shoulder straps which restricted movement of the upper half of the subject's body. One set of straps were fastened over and under each shoulder and the remaining two sets were placed around the chest and waist. Two metal rods 12" in length protruded perpendicularly to the subject's head on either side when he was seated in the chair and functioned as outriggers. Both outriggers were sensitive to contact via a drinkometer.
circuit with the positive terminal attached to the outrigger and the negative terminal attached to the subject's leg. When he came into contact with either outrigger, the subject completed a circuit which triggered the activation of relays. The shock source was a nine volt battery interrupted by a six volt doorbell buzzer and transformed through a filament transformer. The shock was monitored by an A.C. milliampmeter. The three milliamp shock of .5 second duration was delivered through an electrode attached to the calf of the subject's left leg by means of an elastic bandage. When the shock placement was changed, shock was delivered through an electrode inserted in plastic finger guards to the middle finger of the left hand. A Grason-Stadler cumulative recorder and an Esterline-Angus twenty pen event recorder recorded right and left responses and shock delivery. Two recycling timers were used to program the response-shock and shock-shock intervals, and a running time meter recorded the amount of time the subject was in contact with the right outrigger. A bank of four Sodeco counters recorded responses to the right and left as well as shocks delivered at the end of the response-shock and shock-shock intervals.

Procedure

The experiment was conducted daily in two hour sessions with the subject seated in the chair throughout the session. The time of the sessions varied according to the compatibility of both the experimenter's and subject's schedule. The majority of sessions were conducted between the hours of 4:00 and 6:00 p.m. An experimenter was present in the room for the duration of each session.

The basic experimental design was a Sidman avoidance paradigm.
The subject was required to make a head movement to the left in order to avoid impending shock to the left leg. The specific head movement was defined as forehead or nose contact with the left outrigger. No exteroceptive stimulus warned the subject of delivery of shock.

The study was conducted in six phases which will be discussed in order. During Phase I, baseline data were collected to determine the amount of time the subject spent in contact with the right bar and the number of separate contacts with the right and left outriggers. The subject was seated in the apparatus two hours a day with electrodes attached to his leg. He was told only that the experimenters were interested in counting his head movements. The shock source was disconnected for this phase.

The subject was informed at the beginning of Phase II that he could avoid a shock by making a head movement to the left. The subject was further told that he had approximately one minute to make each left response. The electrodes were attached as in the previous phase and the shock source was connected. The response-shock interval was 60 seconds and the shock-shock interval was 10 seconds. This phase was terminated when the subject demonstrated 100% efficiency in avoidance throughout one two hour session.

Phases III, IV and V consisted of consecutive reductions in the response-shock intervals from 40 seconds to 20 seconds to 10 seconds. The shock-shock interval remained constant at 10 seconds. 100% avoidance during a two hour session at each response-shock interval was required prior to reduction of the response-shock interval. At the beginning of session 56 of Phase V, the shock placement was
changed from the calf of the subject's left leg to the middle finger of his left hand.

During Phase VI, the subject was required to maintain contact with the left outrigger for a period of five seconds. At the end of the five second period he had 10 seconds during which time he could break contact with the left bar. At the end of the 10 seconds the subject was required to reestablish five second contact with the left outrigger. Shock was delivered in the event that (1) the subject lost contact with the outrigger before the end of the minimum five second period or (2) the subject did not return to the left outrigger before the end of the 10 second "free" period.

Throughout the experiment the subject was allowed ad lib access to drinks and cigarettes, but could not leave the chair and the program in effect continued. The subject was also told about schedule changes on the day a new phase was introduced. Except for the last phase, the schedules were not explained in detail. If he inquired, the subject was also given information regarding his daily performance.

RESULTS AND DISCUSSION

Fig. 1 shows the number of head movement responses, both to the right and to the left. It indicates the number of separate contacts made with both outriggers in each session, thus, enabling a comparison of the effects of the various experimental manipulations. Fig. 2 shows the amount of time in a two hour session that the subject spent with his head tilted over his right shoulder, resulting in contact with the right outrigger. Fig. 3 is a dual ordinate graph indicating
both the number of shocks received and the percent of shocks successfully avoided per session. With the shock-shock interval constant at 10 seconds, the subject could receive a maximum of 720 shocks per two hour period. The percent of successful avoidance is figured by dividing the number of shocks avoided by the total number of possible shocks. The results of this study will be presented and discussed in the successive order of the six phases.

