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ABSTRACT

The manual contains articles about evaluating and addressing the feeding needs of children who have oral-motor dysfunctions. "Helpful Hints for Feeding Children with Oral-Motor Dysfunction" (Janet Wilson) offers 20 suggestions relating to such areas as positioning the child, monitoring food preferences, and attending to oral hygiene. "Procedures to Promote Jaw Control" (Sandra Hall) is a one-page paper on positioning the child for more effective jaw control. "Oral-Motor Development: Normal and Abnormal" (Suzanne Evans Morris) describes three stages in oral-motor development: sucking and swallowing of liquids, spoon-feeding of semi-solids, and development of chewing. "Feeding Patterns of the Normal Infant" (Morris) offers a developmental perspective on feeding patterns from birth to 36 months of age. "Problems of Cerebral Palsy and Oral-Motor Function" (Morris and Sandra Stockdale Weber) discusses characteristics of cerebral palsy which may impair the development of oral-motor skills, such as abnormal postural tone, abnormal oral and facial sensitivity, abnormal oral reflexes, and inability to imitate oral movements. "Overview of the Anatomy and Physiology of the Oral-Pharyngeal Mechanism" (Morris) addresses how anatomy and physiology affect the normal developmental process and how they influence the approach to treatment in neurologically impaired children. (JDD)

Selected Articles on Feeding Children Who Have a Neuromuscular Disorder

Sandra Hall, Merry Meek,
Nancy Cicirello, Penny Reed
and Judith Hylton, Editors

TIES: Therapy In Educational Settings

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SELECTED ARTICLES ON

FEEDING CHILDREN

WHO HAVE A

NEUROMUSCULAR DISORDER

Sandra Hall, Merry Meek,
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September 1987

In writing this manual we have chosen to avoid awkward word combinations such as (s)he and his/hers, and instead have selected to refer to children as "he," therapists, teachers and aides as "she," and supervisors as "he." We hope the reader will accept this style and find it comfortable, for that is our intent.

PREFACE

Project TIES: Therapy in Educational Settings is a collaborative effort conducted by the Crippled Children's Division - University Affiliated Program at the Oregon Health Sciences University and the Oregon Department of Education, Regional Services for Students with Orthopedic Impairment. Project TIES was funded by the U S Department of Education, Office of Special Education and Rehabilitative Services, grant number G008630055. The goal of this three year project is to develop training materials for physical therapists and occupational therapists who work in schools with students who have a severe orthopedic impairment.

The content for these training materials was determined by therapists practicing in schools in Oregon through a series of formal and informal needs assessments. Project staff then grouped the identified needs into topical categories and determined which format - a manual or a videotape accompanied by a manual - would best convey the content of each topic. Sixteen topics were identified, eight warranting coverage through both a videotape and a manual.

The training materials were developed primarily for therapists who are new to the unique demands of the school setting or who have had little experience with children who have a severe orthopedic impairment. Other people such as administrators, teachers, aides and parents will find these materials helpful in understanding what therapists do and the rationale behind their efforts to integrate students' therapy programs into the larger context of their educational programs.

The titles of the manuals and videotapes planned for completion by May 1989 are listed below. The titles are subject to change if similar materials become available through sources outside Project TIES.

Adapting Materials and Equipment, with videotape

Adaptive Physical Education, with videotape

Augmentative Communication, with videotape

Assessing Students' Need for Therapy

Considerations for Feeding Children Who Have a Neuromuscular Disorder, with videotape

Developing and Monitoring Intervention Programs

Developing Functional IEPs

Positioning and Handling, with videotape

Promoting Acceptance of Students Who Have a Handicapping Condition, with videotape

Role of the Physical Therapist and Occupational Therapist in School Settings

Role of Teachers, Aides and Parents in Enhancing Therapy

Selected Articles on Feeding Children Who Have a Neuromuscular Disorder

Self Help Skills, with videotape

Therapists as Consultants

Training School Personnel

Tri-wall Construction, with videotape

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We are grateful to Dr. Gerald Smith, Director of Training, University Affiliated Program at Oregon Health Sciences University and to Patricia Ellis, Associate Superintendent of Special Education, Oregon Department of Education, whose vision was essential to the inception of this undertaking and whose support vastly contributed to its successful execution.

We are indebted to Allan Oliver, Art Director of the OHSU Design Center for his fine work and infinite patience in developing a cover design.

We are especially indebted to the talents and generosity of Suzanne Evans Morris, Ph.D. and Janet M. Wilson, L.P.T., M.A.C.T., for permission to use their previously published articles which remain pertinent to the needs of therapists who are practicing today. This manual would be slim, indeed without their valuable contributions. Two of Suzanne Evans Morris's articles, "Feeding Patterns of the Normal Infant" and "Overview of the Anatomy and Physiology of the Oral-Pharyngeal Mechanism," were originally published in The Normal Acquisition of Oral Feeding Skills: Implications for Assessment and Treatment written by Ms. Morris and published by Therapeutic Media, Inc. Two other articles by Ms. Morris, "Oral-Motor Development: Normal and Abnormal" and "Problems of Cerebral Palsy and Oral-Motor Function," and one by Ms. Wilson, "Helpful Hints for Feeding Children with Oral-Motor Dysfunction," first appeared in Oral-Motor Function and Dysfunctions in Children, edited by Ms. Wilson and published by the University of North Carolina at Chapel Hill.

INTRODUCTION

The many children in our public schools who need feeding therapy typically are fed at least once during the school day. Teachers and aides who feed these children rely on occupational therapists, physical therapists and speech-language pathologists to recommend preferred practices and, if necessary to train them in these practices. Therapists and speech-language pathologists are expected by the standards of their professions and the policies of school districts that employ them to be competent in handling the conditions they evaluate and treat. Professionals whose training has not prepared them to address the variety of complex feeding needs encountered in the school may need additional information and training.

This manual, assembled for occupational therapists, physical therapists and speech-language pathologists contains selected articles about evaluating and addressing the feeding needs of children who have oral-motor dysfunctions. While the articles will undoubtedly contribute something to the reader's knowledge, feeding is far too complex an activity and some feeding needs are too unique to be covered adequately even in a carefully chosen collection of well written articles. Therefore, it is recommended that professionals continue to upgrade their competency by participating in workshops on feeding, consulting with the medical services providers who care for students they serve, and reading the resources listed in the bibliography.

This manual is a companion to one entitled, "Considerations for Feeding Children who have a Neuromuscular Disorder." That manual was developed for non-therapists who carry out feeding programs under the supervision of a therapist or a speech-language pathologist. It is hoped that these two manuals will enhance the professional's ability to address feeding needs and to train others to conduct feeding programs.

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HELPFUL HINTS FOR FEEDING CHILDREN WITH ORAL-MOTOR DYSFUNCTION

Janet M. Wilson, L.P.T., M.A.C.T.

Many children who are severely or profoundly multiply handicapped have oral-motor dysfunction which can result in problems in feeding, breathing or speaking. They may be unable to suck, chew or swallow. They often cannot coordinate breathing with swallowing, and gag, sputter, choke or cough when fed. They often keep their mouths open and drool. Feeding the child with oral-motor dysfunction is, at best, a frustrating experience and often unpleasant, time-consuming and stressful, both for the child and the caregiver.

If you are involved in the daily care of the severely or profoundly handicapped child, you will be involved in feeding these children. The more normal experience you can provide during feeding provides the child with (1) normal movements of lips, mouth, tongue and jaw; (2) normal preparation for speech, and (3) normal preparation for all the wonderful social experiences based on eating.

There are many things that will help you to be better prepared to feed a child with oral-motor dysfunction.

1. Make certain the child is in an appropriate state for eating. The child should be calm, quiet but alert. The most important rule for planning a feeding program is: Do anything which keeps the child relaxed and facilitates lips together, head coming forward and hands moving toward his mouth. Do not do anything which produces crying, struggling, increased muscle tone, fear or avoidance patterns of head turning, lip retraction, grimicing or tongue thrusting.

2. Position yourself and the child in a comfortable, relaxed place. Make certain the food is readily accessible. There are many variations of the "sitting in a chair" position. Try them. If necessary, consult with a therapist or person who knows the child's problem to see what will work best. Primarily, you want a position that allows the child to eat happily and easily, but be good to yourself--you should be comfortable, too!

3. Provide a method to keep hot food hot and cold food cold. Feeding a child with oral-motor dysfunction takes time, but the handicapped child needs the experience of foods of different temperatures rather than everything at room temperature.

4. Prepare the child for eating. Tell him, "It's time to eat!" Let him smell and see the food. The odor of food is a big part of eating, and many handicapped children are not given the opportunity to smell foods as they are prepared or when they are eating. Preparing the child for the eating experience will help decrease his sensitivity to sights and smells and better enable him to cope with the new stimuli presented at mealtime.

him to cope with the new stimuli presented at mealtime.

5. Develop a rhythm for feeding. The rhythm must be one that is comfortable for both you and the child. Some children must be fed slowly, as they chew and swallow very poorly. Other children require a fairly larger volume of food in their mouths to stimulate chewing and swallowing and must be fed rapidly. If food is given to fast, however, the child may intentionally push it out of his mouth; if food is given too slowly, the child may lose interest in eating once his initial hunger is satiated.

6. Know the child's oral-motor capabilities. Some children have a tongue thrust which forces the food out of the mouth; other children have a bite reflex that causes them to bite down on the spoon or nipple each time it is placed in the mouth. It is important that you know if these activities are voluntary or reflex before you blame the child for spitting out food or biting his spoon. The child may not like what is happening any better than you do. If this is so, say to him, "I know you don't mean to bite the spoon," or "It's not fun to have food come back out of your mouth." This will let the child know you understand his feeding problem.

7. Praise any efforts at normal eating. Say to the child, "I see you chewing." "I see good swallowing." "I see your lips together, and your mouth is closed." This will help the child understand what you expect from him. Children with long-standing feeding problems may not know what normal eating feels and looks like. Keep your voice quiet when you praise him. If you get too excited, the child will smile, open his mouth and you will have a lap full of food!

8. Eating is a good time for verbal interactions. As you feed a child, he will often begin to vocalize. Encourage these vocalizaitons in meaningful ways. Say to the child, "I hear you asking for more milk." "Are you asking me for more food?" "Oh! You like this." This will help him understand that talking has a purpose. Give him chances to talk; say, "Do you want milk or potatoes?" Wait until he verbalizes his choice even if he can't use words. Many children who can't talk don't get an opportunity to make choices about food, and yet this is an important part of eating and, eventually, making choices in other areas of his life.

9. Watch your facial expressions. Often it is not a pleasant experience to feed a child who chews with his mouth open, spits food back out of his mouth and drools. If you show this dislike on your face, the child may feel this means you don't like him. Watch your expressions as you give him foods. If you don't like strained peas (and who does!) and show this on your face, the child will learn not to like them. Severely handicapped children respond to facial expressions even when they do not understand words.

10. Do not put too much food on the spoon. This is particularly important if the child has a tendency to push food out of his mouth with his tongue. The more food you put in, the greater the potential for it coming back out!

11. Give the child a consistency of food he can manage. Strained and pureed foods are often easier for the child to manage than either solids or liquids. Yogurt, puddings (particularly rice and tapioca), grits, oatmeals or bran soaked in milk and poached or scrambled eggs give the child some consistency even when he cannot yet handle solid foods.

12. Do not mix foods together unless it is necessary. Mixing foods deprives the child of sensory cues of color, texture and taste necessary for normal feeding.

13. Let the child show preference for food. Remember the handicapped child needs to develop food preferences and you should allow him to express likes and dislikes. It is usually possible to substitute one food for another to make certain he gets the proper nutrition.

14. Attempt semi-solids and solids as soon as possible. The longer the child goes without learning to manage solid foods, the more resistant he will be to try them. Normal children are able to eat many solids by one year of age; the handicapped child should have this opportunity, too.

15. Do not panic if the child chokes and sputters when attempting new foods. Let him have the opportunity to handle choking by himself. If he shows distress by turning red, not breathing, etc., sit him upright and tip him forward or place him on his side. It is often not necessary to slap his back. Most children pick up a fear of choking from those around him. If you stay calm, you can better assist the child in learning to eat new foods of different textures.

