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Operant Control of Pathological Tongue Thrust

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OPERANT CONTROL OF PATHOLOGICAL TONGUE THRUST

by

George A. Thompson, Jr.

A Thesis
Submitted to the
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in partial fulfillment
of the
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Western Michigan University
Kalamazoo Michigan
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OPERANT CONTROL OF PATHOLOGICAL TONGUE THRUST

George A. Thompson, Jr., M.A.
Western Michigan University, 1978

Pathological tongue thrust (reverse swallowing) has been linked to malocclusion, articulation problems, difficulty in eating, and excessive drooling. Observable tongue thrust in a 10-year-old severely retarded male was modified during lunch using a contingent pushback procedure. Comparison of baseline and treatment data collected by the partial interval method showed a significant reduction in tongue thrust and food fallout and a substantial increase in observed chewing. Results indicated the possibility that an operant approach to treatment can be effective in the modification of this physiological response.
ACKNOWLEDGEMENTS

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George A. Thompson, Jr.
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WESTERN MICHIGAN UNIVERSITY, M.A., 1978
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Tongue thrust has been defined as a condition in which the anterior or lateral portions of the tongue contact more than half the surface area of either the upper or lower incisors, cuspids, or bicuspids or protrudes between them; or when, during swallowing, there is a visually observable increase in force, degree of protrusion, or amount of tooth surface area contacted by the tongue (Hanson, 1976). Demographic studies have suggested the prevalence of tongue thrust among normal school age children to be between 30.4% (Werlich, 1962) and 56.9% (Rogers, 1961). Two problems are correlated with persistent tongue thrust in normal individuals—severe dental malocclusion usually in the form of overjet and significant sound distortion during speech (Rix, 1946).

Tongue thrust is natural and normal behavior in suckling and swallowing and in the acquisition of speech in early life. Sometime between five and ten years of age, a transition away from the protrusive tongue movement takes place. Failure to achieve this results in pathological tongue thrust. The etiological factors underlying this lack of development are important because they form the basis for the various treatment approaches. The etiology of tongue thrust has been attributed to several factors, none of which has conclusively been established as the actual cause. Familial patterns of tongue thrust suggest a possible genetic connection (Ballard, 1955; Ballard & Bond, 1960; Gwynne-Evans & Tulley, 1956; Tulley, 1969), the problem is highly correlated with neurological disturbances such as cerebral palsy (McDonald & Chance, 1964; Palmer, 1948), and has been linked in some cases to respiratory obstruction (Bosma, 1963; Rix, 1946) and habit formation (Peterson & Fletcher, 1946).
Although spontaneous modification, apparently through maturation, has been reported (Anderson, 1963; Fletcher, Casteel & Bradley, 1961; Werlich, Note 3), research documenting the lack of spontaneous remission (Hanson & Hanson, 1975) is sufficient to warrant the development of an active intervention. Hanson (1976) has outlined four types of currently employed tongue thrust treatment strategies: (1) surgical and/or orthodontic modification of the oral environment; (2) mechanical restraints; (3) speech therapy; and (4) oral myofunctional therapy.

In the area of restraint, some positive effects have been obtained using dental cribs and rakes to impede the inappropriate tongue movements (Cleal, 1965; Subtelny & Sakuda, 1964; Subtelny & Subtelny, 1973) while Mason and Proffitt (1974) reported that speech articulation therapy promoted proper tongue position.