During the baseline, the number of right responses ranged from 1124 responses to 143 with a mean of 350.6 responses per session. The left responses ranged from a high of 67 to a low of 6 resulting in a mean of 27.4 responses per session. In addition, the time of the right (Fig. 2) increased from 81 minutes or 67.5% of the total session time to 119 minutes, 6 seconds which was 99% of the session time. It is interesting to note that the first session resulted not only in the highest number of both right and left responses, but also in the lowest amount of time spent on the right. As the baseline progresses, there is a decrease and stabilization of right responses, an increase in the time expenditure on the right and a successive decrease in left responses. A possible explanation for this decline in performance is adaptation to the apparatus and experimental procedures. Although the results of the first session are sufficiently different from the other baseline sessions, they do show the significant aspects and variability of the subject's behavior. The subject purposefully demonstrated to the experimenters how often he could turn his head to the left, etc. and, in general, engaged in his own form of experimentation with the novel apparatus during the first session. The
remaining baseline sessions were more consistent; adaptation to the apparatus and experimental situation had taken place. Therefore, the baseline data of Fig. 1 and Fig. 2 represent a return to the normal patterns of behavior.

The introduction of shock during the second phase resulted in a dramatic change of behavior. The response-shock interval was 60 seconds and the shock-shock interval was 10 seconds. For the first time, the left responses outnumbered the right responses; the mean number of left responses during this phase was 660.33, whereas the mean of the right responses was 142.5. Unlike the baseline phase, during which there was an increase in the time on the right concurrent with a decrease in right responses, the time spent on the right also decreased to a low of one minute, six seconds, or 1% of the total session time. During the first session of this phase, the subject received a total of two shocks, representing an avoidance percent of 99.7% (Fig. 3). Both shocks were received early in the session. The subject reported the unpleasantness of the shocks and his determination to avoid them henceforth. The subject received no shocks in the next session, thus, meeting the criterion of 100% avoidance. The response rate during the second session was of a more sustained nature in that it was lower and very stable. As indicated in Fig. 4, the rate, however, was five times higher than that required by the shock schedule. The introduction of the shock contingency produced a noticeable, rapid change in the subject's behavior. For the first time in months, he was able to prevent his head from remaining in the stationary, "locked-in" position over his right shoulder.
With the introduction of a new response-shock interval of 40 seconds in the third phase there was little dramatic change initially. During sessions 10-14 the number of responses both on the right and left outriggers remained relatively stable, as well as the time spent on the right. The number of shocks taken at the time were minimal ranging from one to four per session and representing 99.8 to 99.5% avoidance (Fig. 3) respectively. Following session 14, there was an abrupt increase in the number of right responses as well as the time on the right. Until the end of the third phase, the number of right responses continued to fluctuate in a somewhat erratic manner, as did the time element, although the time eventually stabilized around 20 minutes. The left responses also began an upward, inconsistent surge in later sessions. The mean number of right responses was 920; the left response mean was 714.7. For the most part, the responses per minute were still above the criterion necessary for avoidance and show little increase over the responses per minute during the response-shock interval of 60 seconds.

An analysis of the cumulative records from the initial sessions of Phase III reveals a stable, moderate rate of responding on the left outrigger with little adherence to the temporal aspect of the shock contingency. A possible explanation for the apparent degeneration in performance during later sessions can be found in the cumulative records and from the subject's verbal report. Adaptation to the new schedule had taken place and the subject, after taking several shocks since its first introduction, was less frightened of the possible onset of shock. He also reported that the schedule was lenient enough
to permit him to think of other things with a consequent lack of concentration on making the appropriate avoidance response. The subject then attempted to make temporal discriminations as to the approaching onset of shock. The cumulative records of later sessions are characterized by less stable responding and are composed of many small, somewhat discontinuous segments. Thus, it would seem that the schedule, along with the subject's adaptation to the experimental situation, allowed the subject to engage in inappropriate behaviors which at times were incompatible with the necessary avoidance response.