16. Do not tease a hungry child. Often if you want to work on changing a child's eating pattern, you will have to give him a few bites first to help take the edge off his appetite, then you can slow down his feeding, asking him to close his mouth, chew or whatever you want. Do not withhold food because the child is drooling or spitting. If this is due to poor behavior, work on changing the behavior other than at mealtimes. Sometimes the only control a severely handicapped child has in his environment is to refuse food. He can make you pay attention to him longer by taking a long time eating. If he is really messy, you will have to change his clothes after the meal, again prolonging the attention he gets. Make certain the child is getting adequate attention other than at mealtimes. It may be the only time he can make you angry and frustrated. If you make the feeding experience a pleasant time, giving the child lots of attention and praise, he

will learn he can use his control of eating to make you happy and pleased.

17. Sweets cause an increase in drooling. Do not reward a drooling child with sweets, as this will only make matters worse. Many handicapped children have dental caries, and sweets are often unpleasant for them, which is another reason not to give them sweets.

18. Brush teeth often. Children with oral-motor problems often do not move their tongues well in their mouths. They cannot use their tongue to remove food from the hard palate or from between the cheeks and gums. They do not get the natural tooth brushing effects from a mobile tongue. Often these children have their mouths open and do not swallow their saliva, producing a warm, wet environment for bacteria to grow. This produces rapid dental caries, as well as bad breath. The child's teeth should be brushed after each meal. This provides good stiumulation for the gums, teeth, palate and tongue, as well as removing food remaining in the mouth. It is not necessary to use toothpaste. The stimulation from the brush is far more important.

19. Many handicapped children are small and poorly nourished. This is due to several factors. First, they do not get enough food because it is difficult for them to eat. Second, they do not eat because they do not move much and do not develop much appetite. Third, foods they can eat are often not very appetizing, are often the same color, texture, taste and temperature. Fourth, they do not get foods that provide them with balanced nutrition. One way to enrich foods is to add eggs. This is a high source of protein. You can add two eggs to any recipe that calls for one. You can add raw egg to milk, juice or yogurt.* You can cook egg in cereal and puddings. Consult a nurse or nutritionist for additional suggestions for enriching the diet.

20. Constipation is often a problem. This is partly because the diet is low in roughage and liquids, and partly because the children are inactive. You can add bran by soaking 100 percent bran buds in milk and using it in combination with molasses in muffins or bread.

    Give the child vegetables with skins, such as cooked corn, lima beans or peas. Certainly raw vegetables are ideal if the child can manage the texture.

    Promote liquids, water, prune juice or orange juice (<u>not</u> apple juice--this is constipating). Because he cannot ask for a drink, the handicapped child often gets liquids only with his meals.

*Editor's note: Use only eggs eho shells are uncracked before you prepare them to ensure that the raw egg has not been invaded by salmonella bacteria.

Many of these children have abnormal posture and movements; e.g., tongue thrusting, jaw opening or head tilted back. There are specific therapeutic techniques designed to assist with these problems and normalize the feeding process. You should consult a physical therapist, occupational therapist or speech therapist to assist you with these specific techniques for an individual child. Remember, before you attempt to alter a child's feeding pattern, make certain you have a way that will make feedings easier and more pleasant for both parent and child. No parent wants a feeding program that is time-consuming and frustrating for her and her child. Eating time should be fun and is the basis for many social experiences a the child grows--picnics, family gatherings at holidays, restaurants, etc. Eating for most children and adults, goes on three times a day. It is a big part of life. Do not let the handicapped child miss out on these wonderful experiences.

This article was previously published in Oral-Motor Function and Dysfunction in Children, Janet M. Wilson (ed.), University of North Carolina at Chapel Hill, 1977. It is reprinted here with the permission of the author.

PROCEDURES TO PROMOTE JAW CONTROL

Sandra Hall, O.T.R.

Some children benefit when the feeder uses jaw control procedures. The therapist must evaluate the effectiveness of these proceudres with the child before teaching the feeder how to use them. Because most children's need for assistance with jaw control diminishes as each meal progresses, the therapist should determine the child's changing pattern of need through frequent monitoring during its early use. Procedures that promote jaw control in some children are outlined below.

1. Position the child on your lap or seat him to your side. Place your arm around his head to keep it forward. Place two fingers below his jaw and one finger under his lower lip to control opening and closing. (Figure A). Use your upper arm to keep child's head forward and centered.

Figure A

2. Sit the child in front of you. Place your thumb on his chin under his lower lip, and your middle finger under his chin to control opening and closing. (Figure B).

Figure B

ORAL-MOTOR DEVELOPMENT: NORMAL AND ABNORMAL

Suzanne Evans Morris, Ph.D.

A strong knowledge of normal oral-motor development is critical for understanding which aspects of a child's feeding are normal, delayed or truly abnormal. It is also extremely important for a good diagnosis and provides a rationale for the treatment approach as well as many of the specific steps in treatment. This section will describe three areas in oral-motor development: 1) sucking and swallowing of liquids, 2) spoon-feeding of semi-solids and 3) development of chewing.

Sucking and Swallowing of Liquids

This sequence begins with either breast or bottle feeding and progresses to drinking from a cup. The terminology used is sometimes confusing. The terms suck and suckling are often used interchangeably. The British literature is much more precise both in its definition and use of the terms. Suckling is the first pattern developed and is defined as the early infantile pattern which involves definite protraction and retraction movements of the tongue. Ardran and Kemp have described it as lick-suck. (1958) The liquid is obtained through a rhythmical licking compression action of the tongue on the nipple combined with jaw opening and closing, involving activity of the entire sucking organ. In addition to the movement of the tongue in the suckle pattern, there is also rather loose approximation of the lips. The amount of pressure of the lips depends on how hungry and how far into the feeding the child is. Generally, however, the lips are only loosely approximated, and the lateral borders of the lips may actually be open. Suckling is commonly, but not exclusively, seen in infants during the first five or six months and is gradually replaced by the suck pattern. The suckling pattern may also be observed in the early stages of spoon-feeding before the upper lip is able to remove food from the spoon.

Sucking is defined as the rhythmical raising and lowering of the body of the tongue as a method of obtaining liquid. It involves much more activity of the intrinsic muscles of the tongue, tongue tip elevation and firmer approximation of the lips than does the earlier suckling pattern. In the sucking pattern, jaw movement is less observable, and the tongue is more independent of the movement of the jaw. A relatively great negative pressure within the oral cavity is built-up as a result of the combined closure of the lips and lowering of the tongue. With the build-up of negative pressure, the child does not have to exert much effort to take in the liquid.

Some investigators have stated that the normal infant has a suck pattern at birth and that this pattern changes to suckling in the first week or two. The major differentiation between suckling and sucking is the greater and firmer closure of the lips in the suck pattern. That kind of jaw closure and lip closure is strongly related to the pattern of flexion. The full-term infant has a predominant flexor tone during

the first few weeks. One can speculate that if the infant typically shows suck pattern during those first weeks, this may be a reflection of the normally high flexor tone, producing more lip closure, a favorable negative pressure gradient and making the suck pattern the most effective.

After approximately two weeks, the sucking pattern gives way in the normal infant to suckling, which requires little lip approximation and an in and out movement of the tongue. At about six months, as the child begins to take more semi-solid foods from a spoon, he begins to develop greater lip activity. The top lip develops the ability to clean and remove food from the spoon, tongue and lip pressure on the nipple increases, and an up and down movement seems to replace the backward-forward tongue movement seen in the suckling pattern. The emergence of this sucking pattern occurs gradually, but it is usually achieved by between six and eight months. As one observes a child, particularly one who is using a bottle, one has difficulty seeing the difference between suckling and sucking. One can often infer what is happening by the amount of liquid lost, by the amount of lip closure, or by seeing the movement of the protruding tongue or the amount of up and down excursion of the jaws. Often the child switches back and forth between these two patterns. The significant thing is that the child has a variety of options available to him, and the normal child is free to choose the sucking or suckling pattern that happens to suit his circumstances at the moment, depending upon how hungry he is, which pattern gives him the amount of liquid he desires in his mouth at any one moment and the pattern that allows him to conserve or expend his energy as appropriate.

One of the most important things to observe when breast- or bottle- feeding, other than types of suck, is the adequacy of the child's feeding. The initiation of suckling or sucking is very smooth and very rapid. The baby begins to suck in many instances before the nipple enters the mouth. There is no biting, he does not mouth the nipple, and there is no difficulty beginning the suck, except perhaps briefly in the age range from nine to 12 months when the child is not hungry and is practicing a lot of chewing patterns. This is the period when the baby bites the nipple and plays with it. This is in contrast to the child who has difficulty initiating the suck or, once started, loses pressure and then starts again with a jerky sort of initiation and sucking pattern.

Finally, the rhythm of the sucking or suckling should be noted. A normal baby has a definite sucking rhythm and though each baby will demonstrate his own particular signature, there does not seem to be a difference in rhythm between sucking and suckling. In the child with feeding problems, the pattern is much less precise and less consistant. The relationship between suck, swallow and breathing may not be consistant. In the very young, but otherwise normal premature infant, the sucking pattern may also be inconsistant and arhythmical with periods of apnea, bradycardia or other difficulties. The difference between these premature babies and abnormal babies is that the

premature child develops a definite rhythm as he matures.

Sucking and swallowing is a chained pattern, with sucking or suckling triggering swallow. The normal newborn has a smooth coordination of suck, swallow and breathing. Some coughing, spitting or choking may occur in the normal infant under three months, but this is unusual and often occurs at the beginning of the feeding when the infant is very hungry or toward the end when he is tired.

To sort out precisely which part of the pattern is suck and which is swallow is difficult. Swallow can be considered the point at which the bollis passes down the esophagus, producing elevation of the hyoid and larynx. If a child has a suck-swallow problem, it is difficult but important to determine whether the problem primarily involves suck, that is getting the bollis in and keeping it in and moving it back in the mouth; or swallow, moving the bollis down the esophagus, or the coordination between the two.

The final topic to be considered in sucking is cup-drinking. Cup-drinking is usually introduced to the child between four to six months. The baby seems to do one of two things, depending upon the type of cup used and the style of the mother. He either allows small mouthfuls to be poured in or he attempts to use the sucking procedure he used with the bottle. Both techniques initially result in a great deal of liquid loss with wide up and down excursions of the jaw, relatively poor lip activity in containing the liquid and some coughing or spitting as the child experiences some swallowing difficulties. One of the most important areas to observe in cup-drinking is the jaw, where the most basic changes in drinking skills seem to occur. Three stages of development in cup-drinking can be observed in the first two years of life. First, from the time the child starts on the cup until past his first birthday, the jaw moves up and down and possibly backward and forward in a fairly wide excursion. With this pattern liquid is lost, fairly poor or inconsistant lip activity is common, and the tongue generally uses a combination of suckling and sucking. The jaw is not stabilized to provide for precise tongue and lip movements, as the jaw movement is primarily responsible for the intake of liquids.

The second stage seems to begin at 15-18 months, a period in which jaw stabilization is developing. Jaw stabilization is initially achieved externally by biting down on the edge of the cup. The child does not yet have the co-contraction for jaw opening and closing, so he provides the stabilization by biting down on the edge of the cup. Lip function is improving, and there is much less liquid loss.

In the third stage of jaw control development, jaw stabilization can be achieved through co-contraction of the muscles controlling movement of the temporomandibular joint. This stabilization through active muscle control is achieved by 24 months. It may be seen earlier than 24 months, but should definitely be a functional drinking pattern by two years. With this kind of stabilization, the child can now control the intake of liquid with the cup between the lips rather than

on the teeth. Usually the jaw opens very little, so the teeth provide a natural barrier to tongue protrusion during swallowing. Now there is a structured situation which is conducive to greater tongue movements for swallowing.

In swallowing liquids, both from the bottle and from the cup, the swallowing occurs as part of a suck-swallow reaction. The tongue initially protrudes between the gums or may move back and forth with active protraction retraction type of movements. Initially, there is no tongue tip elevation except that the tongue may be pressed in approximation to the hard palate area; usually this approximation occurs at rest or in the final stage of swallowing rather than in the dynamic up and down manner of more mature swallowing. As the child goes on to cup-drinking, he must learn to swallow without an initial suck triggering the swallow. The liquid comes much faster from the cup, and the child has to learn to suck with the lips and to swallow easily. In cup-drinking, he gradually begins to use tongue tip elevation with swallow. The length of time children protrude the tongue during swallow as a normal pattern of cup-drinking is still unresolved. Some studies show that the majority of children still protrude the tongue until six to seven years of ages. This author found that all of the normal children (six) filmed and observed as part of a longitudinal study showed tongue tip elevation by 18 months.

