Patterns of Feeding, Eating, and Drinking in Young Children with Down Syndrome with Oral Motor Concerns

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Thirty children with Down syndrome from 8 months of age to 4 years 11 months of age were seen for an evaluation of oral motor skills related to feeding, eating, and drinking. The children were referred for evaluation because they exhibited oral motor concerns. Although the data can be used to describe problems and patterns in feeding, eating, and drinking of some children with Down syndrome, it is not possible to generalize the findings of this study to all children with Down syndrome. Observational data on postural stability, position of the oral structures at rest, spoon-feeding, chewing, bolus formation, and drinking were analyzed. Approximately half of the children demonstrated some postural concerns. The children with Down syndrome in the study were generally found to have symmetrical patterns in the areas of posture and jaw movements. Hypotonia was present in most of the children, but different degrees of hypotonia were evidenced in different oral structures. Low muscle tone was observed more frequently in the tongue than the lips. Decreased sensory awareness and feedback, jaw instability, reduced upper lip mobility, open mouth posture, and tongue protrusion were some of the observed factors that impacted on feeding, eating, and drinking. The results supported many of the anatomical and physiological findings that have been reported in the literature as associated characteristics for children with Down syndrome. The discussion considers compensatory and developmental patterns observed. Directions for future research are explored.

Children do not begin to speak at birth. However, they use the oral structures that will be used for speech in the processes of feeding, eating, and drinking. "The human feeding cycle is dependent on an integrated sequence of events requiring the coordination of over 20 different muscles for the movement of saliva or ingested foods from the mouth to the stomach" (Reilly, Skuse, Mathiesen & Wolke, 1995). Speech appears to be an overlaid function using many of the same structures and movements used in feeding. Although the neurological control for these processes originate in different areas of the brain (Moore & Ruark, 1996; Ruark & Moore, 1997; Moore, Smith, & Ringel, 1988), the process of speech employs the same mechanisms that are used for the more basic biological functions of feeding, eating, and drinking.

"The mouth is highly organized in its responses long before the body can be handled in a predictable manner....More sensory nerve fibers are present in the mouth than in any other part of the human body, and evolution of mouth function supports organization of the entire body" (Nelson & DeBenebib, 1991, p. 131). The mouth is a sensory environment, which can be affected by treatment. Clinicians have found that oral tactile sensitivity can be normalized in the process of feeding therapy. "The various parts of the mouth need to relate to one another at a sensory level to coordinate their function, so the clinical objective becomes one of introducing more normal movement sensations and establishing the orientation of each segment of the whole to encourage more normal function (Nelson & De Benebib,1991, p. 137). Normalizing sensation forms the basis for working on oral movements and function.

The sensory, postural, and oral motor foundations for speech are developed during the first two years of life in the typically developing child. For children with Down syndrome, the pre-speech period may be extended. Children with Down syndrome may not begin to use speech until ages 3 to 5 years. During the pre-speech period, it is important to provide the child with an expressive system of communication (e.g., sign language, picture communication, etc.), while addressing the oral sensory and motor needs of the child that will form the basis for speech production. It is important to begin treatment addressing the oral motor needs of children with Down syndrome in infancy. This has not typically been the approach of many early intervention programs. Oral motor treatment has often not been provided until 18 months to 2 years of age or has not been part of the treatment plan.

By analyzing the feeding, eating, and drinking patterns of children with Down syndrome with oral motor concerns, we can learn more about the processes that need to be more specifically developed or refined to provide support for later developing speech. Children with Down syndrome exhibit both anatomical and physiological differences that are documented in the literature and that appear to have an effect on overall oral motor development, including feeding, eating, drinking, and speech production. The purpose of this descriptive study is to document and provide information on the processes of feeding, eating, and drinking in children with Down syndrome with oral motor concerns from 8 months to 5 years of age. This will begin to provide a knowledge base about the development of oral motor processes in children with Down syndrome.