The treatment of choice in most cases and the one most widely discussed and reported successful is oral myofunctional therapy (Barrett, 1961; Garliner, 1971; Harrington & Breinholt, 1963; McCracken, 1978; Stansell, 1969; Case, Note 1; Overstake, Note 2). This approach consists of the application of vibration and massage directly to the oral structure for 20 minutes daily (McCracken, 1978) and of various tongue and mouth exercises (Peterson & Fletcher, 1976). Myofunctional therapy is an application of basic neurophysiological research. Sauerland and Mizuno (1970) found that stimulation of certain areas on the tongues of cats could effectively inhibit thrusting; and Schmitt, Yu, and Sessle (1973) further found that the stimulation applied could be mechanical and still inhibit tongue protrusion.
McCracken (1978) has reported some success in treating tongue thrust in severely impaired individuals using the oral myofunctional approach. Peterson and Fletcher (1976) reported that the failures they encountered in using this treatment were those cases where the client was uncooperative and/or disruptive--two characteristics often found in severely impaired populations. Although exact figures are unavailable, it is clear that the incidence of tongue thrust among the severely impaired is at least as high if not higher than that encountered in the normal population. The presence of tongue thrust in these individuals causes problems in addition to the dental and speech difficulties found in normals. The increased difficulty in food consumption may lead to nutritional problems especially when the individual resides in an institution. In addition, the foul aroma and unsightly appearance caused by constant drooling and food expulsion further decrease social acceptability.

Recent studies have shown that operant techniques can be successful in treating a number of medical problems. Budzynski and Stoyva (1969) demonstrated that feedback in the form of a tone with a pitch proportional to the electromyographic activity in a given muscle group could facilitate relaxation. Several studies have used punishment procedures to eliminate excessive vomiting and rumination (Kohlenberg, 1970; Linscheid & Cunningham, 1977; Sajwaj, Libet & Agras, 1974). Modification of gastrointestinal function (Kohlenberg, 1973; Whitehead, Renault & Goldiamond, 1975) and blood pressure (Elder, Ruiz, Deabler & Dillenkoffer, 1973; Elder, Welsh, Longacre & McAfee, 1977; Whitehead, Lurie & Blackwell, 1976) has been accomplished with notable success.

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In addition to these chronic problems, acute and congenital problems such as poor nasal resonance associated with cleft palate (Roll, 1977) and the frequency of seizure (Iwata & Lorentzson, 1976; Zlutnick, Mayville & Moffat, 1975) have been successfully treated using operant strategies. Operant procedures have several advantages over more traditional intervention strategies. They may be considered less intrusive than surgery, they are potentially more precise (i.e., oriented toward specific observable response contingencies) and therein more generally effective than more traditional methods such as myofunctional therapy, and their application can be effectively accomplished by paraprofessional staff.

The present study examined the effectiveness of an operant approach to the control of pathological tongue thrust. Although one might argue that the use of dental appliances discussed above may be more efficient, several factors such as the possibility that normal as well as pathological tongue movements may have been punished detracts from the reliability of the procedure and may account for the maintenance problems reported. The only report of an actual behavioral procedure in the treatment of tongue thrust comes from Stansell (1970) who used tokens to maintain attendance and data collection during myofunctional therapy.
METHOD

Subject and setting

A 10-year-old white male diagnosed as profoundly retarded served as the subject. He exhibited spastic cerebral palsy characterized by moderate spastic and athetoid quadriplegia and mild general motor dysfunction. He was unable to move effectively in an upright position in a saddle seat walker. Recent hearing and vision examinations indicated the possibility of significant hearing loss but that there was at least some use of vision. The subject failed to demonstrate consistent receptive language and exhibited only undifferentiated gutteral vocalizations.

Assessments conducted by an occupational therapist indicated pathological tongue thrust, no effective sucking, and no finger feeding or lip closure. In addition, formal psychological testing placed the subject between the 12th and 14th month of development. The subject was selected because traditional treatment methods failed to correct these problems, yet the target behaviors appeared under control at various times throughout the day. Therefore, the probability of gains based on an operant intervention strategy was considered high.

The subject resided at a private nursing home for handicapped individuals and attended school for five hours each day at a program for the severely mentally impaired. The intervention was conducted during the school lunch period each day, Monday through Friday; this session lasted between 10 and 30 minutes depending on several factors.
(e.g., food consistency, number of consequences, and the ability of the subject to breath through his nose). The lunch period was selected because the primary target behavior (tongue thrust) was most consistently exhibited during lunch and because its presence caused the most problems (i.e., drooling and expelled food) during lunch.