Implications for Treatment

Several interesting implications for treatment can be derived from the normal development of bottle and cup drinking. First, the shift from suckling to sucking seems to be dependent on, or at least related to, increased lip activity to obtain greater negative pressure. Work on improved lip activity in spoon-feeding and other activities helps to change the suckling pattern of the tongue. Second, the normal developmental process appears to be one of gradual increase in jaw stabilization as the child requires a rapid and well-coordinated drinking pattern, particularly with a cup. Initially, the child provides this stabilization externally by biting down on a cup and gradually develops co-contraction of the jaw muscles. This normal development process provides a rationale for the therapeutic technique of manually stabilizing or controlling the jaw to allow the child to develop some independence of tongue and lip movement. The third implication for treatment is that sucking itself is a pattern enhanced by flexion. Placing a child in flexion, bringing him forward at the hips and bringing the head down will enhance the protrusion of lips for sucking.

Spoon-Feeding

The age at which cereal and other semi-solid foods are introduced to infants is quite variable. The age of being placed on spoon feeding depends on the child's hunger level, the pediatrician and the mother's preference. Most children, breast or bottle fed, do not need other kinds of food nutritionally until about six months when, in the case of

breast fed babies, the mother's milk no longer carries enough iron. The oral-motor patterns used by the child seem to be more dependent upon his neurological maturation than on experience with solid foods. Initially he has an overt suckling pattern which may actually precede the food coming into the mouth. The baby sees it, anticipates it and begins to suckle. In the normal child, food on the spoon is scraped off on the upper gum ridge or teeth; the lips do not particpate in removing it. By the time the baby is four or five months old, he can usually keep the tongue quiet in anticipation of the food entering his mouth. The configuration of the tongue changes during this period. In the normal infant, the tongue is flat across the front and concave. A depression in the center is formed as the tongue moves backward and forward in suckling, working the food back to the pharynx for swallowing. The shape and activity of the tongue changes as the child's feeding pattern matures.

Early in development the lips may reach forward for the spoon quite nicely, but they do not actively participate in cleaning the spoon until approximately six months of age. Lip coordination and lip pressure improves with increasing age. By nine months, the baby begins to use his upper incisors or the gums to clean food off the lower lip. Before this, he really does not care whether he is sloppy, but at about nine months he will begin to demonstrate this scraping movement. This movement is usually well-integrated with the whole feeding act and may also trigger a lot of babbling or sound play. Initially, the baby lacks sufficient use of visual and tactile-kinesthetic cues to grade jaw opening to the spoon. The child has one motor set for mouth opening, incorporating fairly wide opening, then closing. This could be considered an "orienting response of the mouth," similar to the orienting response in the hand. As the child grows older he is able to grade the amount of mouth opening depending on the size of the food he is to receive.

Swallowing semi-solids and solids may initially be accompanied by some gagging and coughing. This probably occurs because food rests on the back of the tongue as the baby has difficulty working it far enough back for swallowing. The tongue pattern follows the same process for swallowing semi-solids as with liquids. Gradually, intermittent tongue tip elevation and greater lip closure occurs during swallowing. As the child becomes more proficient in taking food from the spoon, a progression of mouth and tongue movement is evident. Initially, the jaw seems to be only partially opened, and the food is scraped off the spoon into the mouth. The lower jaw and tongue act as a single organ, and the tongue may protrude as the jaw opens. The remarkable thing at this stage is lack of tongue elevation. In the second stage, the tongue becomes freer of the mandible. As the jaw closes in taking food from the spoon, the tongue is elevated mechanically, but as it becomes freer of the mandible, a slight timing difference occurs. The mandible begins to descend and the tongue remains on the alveolar ridge, then comes down, giving the appearance of intermittent tongue tip elevation. It is however, a timing difference in the descent of the tongue rather than an independent elevation of the tongue. While this is still

mainly a mechanical phenomenon, it may give the baby a feeling of tongue tip elevation and independence of tongue from jaw movement. In the third stage, the tongue can be raised whem the jaw is down to a tip elevation independent of mandibular movement.

Several implications for treatment can be based on these stages of spoon feeding in the normal child. First, the normal infant is able to inhibit tongue movement in anticipation of food entering his mouth. This seems to precede the ability to use the lips actively in cleaning the spoon. Lip movement must proceed from a quiet position of mouth control. Children with cerebral palsy have difficulty developing good lip activity until they can control, or inhibit, the anticipatory suckling of the tongue as the food is presented. Work on control of anticipation and control of the movement accompanying it, therefore, may be necessary before going on to get good lip control. Secondly, the initial development of tongue tip elevation for swallowing appears to be dependent on the mechanical elevation of the tongue as the jaw is closed. This gives support to the use of the jaw control technique with spoon feeding to facilitate tongue tip elevation.

Development of Chewing

The development of chewing involves the development of jaw control, tongue control and lip control in the evolution of biting and chewing. The baby is described as having a bite reflex at birth; this is a rhythmical bite and release pattern with a series of jaw openings and closings which occur when the teeth and gums are stimulated. It is present at birth and continues, primarily at an automatic level, until three to five months. A bite reflex is also described in children with cerebral palsy, but this bite reflex has a tonic quality. It can be called the tonic bite reflex and is characterized by a strong closure of the jaw when the teeth or gums are stimulated, often with difficulty in releasing and opening the mouth after it has been elicited. The normal infant (four to six months) will occasionally bite and hold on, but this is usually associated with play and partial satiation. It occurs again around nine months and may be associated with attempts at jaw stabilization, similar to that seen with the cup, when solid food requires greater demands on the infant's jaw, teeth and gums. The child with athetoid cerebral palsy may also aid jaw stabiliation by biting on the spoon. This may be his attempt to stabilize his jaw to gain independence of lip activity. The difference is that, even though he bites down hard, he does not have the difficulty releasing, which is characteristic of a tonic bite reflex.

Chewing is defined as the process of using the teeth and tongue to breakup and pulverize solid pieces of food in preparation for swallowing. Both tongue and jaw movements are different from those used in sucking. The tongue shows much greater spreading and rolling motion in an attempt to project the food between the teeth. Chewing begins as a munching pattern at about five months, before the teeth have developed. Tongue lateralization and a rotary type of jaw movement develop and are combined with retained elements of this

munching pattern for greater chewing proficiency. Munching can be described as the flattening and spreading of the tongue combined with an up and down motion of the jaw. The body of the tongue may elevate slightly and make contact with the hard palate, but the tongue makes no lateral movement to transfer food onto the teeth. The food is mashed or pulverized against the hard palate. Usually at the time the child is using a munching pattern, he is given soft food which melts with the saliva. If there is minimal up and down jaw movement, the child may be using a true sucking pattern with tongue elevation and a series of rhythmical clicks against the hard palate. Munching seems to develop as the combination of two primitive patterns, the phasic bite reflex and sucking; it is a type of sucking pattern which is combined with a biting and chewing motion of the jaw. Later is is combined with tongue laterization and continues to be part of the mature chewing pattern into adulthood. Gradually, the child changes from using primarily munching to chewing. This begins with a gross rolling type of tongue lateralization as early as five to six months and is characterized by movement of the tongue to the side of the mouth in an attempt to project food between the molars on that side. Rapid and precise tongue movements then develop for chewing. These include movements in which the front of the tongue will narrow into a skilled point to assist skillful projection and manipulation of smaller pieces of food. Initially, the child is able to lateralize the tongue only when food is placed between the gums or the molars on one side. Later he is able to transfer food placed in the center of the tongue to one side and finally, he is able to move the food from one side of the mouth to the other, transferring it across midline. Initially, the chewing motion of the jaw is vertical, next lateral movement develops and gradually rotary motion is possible. Rotary motion involves smooth interaction of the muscles which open and close the mouth with those that pull the jaw in a lateral or diagonal direction. On can note here a parallel with normal gross motor development. The development of good rotation in walking and running is the highlight of locomotor development. Refinement of rotation preoccupies the child for probably a year or more after he has first gotten to his feet and begun to walk. This same phenomenon of diagonal movement of rotation is the high point of development of the feeding process. By the age of one year and a half, everything the child needs for feeding has developed with the exception of refined rotary jaw movement.

The lips are active with the jaws in chewing, during which the child gradually gets more lip closure and the ability to clean the lips if food or saliva escapes. Chewing with the lips closed is extremely variable. Some babies show it before nine months, others not before 24 months, and many who show it early will later go back to chewing with the mouth open for a while.

Different types of movement may be used to swallow foods of different consistencies. This author believes that more tongue tip elevation tends to be used for solid or thicker foods, except when these have been pulverized well and mixed with saliva, so that at the point of swallow, they are really liquid or thin, semi-solids.

Finally, initial chewing responses in infants occur before the child has many teeth and definitiely before he has teeth in the premolar and molar areas for chewing. Chewing is not dependent on the devleopment of teeth, an important fact to remember. Many persons feel they cannot understand why a child is unable to chew if he has a mouthful of teeth.

Abnormal Oral-Motor Patterns

Some oral-motor patterns are seen in atypically devleoping children which are not seen in the normally developing infant. These include jaw thrust, tongue thrust, tonic bite, lip retraction, tongue retraction and nasal regurgitation. Each of these abnormal patterns has a counterpart in normal development.

Jaw thrusting can be defined as a strong, downward extension of the lower jaw. The strength, tension and often the speed involved differentiates the jaw thrust from the normal full opening of the jaw, which often occurs in normal infants. Lack of fine jaw grading in normal infants occurs predominately when food is presented, while jaw thrust occurs while food is in the mouth as well. It can occur during chewing or at the point of swallow. The jaw may appear to be stuck in the open position, and the child may actually have difficulty closing his mouth to take the food.

Tongue thrust is a strong movement of extension and protraction before or during feeding. In the normal child, tongue thrust is described as a relatively light extension-retraction pattern of swallowing with protrusion of the tongue at the point of swallow. A very different pattern is described in the atypical child. The tongue appears thick and bunched as it is extended. Thrusting of the tongue may make it difficult to insert the nipple or spoon into the mouth or may cause the food to be ejected during feeding. During cup-drinking, the tongue may thrust into the cup itself or may protrude in a very tight fashion beneath the cup. A tongue thrust may also occur during swallow after the cup is removed from the mouth and the child is swallowing the last mouthful of liquid and as the child is chewing. Children who develop into tongue thrusters demonstrate a difference in the timing and emphasis of movement in suckling. In the normal infant, you see in-out, in-out, in-out, with emphasis on in. In the infants who develop tongue thrusting, you see in-out, in-out, in-out with suckle. The force of protrusion and emphasis of timing on the out phase is greater.

The tonic bite reflex is defined as the strong closure of the jaw when the teeth or gums are stimualted. The child may have difficulty reclosing and opening his mouth after the tonic bite reflex has been elicited. The child often has a very low threshold for elicitation of the bite. When he takes in food and bites down, he has trouble releasing, or when something touches his face, lips or tongue, he immediately closes down. This is in contrast to the phasic bite reflex seen in normally developing children.

Lip retraction is the tight drawing back of the lips so that they form a tight line over the mouth. In this position the lips cannot assist in sucking food from the spoon or cup. A variation of lip retraction is called a purse-string retraction in which, as the child tries to counter the tight pulling back movement, a protraction and pursing of the lips follows. A normal child never shows active lip retraction unless something is introduced into his mouth that he does not like. The normal counterpart of this reaction is probably the simple inactivity of the lips seen before six months of age.

Tongue retraction is the pulling back of the tongue into the pharyngeal space. The tongue may be elevated with the tip firmly against the posterior part of the hard palate. Sometimes such an approximation occurs in this position that it really interferes with breathing and makes impossible the insertion of a bottle into the mouth.

With tongue retraction, the child has difficulty handling food as it is taken into the mouth. It also contributes to the noisy stridorous breathing in abnormal infants.

Nasal regurgitation is another oral-motor problem seen in abnormal children. It is the loss of liquid or food through the nose during sucking and swallowing. This may occur when the movement of the soft palate is poorly coordinated or when the palate is too short or contains a cleft. Some normal infants will regularly lose food through the nose when spitting up or vomiting. In children with poorly coordinated movements during swallow, food will regurgitate back through the nose. Examining the coordination of sucking and swallowing as well as the anatomical configuration of the soft palate is important.

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FEEDING PATTERNS OF THE NORMAL INFANT

Suzanne Evans Morris, Ph.D.