Review of the literature

The research literature has documented many structural and physiological characteristics in children with Down syndrome that impact on feeding, eating, and drinking. These include:

- small oral cavity
- hard palate abnormalities
- malocclusion (i.e., an abnormal relationship between the dentition of the upper and lower jaw)

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- lax ligaments in the temporomandibular joint (i.e., the joint that allows the lower jaw to move)
- relative macroglossia (i.e., average sized tongue in small oral cavity)
- true macroglossia (i.e., enlarged tongue)
- hypotonia (i.e., low muscle tone) in the lip, tongue, soft palate, and jaw areas
- open mouth posture (i.e., mouth habitually open at rest)
- abnormalities of the neuromuscular junctions of the tongue (Yarom, et al., 1986)
- poor neuromotor control of tongue movements
- mouth breathing
- chewing difficulties
- bruxism (i.e., tooth grinding)

The small size of the oral cavity appears to be related to the individual having a small skull, missing or poorly developed midfacial bones, and a small but wide mandible (Frostad, Cleall, & Melosky, 1971; Kislin, 1966; Miller & Leddy, 1998; Roche,Roche, & Lewis, 1972; Sanger, 1975). Although some researchers have described the hard palate as short and narrow (Redman, Shapiro & Gorlin, 1965; Shapiro, Gorlin, Redman, & Bruhl, 1967; Shapiro, Redman, & Gorlin, 1963), other researchers describe a high palatal vault (Stoel-Gammon, 1997; Kumin, 1996). Some cite a "v" shaped stair palate configuration (Desai, 1997). A majority of individuals with Down syndrome have been reported to demonstrate Angle's class III malocclusions (i.e., the lower teeth are anterior to the upper teeth) with prognathism (i.e., protruded lower jaw) (Borea, et al., 1990; Desai, 1997).

Although most researchers have noted tongue protrusion, there is no general agreement about whether the tongue is enlarged. (Ardron, Harker, & Kemp, 1972; Cavanagh, 1995; Nowak, 1995). Some researchers have found an average sized tongue, while others have reported that the tongue is enlarged (i.e., true macroglossia). Even when clinicians and researchers report a normal sized tongue, the combination of a small oral cavity and a normal sized tongue (i.e., relative macroglossia) may limit the distance and range of movement that the tongue can display (Miller & Leddy, 1998). The small oral cavity, normal sized tongue, hypotonic lip and jaw muscles, and lax ligaments (Rynders & Horrobin, 1996) in the temporomandibular joint can result in open mouth posture (i.e., mouth habitually open at rest). Other factors contributing to open mouth posture include frequent upper respiratory infections, enlarged tonsils and adenoids, and allergies which may result in the need to breathe through the mouth. (Kavanagh, 1995).

Hypotonia or low muscle tone is present in most children with Down syndrome. One study estimated the incidence of hypotonia as present in over 95% of children with Down syndrome (Share & French, 1993). Hypotonia has an effect on feeding, eating, drinking, and speech production. Functionally, hypotonia may result in open mouth posture, drooling, difficulties with lip closure, angle of mouth pulled down, tongue protrusion at rest, aspiration related to hypotonia of the pharyngeal musculature, and pharyngeal muscle incoordination (Desai, 1997, Frazier & Friedman, 1996; Spender, Stein, Dennis, Reilly, Percy & Cave, 1996). The muscles of the oral mechanism are poorly dissociated secondary to prevailing low oral muscle tone and difficulties with neuromotor control. Functional difficulties observed by Borea, Magi, Mingarelli, & Zamboni, (1990) in a study of 50 children with Down syndrome included mouth breathing (96%), chewing difficulties (66%), and bruxism or tooth grinding (45%). Other effects noted by researchers include reduced hand to mouth and toy to mouth play as well as reduced sensory feedback resulting in difficulties with food management and saliva control (Boehme, 1990).

Infants with Down syndrome often demonstrate a variety of difficulties with feeding related to a small oral cavity and hypotonia. The low muscle tone is especially evident in the small muscles needed for suckling (Rynders & Horrobin, 1996). This can contribute to liquids often spilling out of the side of the mouth. In typically developing infants, the tongue usually forms a groove that assists in transporting liquids to the back of the mouth and in forming a tight oral seal for suckling. In children with Down syndrome, hypotonia causes the tongue to be flat in shape during suckling. This contributes to difficulty with early suckling behavior (Rogers & Coleman, 1992). Frazier and Friedman (1996) found that young infants with Down syndrome had difficulties which included problems with the initiation of suckling, lip seal weakness, insufficient suction on the nipple, fatigue, and incoordination of the suck-swallow-breathe sequence.

In older infants and children with Down syndrome, poor control of tongue movements will often result in gagging and rejection of increasing food textures (Rogers & Coleman, 1992). Children with Down syndrome may have difficulty with specific food textures, i.e. puree, semi-solid, and crackers (Spender et al., 1995, 1996). Other difficulties include delayed opening of the mouth to begin the feeding process, insufficient lip closure, arrhythmic sequencing in the oral stage of swallowing, poor control of the bolus through the oral transit stage, insufficient jaw stabilization, and difficulty grading jaw movements (Frazier & Friedman, 1996, Spender et al., 1995, 1996).

