Decreasing Drooling through Techniques to Facilitate Mouth Closure

(neurodevelopmental therapy, oral-motor functions, jaw control, mental retardation, cerebral palsy)

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A single case ABA experimental design is presented in which techniques to facilitate mouth closure were hypothesized to decrease drooling. The subject was an 11-year-old male with mental retardation and cerebral palsy. Baseline 1 consisted of 10 half-hour sessions of play, followed by 1-hour periods during which the amount of saliva collected on an absorbent bib was measured and recorded. The subsequent treatment phase of 4 weeks was identical to the baseline except that a half-hour period of intervention was substituted for the half-hour of play. Intervention involved providing jaw control with intermittent tapping and jiggling, stroking the upper gum, and giving juice with jaw control. Baseline 2 consisted of 10 sessions identical to baseline 1. Results indicate that the amount of saliva leaving the mouth was a function of the presence or absence of intervention.

The patient who drools is frequently treated by the occupational therapist or speech pathologist within the context of feeding or articulation problems. However, drooling, which is a problem for many patient populations including individuals with mental retardation with or without cerebral palsy, is itself a major disability. Doll(1) reports that normally developing infants stop drooling toward the end of the first year of life. Because drooling is associated with infantile behavior, others interacting with the older child who drools tend to underestimate the child's abilities, and a vicious cycle of low expectations and underperformance might develop(2). In addition to its negative social impact, excessive drooling may cause the person to be at risk for dehydration or infection(8).

Jaw stability, mouth closure, and the ability to swallow play important roles in drool control. The normal act of swallowing implies that the mouth is closed and the jaw stable. When swallowing begins, the mandible is raised in full masticating force and remains so throughout the first two stages of swallowing (1, 5). The tongue is pressed forward and upward against the hard palate and arches backward into the pharynx. As the saliva moves backwards, the soft palate depresses and the pharyngeal wall is brought forward to squeeze the saliva into the pharyngeal region. Swallowing has been divided into three stages: 1. conscious and voluntary transport of the saliva to the back of the mouth; 2. conscious, but involuntary transport of the saliva through the laryngeal portion of the pharynx; and 3. unconscious and involuntary transport of the saliva through the esophagus.

Drooling in older individuals reflects oral motor dysfunction. Ekedahl, Mannson, and Sanberg (6) demonstrated that neurologically impaired droolers have marked abnormality of the first stage of swallowing, whereas the last two stages are intact. In neurologically impaired droolers, the first stage of swallowing is immature or abnormal, and manifests tongue thrusting and/or reverse swallowing (4, 6-10). The tongue protrudes through the teeth, the obicularis oris and other facial muscles tense to keep the saliva in the mouth. The first stage of swallowing is accomplished through contraction of facial rather than jaw muscles (9).

Inability to maintain jaw closure interferes with the ability of the lips to form a seal in order to keep the saliva in the mouth. As liquid pools
in the anterior region of the oral cavity, it may spill over the lower lip (7). Jaw closure is also required to facilitate normal coordination of tongue movements needed for the transport of saliva.

Abnormalities of muscle tone may contribute to problems in swallowing. Increased tone may restrict the freedom of movement necessary for smooth oral-motor coordination. Hypotonicity or spasticity of tongue and mandibular musculature needed to execute a normal swallowing pattern (7, 11). Abnormal oral reflexes, such as the bite reflex, may override the normally smooth coordination of the jaw. Abnormal postural reflexes may interfere with oral musculature and interfere with (7).

Problems of drooling have been related to abnormalities in, rather than absence of, swallowing (6). Hypotonicity of the mandibular and tongue musculature needed to produce normal tonic swallowing (7, 11). Abnormal oral reflexes, such as the bite reflex, may interfere with the normal coordination of oral, facial, and head movements needed for swallowing (7, 11). Abnormal postural reflexes may interfere with the normal coordination of oral, facial, and head movements needed for swallowing (7).

Drooling may be a sign of poor transport of saliva, which is a prerequisite to surgical approaches to drool control. Surgical procedures may have been used to alleviate drooling with varying degrees of success, most of them focus on decreasing the secretion of saliva rather than on improving transport to the back of the mouth. Surgical procedures include excision or ligation of the parotid and submandibular glands or division of the parasympathetic fibers (7). The Wilke and modified Wilke procedures are the only procedures to address the problem of poor transport of saliva by translabial (7).