Informed consent for the procedure was obtained from the subject's parents, and the project was approved by a university human subjects' committee and the program director of the school.

Behavioral definitions

The following behaviors were scored during each session:

1. **Tongue out.** The tongue protruding from the mouth enough to touch the middle of the lower lip.

2. **Fallout material.** Food and/or saliva falling from the subject's face and/or neck onto the catch tray.

3. **Chewing.** The subject's mouth moving from the closed to an open position, while the tongue was in the mouth.

4. **Pushback.** The spoon coming into contact with the subject's tongue when food was not being presented. The pushback was an experimenter behavior, and it was only scored during the treatment phases.

Observers' and observation procedures

Observers consisted of several center staff and undergraduate psychology practicum students, all of whom were trained prior to the experiment during a pre-baseline observational period.

A partial interval observation procedure (Powell, Martindale & Kulp, 1975) was used throughout the study. During the first 7.5 seconds of each 10-second interval, all observers observed; during the final 2.5 seconds of the interval, all observers recorded. After
every five observation intervals, a ten-second rest period was provided. Observational prompts were provided by a cassette tape.

In addition to the interval data taken, observers also counted the number of pushbacks during treatment phases and the weight of the fallout throughout the experiment.

Reliability

Reliability data were collected on all variables for over one-third of the sessions in each phase and for 53% of the total number of sessions conducted. Reliability for the interval data was calculated by dividing the total number of agreements by the agreements plus disagreements and multiplying by 100. This formula was used to calculate percentage agreement for occurrences, nonoccurrences, and occurrences plus nonoccurrences.

In addition to interobserver reliability, intraobserver reliability was assessed by having each observer view a videotape of the same session twice with the observations separated by a two-week period. Calculations of reliability were accomplished in the same manner for intraobserver reliability as they were for interobserver reliability.

Total reliability was also calculated for the number of consequences delivered and the weight of food fallout; following independent observations, the smaller number obtained was divided by the larger number obtained for these two variables.

A summary of the reliability results is presented in Table 1. As can be expected, the lowest reliability scores were obtained when the frequency of responses was extremely high or extremely low. Total
reliability for the number of contingent pushbacks averaged 96% and ranged between 94% and 100%. Reliability for weight of fallout averaged 95% with a range of 91% to 100%. Finally, intraobserver reliability was 93%, 89%, and 84% for tongue out, fallout, and chewing respectively, based on one comparison of a videotaped session.

Procedures

Pre-experimental conditions. The subject had been exposed to traditional myofunctional therapy (Peterson & Fletcher, 1976) for two years prior to the present program. No changes were made in this pre-feeding program, which was continued throughout the experiment so that any observed changes in the target behaviors could be more readily attributed to the intervention procedure.

A differential reinforcement of other behaviors (DRO) procedure had also been implemented prior to the beginning of this study. Food was presented only when the subject's tongue was in his mouth; this procedure was unsuccessful apparently because of the subject's ability to consume food with the tongue out after a "tongue in" presentation had been made.

Baseline. The subject was positioned in the following manner to ensure proper posture and to allow accurate delivery of both food and consequences. He was placed in a chair so that his feet were flat on the floor. A Velcro strap was placed around each thigh and secured to
the chair so that the lower back was correctly positioned. The upper body was positioned by a Velcro strap placed around mid-trunk; and a one-half inch diameter, three-foot long rubber tube was run through the trunk strap and over the shoulders forming a V that kept the subject erect in the chair. His hands were placed in his lap, and an adjustable height cutout table was placed in front of the subject so that his head and shoulders were just above the level of the table top. During the procedure, the subject's head was held in midline by the experimenter.