Frazier and Friedman (1996) found that children with Down syndrome exhibit both oral hyposensitivity and oral hypersensitivity. Characteristics of oral hypersensitivity included "rejection of age-appropriate food textures; reduced acceptance of food tastes, temperatures, or smells; picky eaters; aversive or exaggerated response to touch in/or around the mouth; hyperactive gag response; aversion to brushing teeth; and lack of age-appropriate mouthing of toys/hands" (Frazier & Friedman, 1996, p. 699). Rejection of highly textured foods may also be related to oral hypersensitivity (Frazier & Friedman, 1996). Characteristics of oral hyposensitivity included "poor or no awareness of food on lips, slow registration of food in mouth, pocketing of food, and stuffing of mouth" (Frazier & Friedman, 1996, p. 699).

The anatomical and physiological differences affecting feeding, eating, and

drinking also "affect motor speech production probably disrupting the accuracy, speed, consistency, and economy of speech movements thus altering the sequencing and timing of speech" (Miller & Leddy, 1998, p. 168).

"Early automatic patterns of oral, respiratory, and phonatory movements that are part of the child's normal neuromotor system provide the model for similar movements that will be incorporated later in speech production. This concept suggests that the sensory feedback of using of lips to clean the spoon and the separation of tongue from jaw movements in swallowing provide a model to the child when voicing is added and the realm of sound is explored. For example, the movement of the lips coming together and blowing bubbles at mealtimes becomes a familiar behavior that is easily incorporated into the child's sound-making routines to produce 'raspberries' and bilabial sounds. These early patterns develop into the later oral movements that accompany vocalization and are involved in building the repertoire of babbling sounds" (Morris, 1987, p.83-84).

Difficulties with postural control have been noted in the literature and appear to be related to delays in the attainment of motor milestones in children with Down syndrome (Cobo-Lewis, A. B., Oller, D. K., Lynch, M. P., Levine, S. L., 1996). Cobo-Lewis et al. (1996) suggest that possible neuromuscular links among postural and rhythmic behaviors directly affect motor and vocal behaviors. Lauteslager, Vermeer, & Helders, (1998) discussed disturbances in postural control related to hypotonia in children with Down syndrome. These include insufficiency of co-contractions and balance reactions, reduced proprioception, and increased joint mobility. Specific problems noted clinically may include difficulties in achieving and maintaining trunk, shoulder, neck, head, and jaw stability as well as dissociated movements of the jaw, lips, and tongue. The development of feeding, eating, drinking, and speaking are directly influenced by the reduced postural tone. Although the postural tone of children with Down syndrome increases over time, it is essential to note that "the development of basic motor abilities takes place under the influence of a reduced postural tone" (Lauteslager, et al., 1998, p. 13).

Method

Thirty children were seen for a diagnostic evaluation. The children ranged in age from 8 months to 4 years 11 months of age. Seventeen children were male, and 13 children were female. There were 5 children between 8 months and 1 year 11 months of age, 8 children between 2 years and 2 years 11 months of age, 8 children between 3 years and 3 years 11 months of age, and 9 children between 4 years and 4 years 11 months of age. The subjects in this study were not randomly chosen but were being seen because they exhibited oral motor concerns.

Table 1

Age of Subjects

Age Range	Number of Subjects
8 months to 1 year 11 months	5
2 years to 2 years 11 months	8
3 years to 3 years 11 months	8
4 years to 4 years 11 months	9

Each child was seen individually. All evaluations were supervised by a certified speech-language pathologist with extensive experience. In some cases, a graduate student clinician who was closely supervised by a certified speech-language pathologist was presenting the items during the evaluation. All data were reviewed by a certified speech- language pathologist with extensive oral motor evaluation experience. Parents completed an oral motor questionnaire and an interview based on the questionnaire. All parents observed, participated, and provided feedback in the evaluation process. A battery for oral-motor behavior observations was developed for the purpose of collecting data. The battery was based on assessments by Elizabeth Mackie (1996) and Judy Michels Jelm (1995). Each evaluation included detailed observation of postural stability, oral structure and function, feeding, eating, and drinking patterns. Children had the opportunity to eat and drink age appropriate foods and liquids. When possible, the children were observed eating a wide variety of food textures. Each evaluation lasted between 2 and 3 hours and included observations of the child, observations of the parent feeding the child, as well as parent-professional consultation and training.