The Newborn

In the early sucking pattern, the important issues are the rhythmicity and the ease with which the baby sucks, the ease with which the baby stops and starts the suck, and the strength of the suck. All of these are usually well established and intact in those first couple of weeks of life. The infant is able immediately to find a bottle as soon as it touches the lips, and there is absolutesly no hesitation between the time the nipple touches the lips and the initiation of the suck. Although the suck is strong and the tongue is cupped, the infant may not yet have sucking, swallowing, and breathing well coordinated. At this stage there is usally some coughing and sputtering with the bottle or breast.

The normal newborn has a lot of physiological flexor tone, and often this tone carries through to the mouth and lip area. That is why we frequently see much better lip function in babies during the first month. Also during that first month the tongue may be observed moving in the up-down pattern of the true suck, which is part of that more advanced pattern related to lip closure.

At this stage the suck is very efficient and rhythmical. The top lip is able to come down and posture around the nipple. The sucking pads are quite strong and actually pull in, helping to give some compression with the lips. Although they come around the bottle, the lips are not really efficient yet and are not going to be for a while. The amount of opening at the corners of the mouth and the amount of liquid loss varies a great deal in younger infants. Some children dribble excessively; others do not.

What should we look for in a very young baby? Rhythmicity is one of the hallmarks and most important feature of feeding development in the first three months. In addition, strength, ease of initiation, cupping of the tongue, and overall efficiency of the suck, that is, how quickly a child can put all of this together in a time frame, are all important considerations. Most babies are able to suck between six to eight ounces of liquid from the bottle in approximately 20 to 30 minutes. When an infant sucks and sucks and gets only one to two ounces in 30 minutes, there is some reason for concern. The normal infant mouth is highly organized so that, when an infant demonstrates an inefficient suck, it may be due to a disruption in jaw movement. The organized quality of the oral mechanism allows the infant to make an immediate shift from crying to sucking. These are some of the behaviors that we should look for in a newborn nursery.

One Month

Babies at one month do not really have very good digestive

equipment for handling pureed foods. Some of the larger food particles may not be digested well enough so that they later create allergic reactions to certain foods. From an adjustment standpoint it is much more common not to introduce spoon feeding until three to four months, as many pediatricians are now realizing. Sometimes when a baby is being breast-fed, it is not introduced until five to six months.

When a baby is given pureed food prior to three months, he or she may not know what to do with it. The rhythmical suckle may fall apart as the infant squirms and protests the new sensation. As the food is deposited suddenly on the tongue by the spoon, the tongue tends to move upward. The more experience the baby gets with this solid food, the better able he will be to trigger the suckle-swallow response. It may be a very slow, disorganized process because of the difference in sensation. The food not only feels differently to the infant, but it also reacts differently to his oral-motor movements. The infant communicates with both the oral mechanism and feelings about this newness by coughing and sputtering and by difficulty with the initiation of the suckle-swallow. Compensation may also occur with bodily movements, such as wiggling. As clinicians, we must remember to observe the body language and all of the signals that children give us during the feeding process.

Three Months

By three months of age, the infant may be fed semi-solids in an infant seat so as to maintain more of a semi-upright position. Sucking rhythm is about one per second, which it has been all along. The oral pattern is predominately a suckle, and although there is a little gap in the corners of the lips, the infant does not lose a lot of liquid. Some infants compensate for the gap in lip closure by increasing the cupping of the tongue around the nipple. Each infant chooses its own way of valving the system and uses the lips, tongue, and cheeks in a particular combination that fits needs and personal style. A more typical way of valving is to develop better closure at the lateral borders of the lips. At this stage much of the stability and solidity in the cheeks is still being provided by the sucking pads; and there is not much discreet action of the particular muscles in the cheeks, which will develop later around six to nine months.

As the bottle approaches, the three-month-old infant orients toward it with the body. There are still instances of coughing, choking, and gagging during feeding. The infant recognizes the bottle by touch and is beginning to recognize it visually. Similarly, the touch of the spoon triggers a suckle. The top lip does not come down to clean, but does come forward. It loses contact with the spoon, however, and does not yet really posture on the spoon. This is related, in part, to the fact that the mouth is still functioning as a total unit. It is only after the baby begins to develop some jaw stability in the open position that controlled lip function develops.

Very often during spoon feeding, the infant will turn the head

away or avert the eyes. This may be a way of signaling that a pause is needed. Babies usually provide a variety of cues for their feeders. They indicate whether they are still hungry, whether they want more, and when they are full. Babies may do this by turning away from the feeder, turning toward the feeder, opening or closing the mouth, and speeding up or slowing down the suck. These cues become the baby's way of regulating what comes into the mouth and, after eight months of age, begin to be used with strong communicative intent. This is an important concept of normal development to be aware of because many of the children with central nervous system damage are not given the opportunity to regulate what comes into their mouths. Their messages and cues are frequently misinterpreted by the feeders. This situation then has a direct influence on the total mealtime feeding process.

Six Months

At six months the rhythmical component of the suck is still very strong. It is necessary to remember that rhythm is one of the most important features of normal development. The child is just beginning to want to cooperate in holding the bottle and orients very quickly to it. The lips are open and the tongue is very cupped around the nipple. The child now has the ability to hold the mouth open quietly and to stabilize the jaw while the body is wiggling. Normal babies do not just stabilize in quiet positions and wait for something to happen. They are generally moving all the time and in a variety of ways. Also, by six months they are usually much more visually active.

In general, around six months the cup is introduced. At the start the child approaches the cup as if it were the bottle, but more tentatively. The child may have difficulty at first in coordinating the suck with the swallow, and the suck and swallow with the breathing. There may be coughing, choking, and sputtering. Gradually the lips become more active, and the child postures them on both the spoon and the cup. The tongue movement continues to be backward and forward, but there is more up-and-down movement with a tendency for the front of the tongue to elevate. At six months mealtime is a social adventure. The child wiggles, smiles, socializes, and coos while eating. Playful behaviors begin to occur.

When a graham cracker is introduced to the six-month-old, the reaction is a mixture of a suckle and a suck pattern. Because the tongue is out and moving back and forth, biting is not possible. The child uses the very early familiar pattern to deal with this new texture. Some of the cracker will accidentally break off inside the mouth as it softens, and when it falls to the center of the tongue, it will be suckled and pushed out of the mouth. When the cracker is placed on the side of the mouth, however, something very different happens. The lips tighten on the side of the mouth where the food is and the tongue moves to that side. Frequently, although the tongue is not visible, the cues from the lips help to reveal what the tongue is doing and the location of the food within the mouth. As the tongue moves in th direction of the food, it is accompanied by a diagonal

movement of the jaw. However, as soon as the food is moved to the center of the tongue blade, the child goes back to using a mixture of the suckle and the suck; and if the bolus becomes stuck on the tongue blade, the child may gag. Around six months there is a tremendous expansion in the development of oral-motor movements. The child has much more variability of lip, tongue, and jaw function and is learning to handle effectively more solid food.

Nine Months

At nine months the child is capable of holding the bottle and is often quite independent. Most children have developed a great deal of lip closure, and those who have not may use an alternate pattern of the tongue strongly cupped around the nipple during bottle drinking. The normal child of nine months is able to combine movement and play while feeding. This is a skill that we seldom see in neurologically handicapped children, and we do not seem able, unfortunately, to figure out ways of providing these experiences for them during treatment. At nine months the children do an unbelievable amount of environmental exploration. They are constantly climbing out of their high chairs, throwing objects on the floor, and exploring the food at mealtime.

There seems to be a general trend followed by children in normal development that has many variations. The one word that seems to be synonymous with normalcy is "options," and the difference between normal children and the degree of severity of a child's handicap is proportionately related to the decrease in options for movement and for experience in that damaged system. Therapy then can be defined as "the process of increasing the options for function." This definition is applicable to feeding, physical therapy, and even psychotherapy. Increasing the options for function enables the individual to deal with the environment more effectively. It is important to appreciate not only the specific landmarks of development, but also a child's exploration and interaction with the environment, as well as the variations of movement that are possible.

During the feeding process the rhythm of the suck may change. At the beginning of the meal when the child is hungry or thirsty, the rhythm is fairly predictable. Toward the end of the meal, as satiation sets in, playing often occurs. The sucking may be in shorter bursts and somewhat less predictable. Nevertheless, as the child moves about, the sucking rhythm is maintained.

Around the ninth month the child is developing the ability to know the location of the mouth and to be able to aim the nipple so as to get it in the mouth most of the time. The bowl-shaped, cupped configuration of the tongue is still present. The child has developed a greater ability to regulate the flow of liquid from the cup and to compensate for the inability to coordinate long drinking sequences. The child uses about one to three sucks for every swallow and then coordinates this with breathing. With some children the tongue remains out under the lip of the cup for drinking. The tongue may be slightly

protruded with the cup simply resting on it. The tongue then moves with the jaw in a rhythmical up-down suck pattern. It is important to differentiate this slightly protruded tongue holding on to the edge of the cup for drinking from the exaggerated tongue protrusion of the neurologically impaired child.

Many children, during this early cup drinking period, place the cup fairly far back into the mouth. The cup may be really pushing against the corners of the lips, thus providing a positional stability for the jaw and a control for the lips. The tongue and jaw may still be functioning as a total unit; as a result the lower lip does not have the control to keep the liquid in the mouth and much may be lost. Thus up-and-down unstabilized jaw movement will gradually be reduced, enabling the tongue to be kept closer to the cup and the lips to be more functional.

The child now has many movement possibilities during spoon feeding. The body may move forward; the top lip may come down and posture on the spoon; and the jaw may open widely and stabilize. A child's use of a more advanced pattern for which he has the potential depends upon the speed with which we present the food, the size of the spoonful, and the configuration of the bolus. In other words, the child at nine months has the pattern of good downward lip movement on the spoon, but may not necessarily use it. The child has also the ability to pull the lower lip inward and bite it in an attempt at food removal. However, the inward movement is not yet well coordinated with the scraping movement. We want to know whether or not the child has a particular pattern and then to determine whether or not it is present for 75 percent of the time.

At six months the child sucked on a cookie. Now at nine months a different approach is taken. This is called "holding in a closed position." Although the child can exert enough pressure in his lower incisors to bite through the cookie, the jaw is held in a closed position, allowing the feeder to break off a piece of the cookie. This is an important distinction to make in the development of biting. Is the child actually biting through the cookie, or is there holding, allowing the feeder to break off a piece?

At six months when a cookie was presented to the center of the mouth, it was usually suckled and spit back out. Now at nine months when a cookie is presented to the center of the mouth, the tongue easily moves it over to the side with the help of the cheek, which tightens a little. The tongue, lips, and jaw then all work together. There is some diagonal movement of the jaw as it shifts off center. This is not just a simple horizontal shift, but rather an integration of downward and lateral movement on a diagonal. Now the child is able to move the food from the center of the tongue to the side. The jaw and the tongue move together in the up-down munching pattern. It is important to note that at nine months the child may have as few as two teeth in the front. So often parents and child-care workers in residential centers will comment, "Why should we work on chewing? He

doesn't have any teeth." Or conversely, "This six-year-old has a mouthful of teeth and so he should be chewing" (despite the fact that he is at a one-month developmental level!). You would be right to assume that the relationship between the presence of teeth and chewing is not an interdependent one. If, however, the child does not have upper incisors, there is going to be some difficulty biting harder solids.

There seems to be a definite preference in every individual for chewing on one side or the other that begins in early infancy. When a neurologically impaired child appears to be chewing on only one side, it is necessary to determine whether it is because one side is less capable than the other, due to a dysfunction, or whether it is the manifestation of a normal side preference. A neurologically impaired child may demonstrate a controlled bite on a cookie that is presented. When attempting to self-feed the cookie, however, there may be reversion to a more primitive, phasic bite pattern. Remember that, when children are faced with a new situation, they very often will revert to a more primitive level. They may also return to the more primitive or more abnormal levels if they have difficulty with the required motor skills, such as those involved in self-feeding, or if they have discovered that these earlier patterns are just fun to play with because they feel good. A child whose upper and lower incisors are all present may want to play with the phasic bite because the sensory input on a rhythmical basis feels so different.

Twelve Months

At 12 months the child comes quite forward to meet the cup with more flexion and may begin to stabilize the jaw by biting down on the edge of the cup. However, this biting for positional or external stability may not begin until the child is 15 to 18 months old. There is no longer a protrusion of the tongue under the cup, and the child sucks rhythmically while the jaw is stabilized.

There may be an overgeneralization of the biting-for-stability behavior onto the spoon. The teeth, as sensory receptors, provide the mouth with added information and make biting an interesting experience for the child of 12 months who has a few incisors. Now that the routine of biting for stability has developed, the child will later refine it and learn to use it only in situations where it is really functional. It is important at this point to keep in mind the sequence of development from the up-and-down unstabilized jaw movement to the biting for external jaw stabilization, and later the emergence of internal jaw stabilization.