Prior to each meal, all food was ground by a food processor (standard pre-experimental procedure) and was weighed using a metric scale so that each meal consisted of 300 grams of puree food. A Teflon-coated spoon was used to feed the subject and to deliver all consequences during the treatment phase of the study.

After the subject was positioned and the daily myofunctional therapy was terminated, food was presented to the subject when his mouth was empty without regard to tongue position. The food was removed from the spoon by the subject's upper teeth since no lip closure was present. Each spoonful of food weighed approximately five grams. The length of the session varied from 9 minutes to 20 minutes during baseline, with a mean of 13 minutes.

**Treatment.** After the subject was positioned and the myofunctional therapy was completed, food was presented only when the tongue was in the mouth. Food was removed with the subject's upper teeth. When the subject's mouth was empty, the next food presentation was made. Each time the tongue moved out of the mouth past the middle of the lower lip it was gently but abruptly pushed back into the mouth using the
Teflon-coated spoon. The spoon never moved into the mouth more than three centimeters. The length of the meal varied from 12 minutes to 28 minutes during treatment, with a mean of 17 minutes.

Follow-up. Data were collected once each week following the termination of the experiment using the same observation and recording systems used during previous conditions. The treatment procedure was in effect throughout this phase.

Experimental design

An ABAB reversal design (Baer, Wolf & Risley, 1968) was employed in this study because no other subjects were readily available and because the primary target variables (tongue out and fallout) were too closely related to allow accurate differential delivery of the consequences.

Social Validation

Videotape ratings. Observations and ratings of videotaped sessions were made by one occupational therapist and two physical therapists. These persons were asked to give their general clinical impressions of the procedure and to answer five questions relative to procedural effectiveness using a five-point rating scale, with 0% to 20% equal to "1" and 80% to 100% equal to "5." The five questions were asked as follows:

1. Based on your observation, what percent of the time was the subject's tongue out of his mouth?
2. Based on your observation, what percent of the session did you observe something fall from the student's mouth?
3. Based on your observation, what percent of the time did the student do some appropriate chewing?
4. Based on your observation, what percent of the time did the pushback correspond accurately with the occurrence of tongue out?

5. Based on your observation, what was the number of pushbacks delivered during the session?

Normative data. Soon after the implementation of the treatment condition, it became apparent that a reduction of "tongue out" to zero might not be an appropriate goal since some tongue out is functional during eating; for example, to clear the lips of food. In order to determine what an appropriate goal might be, baseline data were collected using the recording procedures described above, for tongue out and fallout, during a randomly selected meal for nine additional individuals. Of these, seven were severely retarded but not considered tongue thrusters; and two were normal adults.
RESULTS

Present results indicate that the contingent pushback markedly reduced both tongue thrust and subsequent fallout. In addition, a substantial increase in the amount of chewing is apparent across experimental conditions. The data for all target behaviors are presented in Figures 1, 2, and 3; and the means and ranges of occurrence for each target behavior across experimental conditions are presented in Table 2.

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Insert Figures 1, 2, and 3 and Table 2 about here
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Baseline data show a high rate of occurrence for tongue out and fallout and a concommitently low rate of chewing. Introduction of the contingent pushback resulted in a mean reduction of 57.4% in the percent of intervals scored tongue out and a 48.7% reduction in the percent of intervals scored fallout, while the mean percent of intervals scored chewing increased by 27.8%. Removal of the contingent pushback resulted in a substantial increase in the percent of intervals scored tongue out and fallout. Specifically, tongue out increased by 44.9%. During the reversal condition, the percent of intervals scored chewing failed to show a clear trend in one direction increasing by a mean of 2.4% over the mean rate of occurrence during the contingent pushback condition.

Reintroduction of the contingent pushback resulted in a 67.6%
reduction in tongue out and a 60.1% reduction in observed fallout over initial baseline. In addition, observed chewing continued to increase, resulting in a mean improvement of 37.4% over the mean score obtained for chewing during the initial baseline.