Results

Results were grouped according to areas assessed. The evaluator looked at each individual to determine postural stability and the position of the oral structures at rest. Oral motor behaviors including spoon-feeding, chewing, bolus formation, and drinking were also evaluated.

The assessment of postural stability included observation of body position while the individual was seated. The position of the trunk, shoulders, neck, and head were observed. Approximately half of the 30 children sat up straight (52%) while 48% sat with backs slouched. Body position was generally symmetrical. Asymmetries were noted in less than 5% of the children assessed. In most of the children, the shoulders were generally in a level position (78%). Fifteen percent of the children elevated their shoulders. Approximately half (57%) of the children had adequate trunk stability for fine oral movements (e.g., imitative lip and tongue movements as well as speech production). Eighty-two percent of the children maintained normal head positioning. However, 11% demonstrated a chin-tuck position, and 11% of the children hyperextended the neck (i.e., head resting on shoulder girdle). When positioned with

Table 2

Postural Stability

Behaviors Observed	Percentage Exhibiting Behavior
Sits up straight	52%
Sits with back slouched	48%
Leans body to the side	3%
Shoulders in level position	78%
Shoulders elevated	15%
Shoulders asymmetrica	14%
Adequate trunk stability for fine oral movements	57%
Head in normal position	82%
Chin is tucked	11%
Neck is hyperextended	11%

Improvement in mouth position when positioned with 90 degree hip, knee, and ankle flexion 63%

90-degree hip, knee, and ankle flexion, improvement in mouth position was noted in 63% of the children. See Table 2 for summary of results.

The assessment of oral structures at rest included observations of the jaw, lips, and tongue. The majority of children demonstrated normal jaw alignment, open mouth posture, low muscle tone in the tongue, tongue held outside the mouth, and low tongue position when the tongue was held in the mouth. Only 15% of the children demonstrated atypical jaw alignment which took the form of jaw protrusion or Angle's Class III malocclusion (i.e., prognathism). Twenty-nine percent of children maintained closed lip posture at rest. Approximately half of the children (44%) exhibited low muscle tone in the lips. Drooling was evident in 41% of the children evaluated. There appeared to be a pattern in which drooling occurred in the first year and again in the third year with the 3 year old children demonstrating greater awareness of the presence of drool. The majority held the tongue outside of the mouth at rest (52%). None of the children demonstrated a normal tongue resting position (i.e., tongue tip/apex elevated to alveolar ridge). For some children, the tongue rested on the lower lip (21%). When the tongue was held inside of the mouth, 74% of the children exhibited a low tongue resting posture. The majority of the children exhibited low muscle tone in the tongue (80%), while 20% exhibited normal muscle tone in the tongue. None of the children demonstrated high muscle tone or fluctuating muscle tone in the tongue. The results can be seen in Table 3.

Table 3

Oral Structures at Rest

Behaviors Observed	Percentage Exhibiting Behavior
Normal jaw alignment	85%
Protracted jaw	15%
Retracted jaw	0%
Lips open at rest	71%
Lips closed at rest	29%
Low muscle tone in lips	44%
Does not drool	59%
Drooling noted	41%
Awareness of drooling	33%
Tongue inside mouth	48%
Tongue outside mouth	52%
Tongue rests on lower lip	21%
Low tongue placement in mouth	74%
Low muscle tone in tongue	80%
Normal muscle tone in tongue	20%

The assessment of oral movements during the process of spoon-feeding included the observations of the jaw, lips, and tongue. Some of the areas assessed during spoon-feeding included sensory awareness, sensory feedback, and practical outcomes (e.g., wiping spillage). The majority of the children demonstrated jaw opening at midrange (78%), symmetrical jaw movement (92%), mouth opening in anticipation of food (91%), and graded jaw movement (69%). To grade movement means to gradually open and close the jaw in response to the size of the spoon and the amount of food on the spoon. During spoon-feeding, lip closure varied. Most of the children used the bottom lip to form a seal on the spoon (78%). Approximately half of the children actively cleared the bowl of the spoon with the upper lip (56%), while 44% did not actively use the upper lip to clear the bowl of the spoon. Only 22% of the children ate with lips closed, whereas many experienced food spillage (74%). Fifty-two percent appeared unaware of the spillage, while 35% demonstrated awareness of food spillage by wiping away the food without prompting. For some children it was not possible to determine awareness of food spillage. A large number of the children demonstrated tongue protrusion when swallowing (86%), while few children exhibited a normal pattern of tongue retraction when swallowing (14%). Sixty percent of the children seemed to form an adequate bolus while managing soft spoon foods such as pudding or yogurt. See Table 4 for summary of results.