Remember that at nine months the child could only hold the cookie while a piece was broken off by the feeder. Now at 12 months the child is able to bite through the soft cookie and possibly the hard cookie in a very controlled way. The child may assist the controlled bite of the harder cookie by pulling the head back and tightening other parts of the body. This tightening, however, is not the same stiffness that

occurs as an associated reaction in a neurologically impaired child. The child is independent and communciates this message well to the feeder.

For the purposes of the assessment of biting, it is important that we use several different thicknesses and consistencies which will enable us to observe the child's ability to grade jaw pressure appropriately, based on sensory input.

During chewing the tongue will not always be visible. However, it is possible to read the signals from the jaw and lips which will indicate the position and function of the tongue. A raisin is a useful tool for the assessment of chewing. It triggers the production of more saliva; it offers adequate resistance to the chewing; and it does not just melt or dissolve in the mouth. At 12 months a child can often be observed playing, chewing, and exploring the sensory and movement properties of food between the central incisors. Both sucking and diagonal-rotary jaw movement may occur at 12 months during this oral exploration.

Eighteen Months

At 18 months oral-motor movements are very different. The child is able to stabilize externally on the edge of the cup, which provides much better lip and tongue control. Drinking in long sequences occurs as the child holds the edge of the cup between the teeth. This sets the stage for the disassociation of separation of movement. As the cup is removed from the mouth, the lips are able to come together in anticipation of its removal in order to contain the liquid within the mouth. The tongue is now able to move separately from the jaw that is stabilized on the cup. Usually by 12 to 15 months a child is able to drink in long sequences with or without jaw stabilization as independence in lip and tongue movements is developed. The child is now taking an ounce or more of liquid at a time with less visibility of the tongue.

During spoon feeding the tongue elevates quite consistently for the swallow, and as the child self-feeds, he or she may push the spoon down on the center of the tongue. This serves to facilitate the curling and makes elevation of the tip more possible. The evidence which suggests that early stabilization of the jaw leads to early tongue-tip elevation is inconclusive at this time. If food gets stuck on the corner of the lip on the way into the mouth, the child may attempt to remove it with either the tongue, or the teeth, or the fingers. At this age many more options are available.

Once the food is inside the mouth, it is rolled around and worked in a smooth and easy fashion with better grading and more controlled movement. The child needs to open the mouth so little for a small cookie that it is difficult to know whether the teeth are biting through it until it has been bitten. There is some stereotyped vertical movement of the jaw and a roll of the cheek in transferring

food from the center to the side of the mouth. This roll of the cheek also prevents food from falling into the buccal cavity between the gums and the inside of the cheek. The cheek muscles are so tremendously active that it is hard to understand how we sometimes forget that the cheeks are part of the feeding system. Although the tongue and lip function are much better, the child may still drool and lose saliva. Raisins, because they trigger greater saliva production, are useful in providing information about whether the child can handle a somewhat more difficult task and is able to deal effectively with the saliva while the solid food is in the mouth.

So, by 18 months there is a much greater precision and independence in movement during oral function. The articulators are immediately responsive to stimuli encountered through oral exploration and feeding. It should now be clear that the issues of rhythm, stability, and separation of movement are important in the normal development of the feeding process.

Twenty-four Months

At 24 months the child uses much better lip control and is beginning to develop some internal jaw stabilization around the temporo-manibular joint, or jaw hinge. There may be some unstabilized vertical movements of the jaw that are very small and alternate with some biting on the cup. Sequences in cup drinking are longer, and prior to 24 months normal children are able to drink from a straw. Information can be gained from the observation of straw drinking. At 24 months the child can bite down on it or hold it just between the lips. When food or liquid remains on the lips, the tongue may attempt to clean it off, using a wide sweeping movement. The tongue, however, is stabilized against the lower jaw.

This stabilization on the jaw provides the positional stability that allows the tongue its movemnt and control. The tongue then is able to sweep from side to side freely during chewing. At age two the child experiments and plays with food and may be observed holding food in the mouth and squishing it around from side to side with the lips pursed forward and the pouching out of the cheeks. Children seem to enjoy this activity and use it to practice their lip seal.

Twenty-four to Thirty-six Months

The primary changes in development that occur between 24 and 36 months are: (1) by age three the child has developed consistent use of internal jaw stabilization on the cup; (2) the tongue has become the major cleaner and now moves in wide sweeping motions; and (3) food is easily transferred from one side of the mouth to the other. Prior to 24 months food would come in at the center and be transferred to one side. Then it was usually transferred from that side back to the center, played with in the center, and next transferred to the other side with a diagonal movement of the jaw. Between 24 and 36 months the child learns to transfer food swiftly and accurately across midline

with large, sweeping movements and a circular-rotary jaw movement. By 36 months the child is able to motor plan and when asked, "Can you make the raisin jump to the other side?" is easily able to transfer it across midline.

This motor planning aspect of feeding begins to develop by age three. Children go through a great deal of exploration of movement, not just with the mouth, but with the whole body. They have a myriad of possibilities for movement and are quite busy trying them all! This search for information about what the body can do in space seems to be strongly programmed into the human learning system. It is important to look not only at gross motor function, but also at mouth function.

There is a strong possiblity that dyspraxic children at the age of two do not present with the feeding problems that would be perceived in a cerebral-palsied child. Because they do have motor planning problems in the mouth, however, they probably do not demonstrate a lot of the explorative play or exploitation of movement. They do not engage in the oral-motor activities that provide the tactile facial movement cues used later in motor planning. These children also do not tend to babble or play with sound. When they do babble, it is often in stereotyped ways.

With the dyspraxic and learning disabled population, three observations in the oral-motor area should be noted: (1) when there is a feeding problem, it is predominately a sensory problem related to the poor acceptance of textures and changes in sensory qualities, the sensory input causing a tremendous difference in the motor function; (2) when they eat, they do not seem to plan and explore with their mouths and to exploit the qualities of food; and (3) they do not babble and there is very little sound play.

By 36 months of age the normal child has all of the basic movement components of oral-motor function. Using the frameworks as a guide, it is recommended that we all spend some time observing normal children and their development. (See Appendix F, page 195, "A Profile of Oral-motor Development: Birth to Thirty-six Months.") The information gained from watching normal children play and eat will be invaluable for both our assessment and our treatment of children with neurological impairment. We should look not only at the components of oral function, but also at the social and emotional components of development. The normal child of three years asks for independence in feeding. Independence is also important for the handicapped child, but may not be appropriate during feeding. The issue of whether or not to allow self-feeding is one of the critical therapeutic decisions that we will have to make. Oral-motor abilities may be, in part, dependent upon the social and emotional status of the child; and as one improves, so may the other.

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PROBLEMS OF CEREBRAL PALSY AND ORAL-MOTOR FUNCTION

Suzanne Evans Morris, Ph.D.
Sandra Stockdale Weber, M.A.

The evaluation completed, the therapist is faced with determining workable and realistic solutions to existing problems. The first step in establishing guidelines is to determine oral-motor problems which are a result of abnormal postural tone.

Characteristics of cerebral palsy which may impair the development of oral-motor skills include abnormal postural tone, abnormal oral and facial sensitivity, abnormal oral reflexes and an inability to imitate oral movements. The most important part of any evaluation is not the collection of isolated facts, but the integration of these facts with overall oral-motor functions.

Abnormal Postural Tone

Hypertonicity causes the following problems which interfere with pre-speech skills:

1. Severe restrictions in gross motor movement may decrease the movements necessary for normal respiration; consequently, vocalization may be short in duration and tense in quality.

2. Inadequate trunk rotation causes the thoracic region to remain fixed without sufficient movements for respiration. This, combined with hypertonicity of the abdominal muscles, affects the function of the diaphragm during inspiration and results in shallow breathing and telegraphic and breathy speech.

3. Limited oral movements may be related to the inability of the tongue to explore the oral cavity and tongue retraction or protrusion, which in turn interferes with feeding and sound production. The lips may be consistently retracted, precluding the closure necessary for sucking, swallowing, chewing and production of bilabial sounds. The jaw may thrust or be unable to maintain closure.

4. Limited, selective movement may be observed due to the inability of the oral structures to move independently. These kinds of oral movements may result in increased tone in other body parts (e.g., the legs may flex or extend when the child sucks).

5. Inadequate velopharyngeal closure results in hypernasality.

6. Laryngeal tension results in a strained vocal quality.

7. Jaw opening when the child attempts gross or fine motor movement may result in drooling.

8. Inability to establish a hand-to-mouth pattern precludes the development of finger-feeding skills.

9. Structural changes such as flared ribs or a scoliosis will restrict normal respiratory movements.

Hypotonicity causes the following problems which may interfere with pre-speech skills:

1. Inability to maintain head and trunk control may affect the ability to initiate or sustain sucking, swallowing, biting, chewing or vocalizing. This lack of head and trunk control may also cause a lack of stability in the laryngeal and thoracic areas, which may impair normal voice patterns and produce inadequate respiration for speech production.

2. Overall hypotonicity reduces the amount of muscle force available to the child for maintaining sustained, well-graded contraction of the abdominal muscles during expiration for speech. This is necessary for controlling volume, stress, intonation and phrasing features of sentences.

Fluctuating tone and/or intermittent spasms may cause the following problems which interfere with pre-speech skills:

1. Irregular breathing patterns may interfere with the coordination of swallowing and breathing, which could result in choking or coughing as well as disrupt the coordination of phonation and respiration. This lack of coordination may result in pitch breaks, wastage of air at the beginning or end of a sentence, audible inhalation, talking on inhalation and fluctuating denasality or hypernasality.

2. An inability to grade movements may interfere with graduated jaw opening for the acceptance of food and for various vowel productions.

3. Fluctuations of tone in the oral and facial area may interfere with the smooth coordination of sucking, swallowing, biting and chewing. Jaw deviations or tongue thrusting may result, and there may be an inability to maintain lip approximation for sucking, swallowing, chewing or the production of labial sounds. There may also be involuntary facial grimacing.

Oral and Facial Hypersensitivity

Abnormal oral and facial sensitivity may cause the following problems which interfere with pre-speech skills:

1. An increase in abnormal postural tone when the oral or facial areas are touched will interfere with all aspects of normal feeding and sound production.
2. Hypersensitivity of the individual oral structures to tactile contact of food, toys or fingers, may produce a bite reflex, abnormal gag response or facial grimacing. Stimulation of the tongue may cause retraction. This will limit continuous sucking or the manipulation of food for chewing. Tooth-brushing may be rejected.

3. Inappropriate tactile-proprioceptive feedback in the oral mechanism interferes with the development of the normal oral experiences of feeding and sound production.

4. Abnormal reactions to temperature change may result in the rejection of hot or cold foods.

5. Rejection of hand-to-mouth experiences, as stated previously, may interfere with the development of future finger-feeding skills and with the awareness of the relationship of body parts.

Abnormal Oral Reflexes

Persistent oral reflexes tend to be the primary response to tactile stimulation in the child with oral and facial hypersensitivity. They may interfere with pre-speech skills in the following ways:

1. Persistence of a bite reflex may inhibit mature sucking or chewing patterns and may affect the child's ability to grade jaw opening for feeding as well as vowel and consonant production.

2. A hyperactive gag response may interfere with the acceptance and manipulation of food and the production of lingua-velar consonants.

3. Retention of a reflex sucking pattern will delay the acquisition of chewing skills and a variety of more refined tongue movements for adjustments prerequisite to advanced sound play.

4. Retention of the rooting reaction can precipitate head turning or extension every time the child's face is touched. This may trigger the elicitation of abnormal reflexes causing hypertonicity.

5. Although jaw and tongue thrusting and jaw deviations are not ordinarily included as pure oral reflexes, they occur with a reflex-like consistency in many children. Their elicitation can interfere with the development of feeding and voicing skills.

Inability to Voluntarily Control the Oral Mechanism

The inability to voluntarily control the oral mechanisms may interfere with pre-speech skills in the followhing ways:

1. An inadequate controlled bite may interfere with the acceptance of hard food substances.

2. Inadequate jaw grading may interfere with a controlled mouth opening for a variety of foods.

3. Inadquate oral control may interfere with the oral initation necessary for the development of chewing, drinking and sound production.

4. Lack of voluntary oral expression may interfere with the gesture communication of smiling, frowning and kissing.

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OVERVIEW OF THE ANATOMY AND PHYSIOLOGY OF THE ORAL-PHARYNGEAL MECHANISM

Suzanne Evans Morris, Ph.D.