Data were also collected for the weight of fallout. A comparison of baseline and initial contingent pushback conditions shows a mean reduction of 16.8 grams, and a mean increase of 6.4 grams during the return to baseline, and a mean reduction of 22.8 grams over initial baseline levels during the final contingent pushback condition.

A comparison of the number and percent of contingent pushbacks from the first to the second intervention phases indicates a mean reduction of 1.9% scored intervals and a mean reduction of 32.3% in the number of delivered contingent pushbacks.

An important factor in the effectiveness of any intervention is the certainty of the consequence; that is, the correspondence between the occurrence of the target behavior and the delivery of the consequence. By comparing intervals scored tongue out by one observer with intervals scored contingent pushback by a second observer, a measure of correspondence was obtained. The results show a mean accuracy agreement of 84.9%. Of the 15.1% error rate, 59.7% were false negatives (instances where tongue out was not followed by contingent pushback); and 40.3% were false positive (instances where the contingent pushback was delivered when the tongue was not out).

Tables 3 and 4 show the results of the social validation analysis. Observation of persons not considered tongue thrusters indicated that actual tongue out ranging from 0% to 30% might not be considered a
"problem." Finally, the rating scales completed by professionals typically involved with traditional methods of tongue thrust intervention indicate that they agreed that the contingent pushback had been effective in achieving the desired changes in the target behaviors.
DISCUSSION

The results of the present study indicate that an operant approach to the control of pathological tongue thrust can be effective. Substantial reductions in tongue out and fallout were obtained along with a significant increase in the amount of observed chewing. This increase in chewing without specific reinforcement can be attributed to the fact that the subject tried various alternatives to the thrusting method of food consumption and was probably reinforced for correct behavior (chewing) by the ingestion of food. Another characteristic of the data collected on chewing is that it failed to show a clear reversal; this may be attributed to the fact that the definition of tongue out and chewing were not mutually exclusive, in that both could be scored in the same interval. A comparison of the data on fallout also warrants further explanation; the grams of fallout failed to show a clear trend during any condition. One reason for this might be that during baseline and reversal a large percentage of the fallout was in the form of saliva, while in the contingent pushback conditions much of the fallout was in the form of food, some of which was dropped from the spoon or knocked from the subject's mouth during the delivery of the food or the consequences.

Punishment was employed for several reasons. A DRO procedure had been attempted and found to be unsuccessful. Presentation of food contingent upon tongue in did not prevent tongue out from occurring during food consumption. Consequently, tongue out could be reinforced
even on trials where food had accurately been presented for tongue in. In addition, the topographies of the target behaviors were such that fine discriminations had to be made by the experimenter in order to shape tongue in. As a result, the length of the meal increased markedly; and the rate of observed change (i.e., tongue in at food presentation) was considered unnecessarily slow and highly unreliable. Finally, although the DRO appeared to change the topography of the tongue out response (duration decreased and frequency increased), a functional decrease in tongue out and fallout was not obtained. The effects of the punishment procedure were expected to be relatively fast.

McCracken (1976) has stated that oral myofunctional therapy is no more pleasant than dental work; and yet this subject had been exposed to this type of treatment for at least two years without substantial improvement.

Several factors probably contributed to the failure of the procedure to completely eliminate the problem. Many gaps occurred because of weekends, school closings, and student attendance problems. During the time of the experiment, 91 sessions were conducted over 380 calendar days. Never more than one session was conducted per day; and at best, 5 out of 21 meals were treated per week. In addition, occurrence of tongue out throughout the rest of the day was never consequated. It must be noted, however, that despite the failure to completely eliminate that problem the additional observation data show that the subject was within the range of other persons not considered tongue thrusters. Several factors also probably contributed to the variability of the data: the frequent interruption of treatment
discussed above; the variability in the characteristics of the food, taste, texture, moistness, viscosity; and the fact that the volume of the food available could not be controlled. The level of the subject's food deprivation and the amount of nasal obstruction were other possible factors contributing to the variability that were beyond our control.