Table 4

Spoon-Feeding

Behaviors Observed	Percentage Exhibiting Behavior
Jaw open at midrange	78%
Symmetrical jaw movement	92%
Graded jaw movement	69%
Opening mouth in anticipation of food	91%
Bottom lip forming seal on spoon	78%
Active use of upper lip to clear bowl of spoon	56%
Upper lip does not clear bowl of spoon	44%
Lips closed while eating	22%
Spillage	74%
No food loss	26%
Wipes spillage without prompting	35%
Not aware of spillage	52%
Tongue forms adequate bolus	60%
Tongue retracts when swallowing	14%
Tongue protrudes when swallowing	86%

The assessment of biting behavior during eating focused on jaw movement. During biting, most children with Down syndrome opened the jaw in midrange upon presentation of food (81%), used graded jaw movements (67%), and opened the jaw symmetrically (92%). Sixty-three percent of the children bit completely through food, while 42% bit through the food incompletely. Those who bit through incompletely tended to stabilize the food between the teeth and then pull the food away from the mouth using the hand. Forty-seven percent of the children took bites using the front, central teeth, while 33% of the children took bites of food using the teeth on the right or left side of the mouth. See Table 5 for summary of results.

Table 5

Biting

Behaviors Observed	Percentage Exhibiting Behavior
Jaw opens in midrange	81%
Jaw opens symmetrically	92%
Graded jaw movement	67%
Bites completely through food	63%
Bites and tears food	42%
Bites centrally	47%
Bites on right side of mouth	17%
Bites on left side of mouth	16%

The assessment of chewing focused on jaw, lip, and tongue movements. Seventy-nine percent of children exhibited a munching pattern, while 21% exhibited mature rotary jaw movement. Munching is a developmentally immature chewing pattern in which the jaw moves up and down in a single plane. The pattern of lateral jaw movement was observed in 7% of the children using the munching pattern. These children seem to be transitioning from munching toward rotary chewing. Only 11% of the children maintained lip closure during chewing, and sixty-four percent demonstrated food loss. The majority of the children demonstrated tongue lateralization (96%), i.e., the ability

to move the tongue to the side of the mouth to retrieve food. Most of the children lateralized the tongue to both sides of the mouth (71%), transferred food from one side of the mouth to the other (74%), and transferred food from the midline to the sides of the mouth (65%). See Table 6 for summary of results.

Table 6

Chewing

Behaviors Observed	Percentage Exhibiting Behavior
Munching pattern	79%
Lateral jaw movement	7%
Rotary jaw movement	21%
Lips closed	11%
Loss of food	64%
Tongue lateralizes to food	96%
Tongue lateralizes to both sides	71%
Transfers food from one side to the other	74%
Transfers food from the midline to the sides	65%

The assessment of bolus formation was obtained while the children ate foods that required chewing. Thirty-six percent of the children formed an adequate bolus, while 64% had food left on the tongue after the swallow. Fifty-four percent of the children were aware of food remaining on the lips and demonstrated this awareness by clearing the food with the tongue without prompting. Fourteen percent of the children pocketed food in the sulci. Tongue protrusion during swallowing was the most common pattern exhibited by the children (93%). Only a small percentage of the children (i.e., 7%) retracted the tongue in a normal manner during swallowing. See Table 7 for summary of results.

Table 7

Bolus Formation

Behaviors Observed	Percentage Exhibiting Behavior
Forms adequate bolus	36%
Food left on tongue	64%
Pockets food in sulci	14%
Aware of food on lips and clear with tongue	54%
Retracts tongue during swallowing	7%
Protrudes tongue during swallowing	93%