The acquisition of mouth closure is a prerequisite to surgical approaches to drool control. These procedures do not completely eliminate saliva secretion; therefore, drooling can still occur if the mouth is open. Although many therapists attempt to facilitate mouth closure in the drooling client, few therapists have addressed this problem. The techniques of Morris (7) and Mueller (13) are among those most commonly used by occupational therapists and speech pathologists in treating the drooling client.

Moric and Mueller advocate a neurodevelopmental approach to the problem of drooling, emphasizing the normalization of muscle tone and the facilitation of appropriate movement patterns. Their techniques include placement of the client in a feeding position that inhibits abnormal postural patterns in order to permit isolated movements of the head and oral structures. If head control is not present, the head is supported. Techniques to normalize tactile hypersensitivity are also used, since hyperesitivitv, when present, interferes with the treatment process by triggering pathological responses. Maintained firm pressure is applied in and around the oral facial area as long as it can be tolerated. The jaw is held closed and the outer gums are rubbed with three firm strokes on one side and then, after a swallow, the other side. This facilitates jaw closure and an automatic swallow. Rubbing is thought to cause increased saliva production and thus provides an opportunity to facilitate a coordinated swallow. Jaw control is given to inhibit tongue thrusting and facilitate a normal swallowing pattern. Jaw control before a stimulus is presented also helps to prevent head and jaw hyperextension in anticipation of the presentation of food. Support is gradually decreased as jaw closure becomes automatic. In order to obtain an automatic swallow, treatment is given throughout functional activities and before and during meals.

Despite the devastating impact that drooling has on the affected patient and on the number of therapists employing neurodevelopmental techniques for its remediation, we did not find any studies that tested the effectiveness of these techniques. Therefore, the purpose of this study was to decrease drooling by facilitating mouth closure. The investigation was a single case experimental design with an initial baseline, an intervention period, and a final baseline.

Method
Subject. The subject was a 11-year-old child with cerebral palsy (spastic quadriplegia). He was nonambulatory and could not sit unsupported. Head control was noted in supported sitting but could not be maintained for prolonged periods. Extension of the head predominated, and posture and movement patterns were influenced by the presence of neurological reflexes. Cognitive skills had not been assessed. The subject was nonverbal but was able to respond to simple commands. He was learning to communicate nonverbally. No vocalizations were heard during the initial assessment.

Observations of oral-motor functions revealed an open mouth posture at rest, jaw thrusting with head extension, and minimal lip closure. In complex drinking he demonstrated a suck-swallow pattern with some gulping and had difficulty closing his mouth. He was able to close his mouth upon command, usually by flexing his head. Some up and down chewing motions were noted. He demonstrated a tongue thrust in swallowing, and no lateral tongue movements could be elicited. The subject had a malocclusion of the teeth. Sensation may have been depressed since he did not swallow during feeding until his hand was
brought to his mouth. No hypersensitivity to touch was noted in the oral-facial area. The subject had been drooling since infancy. His shirt was usually wet, and he required frequent bib changes to keep him dry. No specific intervention had been addressed to the problem up to the time of the investigation.

**Procedure.** Treatment and baseline activities were presented in a distraction-free room at a center for mentally retarded children where the subject resided. Data were collected 5 days per week for 2 weeks during each of the baseline periods. The subject was seen for a half-hour period by the examiner when he was presented with a variety of games and given 6 ounces of juice, an amount equal to that he received during each session of the intervention phase. During these baselines and during the intervention phase, the subject was positioned in a wheelchair with head and trunk supported.

Intervention took place 5 days per week for 4 consecutive weeks. The subject received treatment for a half hour. Methods described by Niessler (13) were used to facilitate jaw closure. Jaw control was applied by placing the middle finger of the left hand under the subject's chin and the thumb on the side of the face. Intermittent tapping and jiggling were given as needed to decrease jaw thrusting and facilitate mouth closure. Jaw control was applied while the subject drank 6 ounces of juice. The purpose of this activity was to stimulate saliva production to allow the build-up of saliva in the mouth while providing jaw control. Pooled saliva is hypothesized to stimulate tactile receptors in the mouth to trigger an automatic swallow during a functional activity (13). The subject was assisted in maintaining mouth closure by placing two lingual.