As indicated by the arrows labeled "A" in Fig. 1, there was apparatus failure during sessions 16 and 17. A one milliamp shock was delivered in place of a three milliamp shock during session 16. The difference in shock intensity was noticeable to the subject, however, the avoidance responses continued to show a slight increase. With this accidental reduction in shock intensity the subject spent 52 minutes of the two hour session on the right bar. During session 17, no shock was administered although it did register on all counters. Contrary to what might be anticipated when the contingencies were removed, there was a slight increase in the number of avoidance responses and a decrease in the time on the right bar as well as right responses. A possible explanation for the maintenance of responding without the shock contingencies in effect is the subject's own determination to make it through a session with 100% avoidance. All ten shocks that registered for session 17 were accumulated in the last 10 minutes of the session, thus, indicating a very fast degeneration in performance once the subject's goal could not be attained.
The fourth phase included a decrease in the response-shock interval to 20 seconds with the shock-shock interval remaining at 10 seconds. This phase is characterized by a slightly more stable configuration of left (Avoidance) responses and a continuously erratic rate of responding on the right that fluctuates concurrently with the amount of time spent on the right. The mean number of left responses per session was 715 which was higher than the mean number of right responses, 637. Initial cumulative curves indicate a high stable rate of responding progressing into a rate characterized by temporal discrimination patterns. The number of responses per minute remain approximately two times the number necessary for avoidance of shock (Fig. 4). Because of the subject's reliance upon temporal cues during this phase, he took as many as 19 shocks during a session. The response-shock interval, like that of R-S 40", was a difficult one for the subject to adjust to as can be seen by the number of sessions before 100% avoidance was maintained throughout a two hour period.

The response-shock interval was changed to 10 seconds at the beginning of the fifth phase. The change in response rate on the right and left outriggers is clearly more evident during this schedule. The left responses remained somewhat stable with a mean of 1277 responses per session. The number of right responses progressively decreased to a low of 69 responses, however, the mean for this phase was 465 responses.

The crucial variable accounting for the extreme separation of right and left responses and the decline in right responses was a change in electrode placement at the beginning of session 56 as
indicated by the arrows labeled "B". The electrode through which shock was delivered was transferred from the calf of the subject's left leg to the middle finger of his left hand and remained on his finger until the end of the study. Up to this point in time, performance (left responses) on this schedule was high, but relatively unstable, and the subject was receiving a large number of shocks per session. It was fairly evident that the shock was not aversive enough to control the subject's behavior. Subsequent to the placement change, the right responses dramatically decreased in number as well as the amount of time spent on the right. Concurrently, the number of shocks received by the subject decreased and there was a return to a high, stable rate of responding on the left. The immediate change in behavior as a function of a change in the electrode placement is evident in all three graphs (Fig. 1, 2 and 3). The subject reported increased aversiveness of the new shock placement and extreme fear of delivery of shock.

During the last phase, the subject was required to maintain contact for a minimum of five seconds with the left outrigger at which time contact could be broken for a maximum of 10 seconds. At the end of this 10 second interval or any time during its duration contact had to be reestablished or shock was delivered. Shock was also delivered if the subject, once he returned to the outrigger, did not maintain contact for at least 5 seconds. While no systematic observation of any behaviors other than bar pressing were taken in previous phases, there were dramatic changes in some of these behaviors during the present phase which are worthy of anecdotal description. Prior to
Phase VI, the subject had proceeded through the daily sessions with minimal difficulty and had exhibited none of those behaviors. At the onset of Phase VI, however, the subject loudly protested the need for further sessions, expressed a desire to terminate treatment, swore profusely, and concurrently sobbed and teared heavily. He then reconsidered and was able to complete one two hour session. The next day, the subject elected to terminate treatment and refused to further participate in the present study.

During the one complete session in this phase, the subject reported that he was afraid to break contact with the left outrigger because he would not be able to make a sustained return. Consequently, the subject maintained contact for 55 minutes despite the appearance of the above described behaviors. The subject returned to the left bar, but lost contact before the end of the five second period and consequently, received a shock. He immediately regained contact and retained this position for the remaining hour and 5 minutes. During this session there were three distinct left responses, zero right responses, and the total amount of time spent on the left bar was one hour, 59 minutes, and 46 seconds.

Surratt, Ulrich and Hawkins (1969) reinforced attending behavior and appropriate study behavior in normal first grade students. They noted anecdotally an increase in the volume of academic output as well as an increase in the quality of that output even though there were no programmed consequences for these two response classes. In the present study it would have been theoretically possible for the subject to have continued to emit the presenting symptom although this did not
occur at the same frequency as it had prior to the experimental manipulations. Even though the contingencies were programmed for lateral head movement to the left, there was a concomitant decrease in the rate of the massive tic which was partially replaced by a forward orientation of the head during those times when bar responses were not being emitted.