The assessment of drinking included observation of jaw, lip, and tongue movements during straw and cup drinking. Thirty-five percent of the children bit on the cup or straw to stabilize the jaw for drinking. Approximately half of the children demonstrated an adequate lip seal on the cup (48%), while 72% demonstrated adequate lip seal on the straw. Twenty-two percent of the children lost fluid from the mouth when drinking from the cup. Approximately half of the children maintained the tongue inside the mouth while drinking from a cup (54%). Forty-three percent of the children placed the tongue under the cup during drinking. None of the thirty children observed held the tongue inside of the cup during drinking. Thirty-two percent of the children demonstrated an immature suckle-swallow-drinking pattern, while 68% demonstrated the more highly developed suck-swallow-drinking pattern when drinking from a cup. The majority of the children exhibited tongue protrusion during the swallow (86%), while 14% demonstrated normal tongue retraction during the swallow. For 78% of the children, swallowing appeared to be effortless. In 15% of the children, some coughing or choking was observed. When drinking from a cup, 90% of the children demonstrated consecutive swallows, while 9% used a single-sip-swallow-drinking pattern. When drinking from a straw, 82% of the children demonstrated consecutive swallows, while 18% used a single-sip-swallow-drinking pattern. Results are summarized in Table 8.

Table 8

Drinking

Behaviors Observed	Percentage Exhibiting Behavior
Bites on cup or straw for stability	35%
Adequate lip seal on cup	48%
Loss of fluid from mouth with cup	22%
Lips close around straw	72%
Tongue under cup	43%
Tongue inside mouth	54%
Tongue inside cup	0%
Suckle-swallow	32%
Suck-swallow	68%
Tongue retracts during swallow	14%
Tongue protrudes during swallow	86%
Effortless swallowing	78%
Coughing/choking	15%
Consecutive swallows with cup	90%
Single-sip-swallows with cup	9%
Consecutive swallow with straw	82%
Single-sip-swallows with straw	18%

Discussion

The present descriptive study provides initial data on posture and oral motor skills evidenced at rest and in the processes of feeding, eating, and drinking in a sample of young children with Down syndrome who had been referred because of oral motor concerns. A large number of observational behaviors were included in the study in order to begin to delineate the patterns exhibited by children with Down syndrome with oral motor concerns. Although there has been documentation of specific anatomical and physiological characteristics of children with Down syndrome, this information has infrequently been applied in a functional manner to the oral motor activities of daily living (i.e., feeding, eating, and drinking). The study provides an observational framework that can be used to clinically examine these oral motor activities of daily living. These oral motor skills contribute to the development of the oral mechanism, which is ultimately used for speech production in addition to feeding, eating, and drinking.

While it is important to observe postural tone and stability, it has been found that speech difficulties are not always in direct relationship with postural issues. Children with poor postural control can have clear speech, and children with adequate postural control can have speech difficulties (Nelson & DeBenebib, 1991). Therefore, it is important to investigate whether the speech difficulties exhibited by an individual with Down syndrome are or are not related to issues of postural control. The findings of the current investigation support the idea that many children with Down syndrome who demonstrate oral motor concerns also exhibit postural concerns. However, 57% of the children in the study demonstrated adequate trunk stability for fine oral movements such as speech production. It is also important to note that improvement was seen in mouth position in 63% of the children when they were positioned with 90-degree hip, knee, and ankle flexion.

The results of this study also suggest that children with Down syndrome who demonstrate oral motor concerns generally have symmetrical postural and movement patterns. Only 4% of the children demonstrated shoulder

asymmetry. Ninety-two percent of the children demonstrated symmetrical jaw movements during both spoon-feeding and biting.

The literature suggests the presence of low muscle tone throughout the body in children with Down syndrome. The findings of this investigation suggest that different degrees of hypotonia may be evidenced in different oral structures. Forty-four percent of the children demonstrated low muscle tone in the lips, while 80% of the children exhibited low muscle tone in the tongue. Seventy-one percent of the children maintained open mouth posture at rest. Although this could be related to low muscle tone in the lips, it also may result from jaw instability, loose ligaments in the temporomandibular joint, or a mouth breathing pattern.

According to the results of the study, sensory awareness and feedback appears to be problematic for young children with Down syndrome with oral motor concerns and seems to impact on feeding, eating, drinking, and speech production. Only thirty-three percent of the children demonstrated awareness of drooling. There also appeared to be a pattern in which drooling occurred in the first year and again in the third year. This may be related to tooth eruption. The 3-year-old children demonstrated greater awareness of the presence of drool than the younger children in the study. This may be related to increased sensory feedback in the 3-year-old children or to greater social awareness regarding the negative social consequences of drooling in these children. Fifty-four percent of the children demonstrated awareness of food on the lips during the process of chewing and cleared food from the lips with the tongue without prompting. Fifty-two percent of the children were not aware of spillage during spoon-feeding, while only 35% demonstrated awareness by wiping the spillage without prompting.