**Figure 1**
(a) Daily weights of saliva are plotted across the three phases on a linear scale. (b) Daily weights of saliva are plotted across the three phases on a semilog scale so that calibration lines could be computed. (c) Baseline measure. (t) Treatment measure.
gers under the chin while strokes were applied to the upper line of the gum from midline laterally. The strokes were given three times in each direction with a pause to permit a swallow. The purpose of this activity was to further increase tactile cues to trigger a swallow with the mouth closed. Jaw control was decreased as active mouth closure occurred.

After each half-hour period, whether during baseline or intervention, the subject was positioned in his wheelchair and taken to a day activity room where other clients were present. At that time, the amount of drooling was measured by weighing the quantity of saliva (in centigrams) that fell on an absorbent bib. The bib was weighed before and after application and the difference was recorded. The dependent variable was the weight of saliva that collected in a 1-hour period.

Results

Typically, the interpretation of single-subject experimental design relies on visual examination of graph data (14). Figure 1a presents the results of the study throughout the 8-week period. During the first baseline period, bib weight remained stable with a slight increase at the end of the second week. Drooling increased at the beginning of the intervention period and declined to a stable level by the end of the second week. (Little fluctuation was noted over weekends during the first two periods.) The new level was substantially lower than the initial baseline measures. During the final baseline period the weights increased and continued to fluctuate.

To assist in the visual analysis of the graph, Wolery and Harris (14) and Kazdin (15) suggested the use of the split-middle technique to calculate celeration lines that indicate the slope and the magnitude of each baseline or treatment phase. To calculate the celeration line, the data must be re-graphed into a semilog chart (see Figure 1b).

When drawn according to published guidelines (14, 15), the celeration lines confirm a major upward thrust in the slope of the treatment phase when compared with the slopes of the two baselines. The slope changes in the hypothesized direction.

There is much hesitancy to apply statistical analysis to single case experimental design, and one of the strongest arguments against its use is the presence of serial dependency, or autocorrelation (14, 15). Serial dependency refers to a correlation between data points separated by different time intervals (lags) in the series. Lag 1 is computed by pairing the first observation with the second observation, the second with the third, and so on throughout the series. Lag 2 is computed by pairing the first with the third, the second with the fourth, and so on. A strong positive correlation on Lag 1 indicates serial dependency (see Figure 2).
Serial dependency, as found in this study, violates the most important assumption of t tests or F tests, namely, the independence of error components. Therefore, no statistical analysis was performed in this study.

Discussion
The results support the hypothesis that techniques to increase mouth closure will decrease drooling. The amount of saliva that collected on the bib was clearly a function of the presence or absence of intervention. Not only was drooling less during intervention than during baseline, but also the slopes of the lines in the three periods confirmed the effectiveness of the intervention. From the start of the intervention to its finish there was a definite downward trend, and the trend was reversed upon the reiteration of baseline.

Drooling was not, however, completely eliminated. The residual amount of drooling toward the end of the intervention period may have been related to other oral-motor factors such as tongue thrusting or jaw thrusting during extensor spasms.

The day-to-day fluctuation of measures during the final baseline period may indicate that the intervention had a prolonged effect. A longer final baseline period may have been beneficial to see whether the measures would stabilize. The possibility of long-term effects of intervention would help explain the stability of measures over weekends without treatment during the intervention period. The subject's caregivers reported a generally drier shirt during the day, an observation that would also support the hypothesis of carryover beyond 1 hour.

Mueller (18) and Morris (7) stated that treatment to decrease drooling often also improves oral-motor function for feeding and speech. A reported increase in vocalizations by the subject's teachers during the intervention period of this study supports this notion.

Conclusions
Treatment to increase mouth closure was found to be successful in decreasing drooling in an 11-year-old male with mental retardation and cerebral palsy. However, drooling was not completely eliminated, which suggests that areas of oral-motor function other than jaw closure may be responsible for control of saliva. In addition, the older client may require a longer period of intervention to effect prolonged improvement of mouth closure. Because this was a single-case design, no generalizations of effects to other clients can be assumed. Therefore, further research is suggested that involves: 1. replication of this study with other subjects; 2. multiple baseline research or group studies to see the long-lasting effects of treatment; or 3. other dependent variables in oral-motor function. The main implication for occupational therapists is that treatment to facilitate mouth closure can be effective in decreasing drooling. Further study is needed to add further support to the use of methods currently used by therapists in addressing oral-motor dysfunction in clients who are mentally retarded and cerebral palsey.

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