The discussion will now turn to anatomy and physiology; how they affect the normal developmental process; and to what extent they influence the approach to treatment.

Consider the oral cavity, together with the nasal cavity, as a single tube that divides into two areas: the trachea to the lungs, and the esophagus to the stomach. In order to constrict that tube, it can be valved by bringing the palate up to meet the back of the pharyngeal wall, thus separating the nasal cavity from the oral cavity. Velo-pharyngeal closure is useful in keeping the contents of the mouth from going up into the nose, and in keeping air and sound coming up the larynx from exiting through the nose. Instead, the sound comes out of the mouth in the form of oral vowels and consonants. This valve becomes very important during swallowing because it helps to direct the food down into the esophagus.

Another important valve in this oral tract is the epiglottis. In part, the epiglottis close off the pathway to the lungs during eating and ensures that the food will travel down the esophagus, rather than down the trachea, into the stomach.

The lips and the tongue may both valve the oral cavity at the front, and the posterior tongue may also slide up and act as a valve. This concept of a long tube having a number of moveable parts that can serve as valves is a useful one. These valves serve the functions of the directing the food down through a certain channel, or the sound and air up through a certain channel, in order to ensure normal operations.

The saggital section of "The Mouth and Pharynx of the Newborn" (page 31) demonstrates well the landmarks of the mechanism: The hard palate, the soft palate, the tongue and the tonsilar tissue at the base of the tongue, and the epiglottis. The less familiar landmark is the vallecula. This is actually a space that sits between the base of the tongue and the epiglottis, important because it is part of a cavity and therefore susceptible to food or liquid pooling in this space. When this little space becomes filled with food, a variety of situations can occur.

Speech pathologists are familiar with the cricoid cartilage and thyroid cartilage and the system that is labeled "the arytenoid." These are the cartilages to which the vocal folds are attached in both the front and the back. At the base of the cricoid cartilage, the muscle fibers from the inferior pharyngeal wall or constrictor attach, forming a muscle called the cricopharyngeus muscle. Muscles are named for their points of origin and insertion, in this case, the cricoid and pharyngeus. The cricopharyngeus muscle is an important one because it marks the top of the esophagus. This muscle is always closed except after a swallowing reflex has been triggered. It remains closed during

breathing and during talking so that nothing goes up or down this pathway or through the trachea.

This pharyngeal-esophageal juncture is important to note because, if it does not open, food cannot pass into the esophagus. Its opening is generally automatic and is triggered as part of the swallowing reflex. When there is no swallowing reflex in a child or an adult, therefore, the muscle does not relax and open to allow the food to pass down into the esophagus and through to the stomach. This P-E junction, as it is sometimes called, is a major landmark to remember.

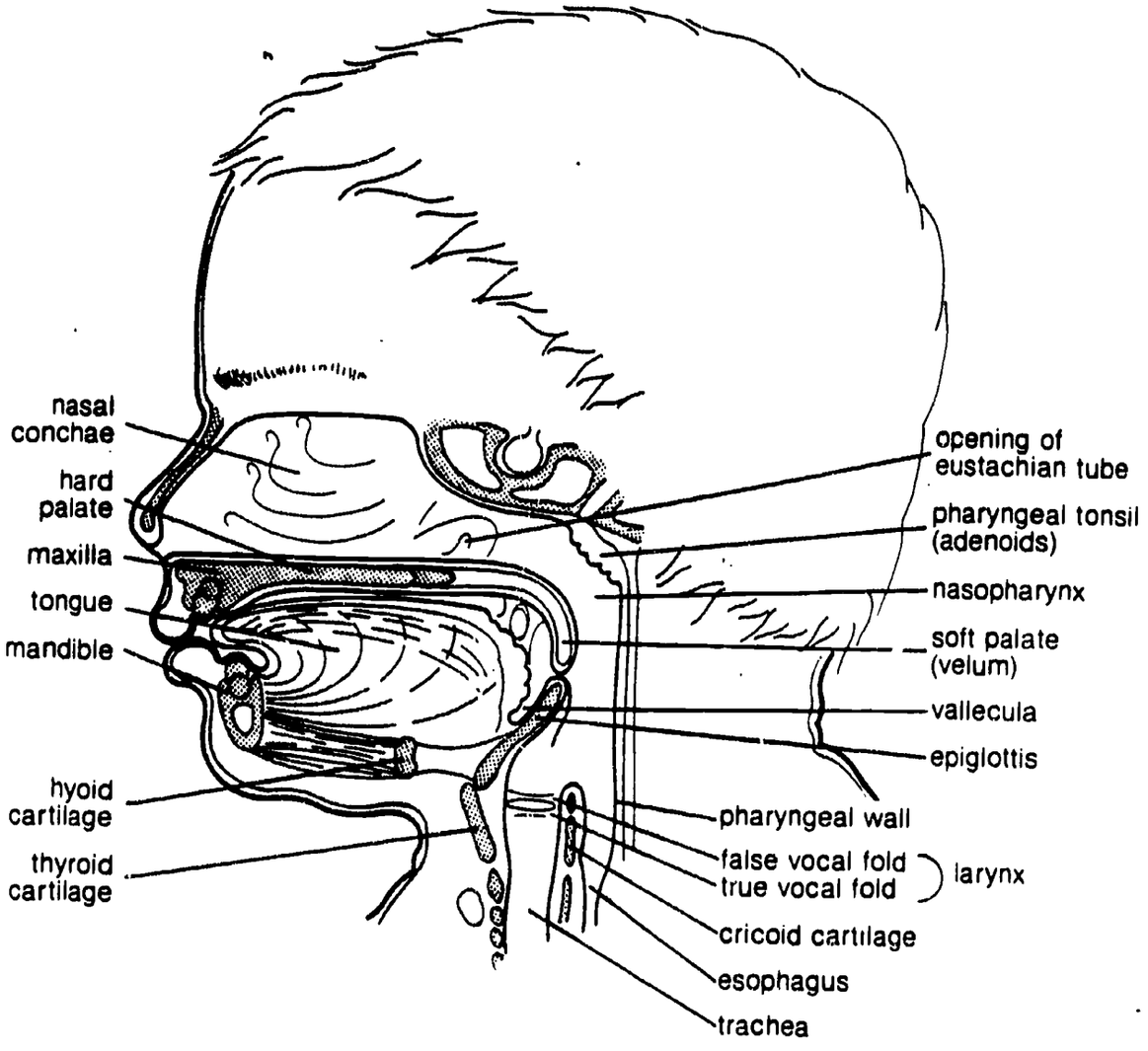
When we examine the saggital section of the adult mouth and pharynx (page 32) we note that there is a great deal of separation between the palate and the epiglottis. The larynx is quite low and the oral space is quite large. The adult eustachian tube is vertical.

Major Anatomical Differences between the Newborn and the Adult

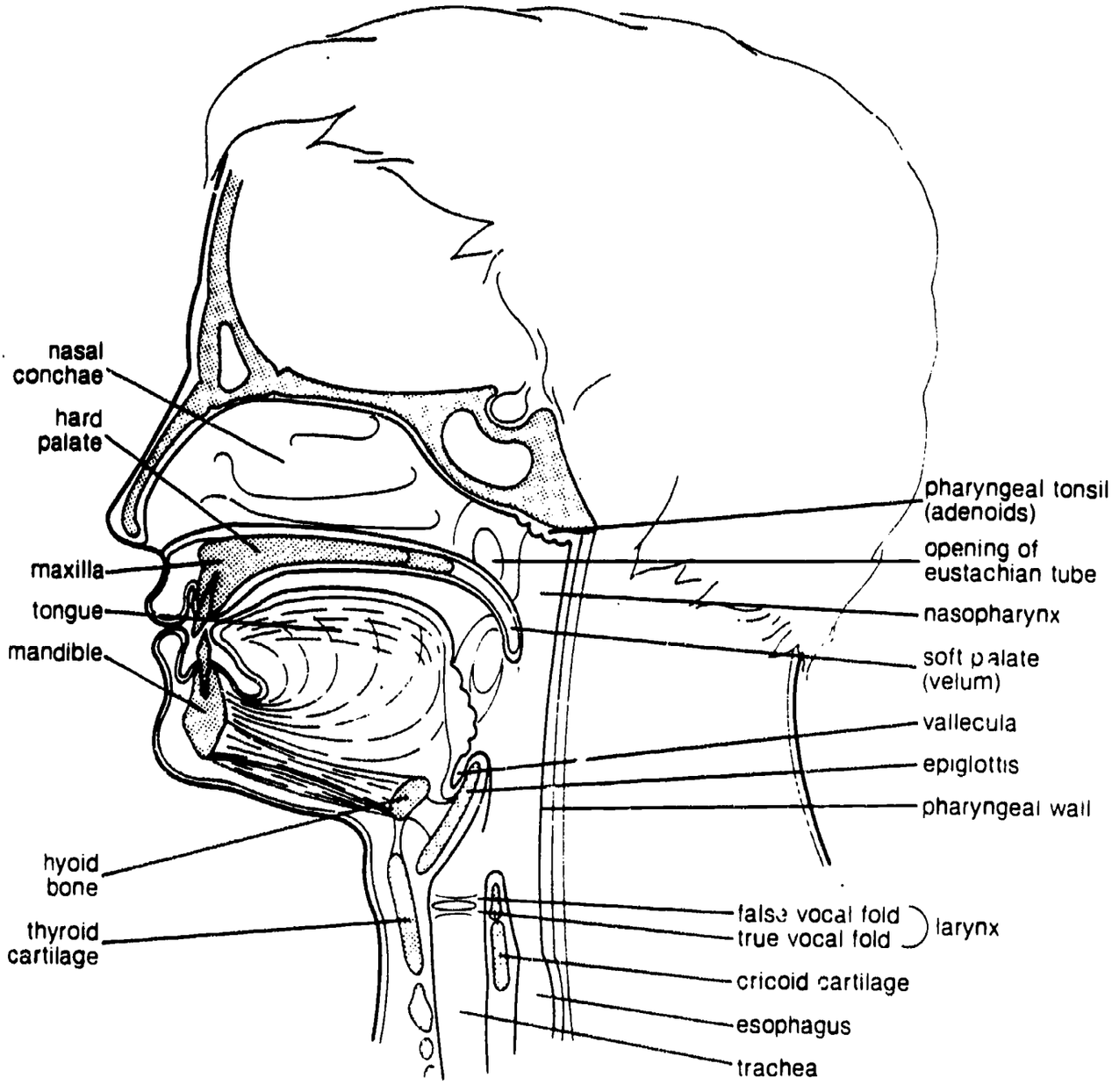
Now let us look again at the infant anatomy (page 31) and notice the differences between the newborn, up to three or four months, and the adult. First, the oral space in the newborn is relatively small, partly due to the comparative smallness of the mandible, or lower jaw. The lower jaw is small and somewhat pulled back in the newborn, and the tongue in relation to cavity size is rather large. In fact, in most instances not much of the oral space is visible since the tongue is usually in constant contact with all borders of this cavity so that it completely fills the space. Due to the small oral space, the extent and the direction of tongue movement is going to be very limited. How does structure affect function? Given this very small space, where is the tongue going to move? If there is very little space upward, is there going to be much possibility of developing up-down tongue movement? If this tongue moves backward, it is almost immediately back in the soft palate. The small size significantly limits oral function. How do you chew with such a structure? Even if the newborn had the neurological ability to chew, there would be an inability to do so because there is really no space for the tongue to maneuver inside the mouth. In addition, newborns are obligate nose breathers and do not breathe through their mouths. This has to do, in part, with the positioning of the soft palate, but also with the fact that there is no space in the mouth for air to be traveling in and out. This particular method of function in the newborn has a built-in protective component. When the system is not very sophisticated, it is much safer breathing through one area and eating through another, thus not requiring the system to share responsibilities for function. We already know that, in the adult, respiratory function and feeding function share a part of the same channel. In order to do this successfully, the sophisticated adult system has to provide a valve so that the food does not travel through the larynx and into the lungs. One of the differences, then, in newborn anatomy is the very small oral space.