In addition to the social validation data reported, reports of the physical and occupational therapists indicated that the procedure was effective in decreasing tongue thrust and drooling; that jaw movements that approximate chewing were more symmetrical and, therefore, more appropriate; that the consequences seemed to have physical prompt characteristics; and that there seemed to be more appropriate lip and tongue movements with partial elimination of some of the athetoid characteristics.

Obviously much research remains to be done in this area. Any final conclusions based on the data obtained from one subject can only be tentative. However, it seems clear that the relative effectiveness of this procedure over more traditional methods warrants its consideration as a viable alternative in some cases, especially those where the subject has not demonstrated consistent receptive language. Future research must investigate the use of more positive behavioral strategies, the modification of that component of tongue thrust that is usually unobservable because of closed mouth (this component was not dealt with in this present study), and the generalization of treatment effects. Eventually, an effective general strategy for the treatment of pathological tongue thrust might be developed based on behavioral principles rather than on the hypothetical constructs that currently form the basis
for the myofunctional approach.
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Table 1

Means and Ranges of Reliability across Experimental Conditions for All Target Behaviors

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<th>Target Behaviors</th>
<th>Reliability Type</th>
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<th>Contingent Pushback</th>
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<td>Tongue Out</td>
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Table 2

Means and Ranges for Target Behaviors across Experimental Conditions

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<td>57.56</td>
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<td>82-09</td>
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Table 3

Percent 10-second Intervals Scored Tongue Out and Fallout for Other Persons Not Considered Tongue Thrusters

<table>
<thead>
<tr>
<th>Subject</th>
<th>Percent Tongue Out</th>
<th>Percent Fallout</th>
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<tr>
<td>Retarded 1</td>
<td>13</td>
<td>4</td>
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<tr>
<td>2</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>30</td>
<td>17</td>
</tr>
<tr>
<td>4</td>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
<td>9</td>
</tr>
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<td>7</td>
<td>0</td>
<td>32</td>
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<td>Normal</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>9</td>
<td>5</td>
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Table 4

Mean Scores across Experimental Conditions on the Five-point Rating Scale where 1 = 0 to 20 and 5 = 81 to 100 (N = 3)

<table>
<thead>
<tr>
<th>Questions</th>
<th>Baseline</th>
<th>Contingent Pushback</th>
</tr>
</thead>
<tbody>
<tr>
<td>Based on your observation, what percent of the session was the student's tongue out of his mouth?</td>
<td>3.3</td>
<td>1.7</td>
</tr>
<tr>
<td>Based on your observation, what percent of the session did you observe something fall from the student's mouth?</td>
<td>2.7</td>
<td>1.3</td>
</tr>
<tr>
<td>Based on your observation, what percent of the session did the student do some appropriate chewing?</td>
<td>1.7</td>
<td>3.3</td>
</tr>
<tr>
<td>Based on your observation, what percent of the time did the pushback correspond accurately with the occurrence of tongue out?</td>
<td>NA</td>
<td>5.0</td>
</tr>
<tr>
<td>Based on your observation, what was the number of pushbacks delivered during the session?</td>
<td>NA</td>
<td>41-60</td>
</tr>
</tbody>
</table>
FIGURE LEGEND

Fig. 1  Percent 10-second intervals scored tongue out and contingent pushback during baseline and contingent reinforcement/pushback conditions.

Fig. 2  Food expulsion (percent 10-second intervals scored and weight) during baseline and contingent reinforcement/pushback conditions.

Fig. 3  Percent 10-second intervals scored chewing during baseline and contingent reinforcement/pushback conditions.
Contingent Reinforcement & Pushback Baseline

Contingent Reinforcement & Pushback Baseline

% Intervals: Tongue Out & Contingent Pushback

Sessions

Weeks