The results indicated the presence of jaw instability in children with Down syndrome in this study. Forty-two percent of the children bit down on the food to stabilize it and then tore the food using the hand. Thirty-three percent of the children took bites on the right or left side of the mouth rather than centrally. Seventy-nine percent of the children used the unsophisticated munching pattern to manage food. Thirty-five percent of the children bit on the cup or straw for jaw stability. As infants, children progress from having an unstable jaw to developing a stable jaw with the ability to grade jaw movements in the full range of jaw motion. A stable jaw is necessary for the development of skilled lip and tongue movements which are basic to sophisticated oral movements for eating, drinking, and speech production (Morris,1987).

It is interesting to note that only 15% of the young children in the study demonstrated atypical jaw alignment which took the form of jaw protrusion or Angle's Class III malocclusion (i.e., prognathism). Clinically, this oral posture may be seen in a larger percentage of individuals with Down syndrome as further growth and development of the maxilla and mandible occur. The upper and lower jaw may lack alignment secondary to loose ligaments in the temporomandibular joint and jaw instability. The individual with Down syndrome may protrude the jaw as a means of attempting to gain jaw stability. This area needs further investigation in older children and adolescents.

The children in the study also demonstrated reduced upper lip mobility. Forty-four percent of the children did not use the upper lip to clear the bowl of the spoon. Limited upper lip mobility can interfere with eating, drinking, as well as speech production.

Tongue protrusion has been noted in the literature as a characteristic exhibited by children with Down syndrome. The findings of this study confirm the presence of tongue protrusion. At rest, 52% of the children were noted to maintain the tongue outside of the mouth. During spoon-feeding, 86% of the children protruded the tongue when swallowing. On foods that required chewing, 93% of the children protruded the tongue during swallowing. During drinking, 86% of the children demonstrated tongue protrusion.

The majority of children in the study (96%) demonstrated the ability to lateralize the tongue. This implies that these children have mastered tongue and jaw dissociation (i.e., the ability to independently move the tongue separately from the jaw) in a lateral plane. However, tongue and jaw dissociation in a vertical plane is required for speech production.

Children with Down syndrome with oral motor concerns demonstrate limited normal tongue retraction during swallowing (i.e., the cupped tongue forms a bolus and then moves the bolus back for the swallow). During spoon-feeding only 14% of the children in the study normally retracted the tongue. After bolus formation of chewed foods, 7% of the children retracted the tongue normally. During drinking, 14% of the children normally retracted the tongue. Regarding bolus formation, 60% of the children formed an adequate bolus while eating soft foods (e.g., pudding or yogurt), while only 36% of the children formed an adequate bolus when managing chewed foods. This seemed to be related to the differences in the way the children in the study managed different food textures. One characteristic used to judge inadequate bolus formation in this study was the presence of food remaining on the tongue after the swallow. Food is more likely to remain on the tongue after the management of chewed foods, which tend to break into pieces and not form into a cohesive bolus.

During the drinking process, 72% of the children had adequate lip closure on the straw. However, it is important to note that the children typically placed the straw far into the mouth and seemed to be using tongue movement to extract the liquid. Forty-three percent of the children also placed the tongue under the cup during drinking. This appeared to be a compensatory pattern used by the children secondary to apparent jaw instability, inadequate lip closure, and the use of tongue thrust pattern. A few children in the study exhibited coughing, choking, and a single-sip-swallow drinking pattern reflecting possible swallowing incoordination.

As children with Down syndrome progress in the development of oral motor

skills, they can demonstrate both sophisticated and unsophisticated oral motor patterns simultaneously. This frequently occurs when a child is developing a skill. For example, 63% of the children in this study bit completely through food demonstrating jaw stability, while 42% of the children bit down on the food to stabilize it and then pulled the food from the mouth using the hand. The sum of these percentages is over 100%, which indicates that some children were using both patterns. This frequently occurs during the time that a more advanced oral motor pattern is emerging.

This study was based on the observations of children with Down syndrome with oral motor concerns as they participated in the natural processes of feeding, eating, and drinking. More discrete information regarding the intraoral and swallowing processes may be gathered through radiological studies. The subjects in this study were not randomly chosen but were referred because they exhibited oral motor concerns. This means that all of the children studied had oral motor issues. Therefore, the data can be used to describe the problems and patterns demonstrated by some children with Down syndrome. It is not possible, however, to generalize the findings of this study to all children with Down syndrome or to infer incidence of the patterns within the entire population of young children with Down syndrome.