Sidman (1953a) noted that with continued avoidance training the rate of the avoidance response becomes relatively stable. However, when the time interval within which the subject is required to press the bar is changed, the response rate varies as a function of the interval (Sidman, 1953b; Sidman, 1954). As the response-shock interval decreases in length, the avoidance response rate increases along with the number of shocks received in criterion periods (Sidman, 1954). Initially, the cumulative curves of this study were relatively stable, but were composed of many small discontinuous segments. With continued training during each phase a stable rate was developed and maintained, for the most part, not only within but between sessions. When the response-shock interval decreased, however, there was minimal change in the rate of the avoidance responses as seen in Fig. 4. In the progression from a response-shock interval of 60 seconds to R-S 40" the change was from a mean of 5.5 responses per minute to 5.95 responses. A comparison of the rates during a R-S 40" and a R-S 20" reveals no change in rate. The most dramatic rate change is indicated during the R-S 10" interval when the response rate doubled (10.6 responses per minute). These data do indicate that the response rate varies as a function of the interval, although the change in rate may
be minimal. In all cases the avoidance rate was considerably higher than that required by the shock schedule, thus, corroborating Sidman's (1953a) earlier findings.

On an avoidance schedule the most efficient means of responding to the situation would be for the subject to separate his avoidance responses by an interval shorter than that of the response-shock interval. This was found to be true during some sessions when the R-S interval was 40 seconds and 20 seconds. As has been previously found (Sidman, 1958; Boren, 1961), when there was some temporal pattern of responding it was often accompanied by a number of closely spaced responses, i.e. "bursts", especially as the time for the shock approached or if shock was delivered, immediately after shock. These post-shock bursts can not be classified as avoidance responses. The pre-shock bursts are understandable in that the response probability increases markedly as the end of the R-S interval approaches. However, a complete explanation of the post-shock phenomenon has not yet been advanced. Perhaps Sidman's conjecture that there is generalization from the presentation of the aversive stimulus to the period immediately following the stimulus is reasonable (Sidman, 1958).

Despite the fact that the experimenters were not able to render a completely successful treatment due to the subject's refusal to continue, the study does dramatically demonstrate the fact that acquired torticollis may be controlled by environmental consequences. There are no physiological data to assert that this procedure was facilitative and successful in providing appropriate exercise for constricted and distended neck muscles. However, towards the end of the
study the subject was reporting increased mobility of the head and better agility in performing such tasks as shaving and bathing.

The study was complicated by several extraneous variables. First of all, the subject had exhibited these symptoms for a relatively long period of time, 18 months. As stated previously, torticollis must be detected in the early stages for treatment to be effective. Each minute of the day that the subject remained in an abnormal position defeated the purpose of the study. Secondly, there appeared to be some functional aspects of this behavior which would be lost had a treatment been effective. The subject had a long history of nervous disorders, nervous breakdowns and many visits to psychiatrists or any medical personnel who would talk to him. At the time of the study the subject also worried about a possible divorce and the loss of his children, but still would not return to work to support his family.

In the opinion of the experimenter the study could have been successful in its treatment of torticollis had additional activities been programmed for the waking hours of each day. The procedural components of the study were designed to force exercise of the neck muscles and to demonstrate to the subject that he was capable of normal head carriage. In addition the experimenters had secured a part time job for the subject which would have provided some positive social contacts, utilization of his skills, and contingencies and practice in appropriate behavior. Other activities such as calisthenics and jogging were also to be scheduled. The subject had already begun a "running-in-place" program as a preliminary phase to jogging, and had successfully progressed from 30 seconds to three
minutes of straight running. Most of these activities should have been programmed and required in an earlier portion of the study.

This study did demonstrate, nevertheless, the environmental control aspects of acquired torticollis and the possibility of more conservative measure of treatment than those currently utilized. For the most part, no effective cure has been found for acquired torticollis. Surgery can be employed, but not as successfully as in the correction of congenital torticollis. Many persons enter state hospitals or begin psychotherapy for lengthy periods of time with no guarantee of a successful outcome. Perhaps this procedure accompanied by appropriate programmed activities in which the subject is required to hold his head in a normal position may provide a means for the successful treatment of acquired torticollis.
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FIGURE LEGENDS

Fig. 1  The number of right and left responses per session.

Fig. 2  Time in minutes spent on the right in contact with the right outrigger.

Fig. 3  Dual ordinate graph indicating number of shocks received per session and the percent of shocks successfully avoided per session.

Fig. 4  Mean left responses per minute during each experimental phase.
Fig. 2