A second difference is that structurally the epiglottis and the soft palate are in approximation. This makes it possible for food to

THE MOUTH AND PHARYNX OF THE NEWBORN
(saggital section)



THE MOUTH AND PHARYNX OF THE ADULT
(saggital section)



come down laterally on the outside of the epiglottis and pass directly down into the esophagus. This structural difference serves to protect the larynx in its own way and provides a great deal of control for the infant. One of the comments that has been made about the difference between infant swallowing and adult swallowing is that the infant has often retained the ability to breathe simultaneously with swallowing. Respiration does not have to be inhibited in order to swallow. It is remarkable how nature has provided the infant with this protective mechanism so that the structure allows the infant to survive with a little less function and coordination. Food is swallowed on either side of the larynx and slips right down into the esophagus, as the larynx rises and becomes much more protected by the epiglottis. This serves to minimize the risk of choking and aspiration in the infant, while also contributing to the nasalization of sounds. Since voice generated at the larynx has no room to come out the mouth, it is rerouted through the nasal passages. The phonological studies that have been done on infants (D. Kimbrough Oller, Rachel Stark) constantly describe the early infant sounds during the first two or three months as being nasally resonated. In other words, the cavities that reverbrate or resonate the sounds generated by the larynx are predominately the nasal cavity. It is not until three or four months that strong oral vowels are clearly resonated in the mouth. Therefore, what we hear in early infant sound production is a function of that child's anatomy, as well as of the more immature neurological control. A mouth which is entirely filled with a tongue, and a soft palate which is in approximation with the epiglottis, closing off the oral cavity, leave little option for the infant but to produce vowels which have a nasal quality. Since the tongue does not have the ability to produce sophisticated movements, it is not going to valve in many places. If it does valve, it will be by pulling back and approximating even further with the palate so that, when the baby first begins producing consonants, they will be tongue-velar consonants which may be nasalized (that is, guh and nguh). Oller calls this the "gooing" stage, as compared with cooing.

In the infant the larynx is quite high, almost under the base of the tongue so that it has a very high position in the neck. As the larynx rides higher and is elevated during swallowing, it becomes quite protected by the structures around it, eliminating the need for sophisticated closing. If the larynx were riding lower, it would be much more dependent upon the activity of the epiglottis and upon closure of the vocal folds to protect the airway. The hyoid bone (a cartilage in the infant) rides above the Adam's apple, or thyroid cartilage, and is connected with the base of the tongue. It moves up and down with the larynx during swallowing. In the adult there is a disengagement of the epiglottis from the larynx and hyoid. As the larynx moves downward in the neck, there is an increase in vertical space, as well as an elongation of the pharynx. There is considerably more pharyngeal space in the adult than in the infant.

Another important difference lies in the eustachian tube. In the adult the opening of this tube is at much more of a vertical level than

in the infant, where it is quite horizontal. It is this difference that accounts for the high incidence of middle-ear infection in infants and young children. It is much easier for bacteria and infection to get into the middle ear through the horizontally positioned eustachian tube; therefore, there is a much higher incidence of otitis media in children up through the first six years of life. When a child's feeding mechanism is not working very well, there may be some reflux into the nasopharynx; and such a child may be much more subject to infections because of the angle of the eustachian tube. The anatomy, together with the poor physiology, may cause this whole area to become contantly bathed in a bacteria-laden mucous.

A major difference between the oral structures of the infant and of the adult is the presence of sucking pads. These pads are fatty tissue pads, encased in more fatty tissue and then in muscles which are located in the infant's cheeks. It is the sucking pads which give babies that puffed-cheek effect. These fat pads are important to the infant because they provide stability for the mouth area. The temporo-mandibular joint, the hinge where the lower jaw connects to the skull, is quite unstable in the early infant period. This aspect of instability, coupled with cheek and lip muscles that are not yet very functional, would render the infant virtually helpless and unable to feed if it were not for the positional stability provided by the sucking pads. These pads, by furnishing stability, facilitate the compression ability of the tongue and cheek area.

Changes in Infant Anatomy

Between four and six months many anatomical changes begin. The infant's pharyngeal space starts to elongate in conjunction with the downward growth of the mandible or lower jaw, the lowering of the larynx and hyoid, and the disengagement from the epiglottis. The downward growth of the mandible creates a larger intro-oral space, which provides a much greater variability for tongue movement, both for feeding and for sound production. Interestingly, it is at approximately six months that parents begin to give babies little bits of food for chewing. Chewing begins during this period when the child has developed a masticatory space. Also at about that point, the baby begins to produce different kinds of sounds. The sounds instead of "g" and "ng" become "ah, oo, ga-da, dada, ah-da" because there is more mobility of the tongue. Further, since the infant also has lateral and upward space available within the oral cavity, there are increased options for sound production. And so it is no accident that, starting at about four to five months and progressing onward, the normal infant begins to make a wider variety of consonants and vowels.

At this stage the normal infant may become a mouth breather or a mouth-and-nose breather. The palate and epiglottis are no longer in apposition, which makes it relatively easy to interchange cavities during inhalation or exhalation. This greater separation of the epiglottis and the soft palate, however, leads toward a different means of swallowing, which relies on active closure of the vocal folds and a

more active protection of the airway by the epiglottis The very early infantile way of swallowing, in which a baby might be able to breathe, suck, and swallow simultaneously, no longer works. Now, between four to six months of age, the epiglottis must come down actively and the vocal folds have to approximate in order to produce an effective swallow in which the airway is fully protected.

When a child has a coordination problem, choking and the onset of aspiration may not begin until the baby reaches the age of four to five months. Prior to this, there may have been no choking or aspiration. Swallowing was merely slow and feeding skills were borderline. As the anatomy changes from a structure in which the laryngeal airway protection is built into the system, to one in which the protection of the airway is dependent upon the adduction of the vocal folds and the function of the epiglottis, children with neuro-muscular or muscular dysfunction may develop difficulties and problems that lead to aspiration. One such problem, for example, might be partial paralysis of a vocal fold. The inability to close the airway would not be a handicap for feeding in the early months when the larynx is at a high level and is physically protected from food injection by the "umbrella" effect of the epiglottis.

This change in the type of swallowing pattern, dictated by the anatomical changes, may be one of the major explanations for the clinical findings of greater feeding problems in neurologically impaired children around four to six months of age. A change in the anatomical structure demands better coordination, and when the system is neurologically damaged, the effect manifests itself in an increased in feeding disorders.

Another changed which occurs as the infant matures is the gradual reduction in the sucking pads as the infant begins to lose that pudgy, fat-cheek infantile appearance. This seems to reduce gradually the amount of positional stability in the cheek and allows for the gradual development of more active muscle movement or more postural stability for the cheek muscles.

Finally, another change which occurs is the ruption of the teeth. The additon of teeth makes some real changes in oral cavity relationships, particularly around 10 to 16 months when the child's molars erupt. As the number of teeth increase, so does the vertical dimension of the oral space. This larger space provides for greater maneuverability and adjustment of the tongue for feeding and for sound production; and it also allows for a much greater possibility of the independent action of the tongue tip for an elevated swallow pattern.

It would seem, then, that in the normal infant there is a working relationship between anatomy and physiology, between form and function. To a large extent, the baby is given a real assist by the anatomy and develops improved neurological function in a very halting way. Anatomical structures and relationships provide stability. They take over functions which will later require greater degrees of

coordination. Anatomical changes occur slowly so that the infant has time to adjust to the change. Then, gradually, function changes as the anatomy changes.

This factor contains two very important issues to be considered when looking at how babies learn movement: how they learn movement for feeding, and how they learn movement for speech. First, both anatomy and form are changing constantly during the first couple of years. The child's movements are dynamic, continually adjusting to a changing anatomy. The infant's neurological system must function within a framework which adjusts to the evolution of a very dynamic, changing system.

Secondly, this has multiple implications for what we do in therapy. We must consider the many alternate ways of providing children with the opportunity to explore space in their mouths and must encourage that exploration in a variety of ways that normal children explore spontaneously. By age seven, a child may be trying to discover how many different ways you can blow bubbles with gum. Younger children are figuring out how many other activities can be done with the mouth.

Even as therapists, unfortunately, we do not seem to encourage this kind of exploration with cerebral-palsied children. By the time many children are referred for therapy, their systems have matured so that they do not have many of the anatomical assists. For example, nature may have eliminated the sucking pads in the cheeks, but the child may not yet have developed active cheek movement and may still need stabilization. Since the assist of nature is impossible, the therapist must figure out ways of providing what nature would have provided. By this time the oral cavity is close to adult size, and the tongue is not in constant approximation or apposition with the palate and the alveolar ridge, as it is in the infant mouth. It may be sitting in a sensory void, unable to receive the rich kind of sensory input that comes with the tongue-filled mouth. How do we, as therapists, provide this rich sensory input? Can we go backwards to that infant mouth? Because of the anatomical changes over which we have no control, the approach to older children may be different from the approach to infants. Nature provides for infants the stability, a way of making swallowing easier, and protection for the airway. For the older child, therapy must provide these through handling and positioning, through a piece of equipment, or through the appropriate stimulation. Using normal development as a guide, we need to ask ourselves, in order to be able to work this component into treatment, "What is the essence of what the structure provides?"

Physiology of Suckling/Sucking and Swallowing

As the anatomy changes, so does the physiology of sucking and swallowing. During the suckle or sucking phase, the base of the tongue moves slightly backward; the soft palate is in approximation with the base of the tongue. The food is taken in either through the

backward-and-forward movement of the tongue in a suckling pattern or by a raising and lowering of both the mandible and the tongue, creating a greater negative pressure in the mouth. As the palate approximates the back of the tongue, food is held within the oral cavity. This approximation creates an oral space for the liquid or the bolus of food. The airway is open as the food is being suckled. The mandible is lowered as the nipple is taken into the mouth. The tongue has a central groove or a cupping effect which serves to hold the liquid. There is a stripping action on the nipple when the tongue moves from front to back, which compresses the milk out of the nipple in a lick type of suck. As the infant suckles, the sides of the tongue are raised; and the center of the tongue is grooved in a cupped configuration, which assists in keeping the bolus together. The liquid is then directed to the back of the tongue for the swallow.

The oral phase of swallowing, as it is often referred to, involves the intake of the food or liquid into the mouth, and the actual propulsion of that bolus of food or liquid onto the back of the tongue for the swallow. The initiation, or the oral phase of the swallow, may be voluntary in the older infant, in the child, or in the adult. This oral phase is characterized by sequential pushing. The tongue moves upward and, as it pushes, it strips along the soft palate, propelling the food to the back of the tongue for the swallow.

During this phase there must be some closure of the front of the tract; if the tract remains open, there is the risk that food will slip out. Valving can occur with either the lips, the tongue, or the teeth. Once the oral cavity is closed, the tongue moves the bolus back. When the bolus reaches the area of the anterior and posterior "pillars of fauces" at the base of the tongue, the swallow reflex is triggered. It is important to remember that, once this happens, there is no longer any volitional control. The volitional control is present only during the oral phase of the swallow when the front of the mouth is involved. The triggering of the swallow reflex marks the beginning of the automatic, pharyngeal phase of swallowing.

There are four events which occur <u>simultaneously</u> when the swallow is triggered. The back of the tongue elevates and is pressed against the posterior wall. The soft palate immediately moves backward and upward, contacting the the back of the pharyngeal wall, and completely closing off the nasopharynx so that food cannot come up and out through the nose. It prevents what is called a "backlash" or "reflux." Then a peristaltic, or wave-like, movement of the pharyngeal constrictors occurs which sequentially squeezes the bolus of food downward. The superior constrictors begin to contract, followed by the medial and the inferior constrictors, squeezing the food down the pharynx. The final stage of this is the relaxing of the bottom of the pharyngeal contrictor, or the cricopharyngeus muscle. The food is then allowed to pass downward into the esophagus.

As all this is occurring, the larynx and the hyoid elevate, bring the structures closer to the epiglottis, which then moves back and down

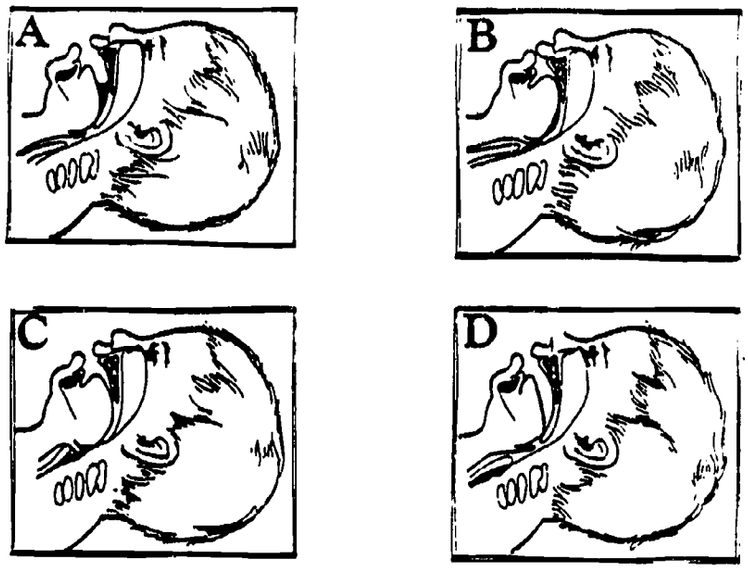
to protect the airway. Protection of the airway or closure of the larynx occurs simultaneously at three different leveles: (1) epiglottis, (2) adduction of false vocal folds, and (3) adduction of true vocal folds.