Future research is needed to clearly determine the typical patterns of oral motor skill development in children with Down syndrome. More subjects should be included in cross sectional studies. Large numbers of subjects could allow the collection of data for the purpose of studying the incidence of oral motor behaviors. This would enable analysis of the data by age groups. A larger number of subjects should also include older children, adolescents, and adults so that data can be collected on the entire population of individuals with Down syndrome. It would also make possible analysis of the relationships among the oral motor characteristics studied. The relationships between feeding, eating, drinking and other areas of motor function need further study. Longitudinal studies are also needed to describe oral motor growth and development over time in the same child.

Children have many opportunities to practice oral motor skills during feeding, eating, and drinking activities prior to speaking. It is important to note any disruption in the development of these processes. The assessment of these processes can assist in the planning of oral motor treatment prior to the onset of speech. This is particularly important for children with Down syndrome, as they tend to develop speech later and have more difficulty developing speech than other children.

Some of the oral motor characteristics studied in this investigation may have implications for the development of speech in children with Down syndrome with oral motor concerns. Difficulties with sensory awareness and feedback, low jaw and tongue posture, jaw instability, low muscle tone in the tongue, limited lip mobility, and the use of a tongue protrusion pattern are some of the anatomical and physiological concerns that can affect the development of speech. If these issues are understood by individuals serving children with Down syndrome, treatment of oral motor concerns can begin at birth.

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News from the Down Syndrome Medical Interest Group (DSMIG)

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Co-Chairs

Mission The Down Syndrome Medical Interest Group (DSMIG) was founded in early 1994 with the express purpose of serving as a forum for professionals addressing aspects of medical care of persons with Down syndrome. *DSMIG* wishes to promote the highest quality care for children and adults with DS 1) by fostering and providing professional and community education; 2) by disseminating tools for clinical care and professional support; such as the Health Guidelines for Individuals with Down Syndrome; 3) and by engaging in collaborative clinical research regarding issues related to the care of individuals with Down syndrome.

For further information, contact either co-chair: Bonnie Patterson at 513-636-4691 or Bill Cohen at 412-692-6546. If you are interested in being added to our mailing list, please send your name, professional title, agency, address, telephone number, fax number, and email address (if any) to William I Cohen MD, Down Syndrome Center, Children's Hospital of Pittsburgh, 3705 Fifth Avenue, Pittsburgh, PA 15213. (412 692 6546; fax 412-692 5679; email: cohenb@chplink.chp.edu).

News From DSMIG

The National Down Syndrome Congress will hold its 27th Annual Convention in Pittsburgh PA Friday August 6th to Sunday August 8th, 1999 at the David Lawrence Convention Center. Please contact NDSC at 1-800-232-NDSC for more information. The following DSMIG members are scheduled to present: Dr George Capone, Dr Allen Crocker, Dr Libby Kumin, and Pat Winders. These conventions are an enormous resource to families, and a tremendous opportunity for networking.

The Down Syndrome Association of Greater Cincinnati in conjunction with the National Down Syndrome Society is holding a regional conference at the Convention Center in Cincinnati, Ohio on Saturday, November 6, 1999. The title is "Believe in a Better Tomorrow." Parents and families are the primary audience; professionals are welcome. The plenary speakers include Richard A Villa, who will be speaking about Inclusion, and Patricia McGill Smith, Executive Director of the National Parent Network on Disabilities. Chris Burke will speak at the luncheon. Contact DSAGC at 513-588-4997 or NDSS at 800-221-4602 for more information

DSMIG will hold its next meeting on Thursday, November 11, 1999 at Children's Hospital of Pittsburgh. The meeting will be followed by a CME Health Care Conference sponsored by Children's Hospital and the University of Pittsburgh School of Medicine, coinciding with the 10th anniversary of the Down Syndrome Center of Western PA on Friday and Saturday, November 12 and 13, 1999. The conference program is in the final stages of preparation and DSMIG members will receive information by mail in late summer. For further information, contact Conference Planning at Children's Hospital, 412-692-7507.

The National Down Syndrome Society is scheduled to hold a Parent-Professional Conference in Washington, DC from July 26 to July 30, 2000 at the L'Enfant Plaza Hotel. Contact NDSS at 800-221-4602 for more information.