Now, let us review the sequence of the pharyngeal phase of swallow. The swallow reflex is triggered; the back of the tongue elevates and presses against the posterior pharyngeal wall; the soft palate elevates to valve off the nasal passageways; the food begins moving downward to the pharyngeal constrictors; the airway is protected by the epiglottis and valving of the true vocal folds and false vocal folds; the muscles continue contracting; the cricopharyngeus muscle relaxes; and food passes downward into the esophagus.

When patients produce excessive amounts of mucous which seem to pool in the oro-pharynx, the therapist needs to rule out two possibilities: (1) the patient may be aspirating small amounts of food, which are causing the lungs to product excess mucous in order to rid themselves of foreign matter, and (2) the pharyngeal constrictors are not working adequately enough to take that mucous farther down. Cinefluorographic studies are used at many of the major hospitals to provide information regarding the efficiency of the swallowing mechanism at this lower level. The swallowing evaluation is usually done by a Department of Radiology and can be reasonably requested for an adult patient who exhibits swallowing difficulties, such as a head and neck cancer patient or a neurologically impaired individual. Although the amount of radiation is relatively small, many people are not as willing, however, to subject infants and small children to this video fluoroscopy technique. This is unfortunate because this type of test provides significant information and conclusive data about the presence of the swallowing reflex and/or any structural problems. If there is no swallowing reflex, none of the sequences in the pharyngeal phase of swallow will occur. When working with infants and young children, therapists cannot generally determine from the oral phase of swallowing what is happening farther down during the pharyngeal phase. Usually a sophisticated guess is made, based on when choking seems to occur, if choking seem to occur, and if the child seems to be aspirating.

Knowledge of the physiology of swallowing enables a therapist to differentiate between the swallow and the gag reflex. The gag reflex is triggered in approximately the same oral area as the swallow, that is, at the back of the tongue near the pillars of fauces. When a gag reflex is triggered, the soft palate elevates; the tongue retracts and elevates; and the mouth opens widely. Diagnostically, it is important to differentiate between the jaw thrust, in which the mouth also opens widely and the tongue retracts; the gag reflex; and the swallow, in which mandibular elevation, rather than depression, usually occurs.

The Normal Infant Swallow of a Liquid Bolus in the Supine Feed Position



A. The tongue and palate prevent the bolus from entering the pharynx prior to triggering the swallow reflex.

B. The tongue moves backward propelling the bolus into the pharynx. The soft palate elevates, closing the nasal airway.

C. The tongue and pharyngeal wall converge behind the bolus while the larynx elevates under the epiglottis, closing the laryngeal airway. the cricopharyngeus muscle relaxes, opening into the pharynx and airway. The airway is fully open.

D. The liquid bolus passes through the esophagus while the cricopharyngeus muscle contracts preventing reflux into the pharynx and airway. The airway is fully open.

Implications of Changes in Infant Anatomy for Feeding and Sound Production

A background in the anatomy and physiology of the oral mechanism is a pre-requisite for an understanding of the developmental sequences which occur in feeding function. The major changes are observed around four to six months and continue beyond the first year. As the intra-oral space increases, it allows for more maneuverability of the tongue and provides the opportunity to maintai through movement, some of the sensory input previously provided by the anatomical structures. The tongue begins to elevate as the infant shifts from suckling to sucking. During the intake phase of suckling, the tongue moves in an extension-retraction pattern, or forward-backward movement. Such a movement pattern occurs early in a tongue-filled mouth where there is no vertical space. As the oral cavity vertically elongates, the neurological system also changes. Once the intra-oral space has increased and the tongue movement has shifted to an up-and-down

pattern, then the child needs to use more intra-oral or negative pressure to expel milk from the nipple. This requires better valving of the lips in order to close off the front of the oral cavity. Previously, in the tongue-filled mouth of the infant, the tongue provided this valve. As the lips become more functional and as the tongue begins to elevate, the four to six month old child is able to produce a greater variety of sounds. In addition, there is now masticatory space in the mouth, which prepares the child for the chewing of solid food.

Also around this time, there is a gradual reduction in the sucking pads. This gradual reduction in positional stability allows for the possibility of greater movement and mobility in the cheeks and lips, as well as the development of their more postural or active stability during the feeding process. As the cheeks become more active as a major force in keeping food in the center of the tongue, in order to project it backwards for the swallow, there is less of a physiological need for the strong central grooving of the tongue. With the cheeks pushing in from the sides, the tongue gradually flattens and broadens until just a very shallow cupped configuration remains. It is now possible for the baby to begin accepting more solid food and to be more active in collecting the bolus for the swallow. In the early months the infant's system is such that the liquid simply has to run down the central groove in the tongue to the back of the mouth. As the anatomy changes, the food is handled in the mouth in a different way. The entire mouth becomes much more active in developing and forming the bolus and in moving it from one side to the other across midline.

The downward growth of the hyoid and the larynx gives a greater separation of the epiglottis from the larynx and the soft palate which results in a shift to the adult-swallowing pattern. The food now passes over the epiglottis, rather than around the sides, so that the infant can no longer breathe and swallow simultaneously. The greater physical distance between the base of the epiglottis and the larynx means that the epiglottis no longer provides an easy, spontaneous "umbrella effect" in shielding the airway. The infant must develop better coordination of the timing of breathing with sucking and swallowing. The larynx now plays a much larger role in the closure of the vocal folds in order to protect the airway. Sound is no longer exclusively directed nasally. Oral resonance of sound is now possible. It is important to be aware of how the changes in anatomy may seem to direct changes in the feeding process.

Swallowing Problems in the Neurologically Impaired

In a neurologically impaired population, there are a number of problems that can occur during the feeding process. One of the primary problems in both children and adults is with the oral phase of sucking and swallowing. Although some children do have pharyngeal swallowing problems, the majority of neurologically impaired children and adults who aspirate do not have an absent swallowing reflex. The reflex may be delayed, but the problem most likely lies with the coordination of

the tongue, the lips, the cheeks, and the larynx. They may be unable to take food into the mouth, to maneuver it sufficiently to the back, and to trigger an efficient swallow reflex with appropriate timing of pharyngeal and largngeal movements.

There are two figures which have been given for the timing of swallowing: one for the oral phase, and the other for the pharyngeal phase. In the adult it should take a maximum of one second to work the food from the front of the mouth to the back of the mouth for the triggering of a swallow reflex. This is called the oral transit time.

The pharyngeal transit time is measured from the point at which the swallow reflex is triggered to the time when the cricopharyngeus muscle relaxes to allow the passage of food into the esophagus. This measurement is usually determined through cineradiographic or video fluoroscopy procedure. The pharyngeal transit time in the adult should be no longer than one second.

The two most commonly observed swallowing problems in the neurologically impaired population are (1) difficulty in forming a bolus, and (2) difficulty in projecting the bolus to the back of the mouth for the swallow. The result is an oral transit time of more than one second. These problems may be related to poor lip, cheek, or tongue function; a lack of central tongue grooving, which allows food to be efficiently projected backwards; or a lack of support from the cheeks. In the older child who has no sucking pads, the food may fall into the cavity between the cheek and the gums, called the buccal cavity, when the cheeks are inactive during the feeding process. In addition to getting caught in the buccal cavity, pieces of food may get scattered on the tongue, triggering gagging and choking rather than a swallow reflex. Children, when unable to form an efficient bolus, sometimes adjust to these pieces of food and simply suckle them onto the back of the tongue. They often do not show signs of a gag reflex until they are really in trouble! These children have learned, through constant exposure to such little pieces of food, to inhibit the gag reflex.

Occasionally, the neurologically impaired individual does have an absent or delayed swallowing reflex. When there is no swallowing reflex, the larynx remains open, and the cricopharyngeus muscle at the top of the esophagus remains closed so that the feeding passage is open at one end and closed at the other. The airway, however, is open all the way down. Then, the airway becomes the path of least resistance, and there is a very real danger that food or liquid will spill over the back of the tongue into the airway. As the food or liquid leaks over the back, it may pocket in the little sinus called the vallecula.

Another set of pockets, the pyriform sinuses, are located on either side of the larynx at the base of the cricopharyngeus muscle. If the cricopharyngeus muscle is closed when the food or liquid comes down, the pyriform sinuses may catch some of it instead of the food or liquid entering the airway. Consequently, when there is no swallowing

reflex, the bolus can take one of three routes by entering either (1) the vallecula, or (2) the pyriform sinuses, or (3) the airway.

The vallecula is usually able to hold one or two swallows. Therefore, when a child is given one or two mouthfuls and there is no coughing, choking, or vomiting, it may be assumed that swallowing has occurred and that all function is intact. However, when aspiration suddenly occurs on the third mouthful, we conclude that a swallow reflex has not occurred. Liquid has spilled over the back of the tongue and has lodged in the vallecula. With the third such bolus, the vallecula becomes filled and spills over into the airway. For this reason, it is important to assess the swallow reflex beyond the first one or two swallows. If the swallowing reflex is absent, delayed, or only partially functional, it may not serve to open the esophagus. After approximately three mouthfuls, the vallecula becomes filled; and after one or two additional mouthfuls, the pyriform sinuses also become filled. The fourth or fifth bolus spills over into the airway. This aspiration of food and liquid in the neurologically impaired child is an area of great concern.

The differential diagnosis of swallowing problems reveals a variety of causes for aspiration: (1) the maximum swallow time for intake into the esophagus is more than two seconds (This slower oral and pharyngeal transit time increases the risk of aspiration.); (2) reduced tongue movement that leads to a premature swallow, so that the swallow is triggered before the child is ready; (3) the swallowing reflex is delayed and is not triggered until the vallecula is filled, rather than when the bolus first contacts the back of the tongue; (4) the reduced closure and adduction of the vocal folds allows the bolus to penetrate the airway; and (5) an inability to relax the cricopharyngeus muscle, which prevents food from passing into the esophagus.

Another indication of swallowing problems with the neurologically impaired population is excess secretions. These secretions are often a sign of aspiration even though the child appears to have a good cough. A good cough was generally thought to be an indication that the larynx was working well and that, as long as food was being coughed up, it was not being aspirated. Cineradiographic studies have revealed, however, that a cough can be triggered from two levels. It can be triggered directly from the epilaryngeal area or from the place where the bronchial tubes bifurcate or separate. The latter is the deeper cough which is often heard in many neurologically impaired children and adults. This deeper cough means that the liquid is down in the lungs and has already been aspirated. Increased mucous production, however, is not always indicative of aspiration. The body produces mucous as a means of excreting unwanted materials and toxic substances. This occurs when there has been aspiration, but may also occur when the body attempts to excrete the toxic effects of contipation, allergy, or food intolerance. The amount and type of secretions present can be a useful diagnostic tool and should be noted.

One of the guidelines which is often used for oral feedings in many adult hospital settings is that, if the swallowing time for a particular consistency of food is greater than ten seconds, then that food will not be included in the patient's diet. If it takes more than ten seconds for an adult patient to swallow a mouthful of food, then oral feeding will not be adequate to maintain weight or meet nutritional needs. It has been suggested that an adult patient should be able to swallow within ten seconds maximum in order to be an oral feeder.

These guidelines have some real implications for the clinicians who are working with children. In many cases with children who are on tube feedings, the clinician may be in a position to push for oral feedings. The children, however, may not be able to suck and swallow fast enough to maintain nutrition or body weight. Sometimes, when a child has a slow oral transit time and does not want to eat by mouth, it may be a way of telling the therapist or the parent that eating is uncomfortable and tiring or that food is getting into the lungs, and that it is awful! We know that adults will stop eating by mouth if there is too much aspiration, or if transit times are too slow and it takes too long to eat.

The ability of the clinician to assess accurately oral-motor function is based on a background of knowledge of anatomy and physiology, as well as on an understanding of the developmental sequences which occur in feeding function.

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