Dentists can play an important role in speech screening by identifying potential speech problems in children, determining the child's ability to outgrow the problem, and initiating referrals to speech pathologists. Speech screening involves less than five minutes and can be done in the dental office.

Speech screening of children in the dental office

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Dentists are frequently questioned by parents about speech development variations in their children. Such questioning is logical since, in many cases, the dentist is the primary professional resource available to the family. Because children with speech variations are often referred to a speech pathologist, it would be helpful if the dentist could conduct a simple screening procedure in his office to make such referrals.

The purpose of this article is to present a screening procedure and rationale for assessing speech development in children. The procedures described are intended for use in the dental office.

Some limitations of screening tests

Speech screening of children should be a valuable addition to dental practice, although it has some inherent shortcomings compared with more comprehensive diagnostic assessments. Since children are characterized by variability in speech and other skills, any results obtained from screening assessments are subject to guarded interpretation. The considerable cultural, dialectal, and other environmental differences between children account for many of the problems associated with making definitive judgments of speech functioning in a screening situation. Even in speech pathology clinics, speech-impaired children are often initially enrolled in "diagnostic therapy" in order to achieve an accurate and specific catalog of deficits and capabilities.

While screening procedures provide limited information about the speech process, it is our view that dentists can play an important role in speech screening by identifying potential speech problems in children, noting situations where maturation may positively influence the speech

variability, and then initiating referrals to speech pathologists for comprehensive diagnostic assessment or therapeutic intervention.

Background information on speech and language

Speech and language are alike, yet different. Speech refers to the output of the physical system in terms of the particular sounds which are combined into word units. The manner in which the sounds are combined is specific to the process of speech. A speech disorder, then, is some problem with the production of particular sounds or units. Language refers to the process where symbols (words) representing objects or events are organized into patterns (sentences) to convey meaning. The message to be transmitted is the purpose of language, and speech is the medium by which language is conveyed.

Speech and language development are progressive phenomena generally completed by about 8 years of age. There is a unique developmental progression expected for each component of speech and language that several authors have summarized.[1-3]

■ *Speech development:* In speech development, vowel sounds are initiated in early infancy and are generally mastered within the first few years of life. In fact, the birth cry is considered by some to be the first attempt at speech sound development. Consonant sounds (all sounds that are not vowels) are acquired slightly later than vowels yet are learned in a rather predictable sequence. The predictability of the occurrence of consonant sounds makes them especially good indicators for the measurement of speech development. The sound acquisition sequence for consonants has been charted by recording the utterances of large samples of children at specific ages and averaging the results of sounds mastered at those ages by a majority of the children sampled. Table 1 is a summary of findings from several studies.[4-7]

The examiner should be cautioned about the application of normative data, such as that given in Table 1, to a specific child. The normative data reflect tendencies characteristic of most, not all, children. (The data in Table 1 reflect 75% of all children tested.) These age-based data, then, are not totally adequate for distinguishing normal sound development from impaired speech production. While these data are useful in making judgments about speech development, they must not be the sole reason for referral.

Table 1 ■ Age at which selected consonants are usually produced correctly by children.

Age (in years)	Consonants
3	p, m, n, ng, f, h, w
3.5	b
4	d, g, k, r
5	t, s, sh, ch, l, v
6	th (unvoiced), z
7	th (voiced), s & r blends (sm, gr, and so forth)

■ *Language development:* The development of language competency also follows a somewhat predictable or universal sequence. However, because language includes a broad range of complex creative processes that are used to convey meaning, the screening of language skills can be particularly complex. Because of this, methods for screening language problems will not be presented in this discussion. Information about the assessment of language development has been presented elsewhere.[8]

Speech screening procedures

Screening for speech problems in the dental office, in our view, should include assessing speech sound production, evaluating speech-related neuromotor capabilities of the child, and assessing the child's ability to modify his incorrect patterns into correct pronunciations after stimulation. Observation of these areas of speech behavior will allow the dentist to offer sound recommendations pertinent to the child's speech skills.

■ *Assessing speech sound production:* The determination of a child's ability to use sounds correctly in words and sentences is the purpose of speech sound assessment. This can be conducted in the office using screening techniques that require only a minimum of materials and time.

For the initial portion of the speech sound screening test, the child is asked to count from one to 20. The dentist should record the numbers pronounced incorrectly. Particular attention should be given to the child's production of the numbers 6, 7, 16, and 17, since these sample production of the "s" sound, one of the most frequent sources of pronunciation errors and one of the most difficult sounds for children to master.

The second portion of the speech sound test requires the child to spontaneously produce a series of sound-in-word items, such as those in Table 2. This is achieved by having him name a series of pictures or respond to the series of questions in Table 2.

The information obtained from recording the incorrect productions in both the counting sequence and the sound-in-word items should provide the dentist with a profile of the child's pronunciation abilities. By comparing the child's sound productions with the age-based data in Table 1, the dentist can determine which speech errors, if any, involve sounds that the child should have attained at a certain age.

There should be no concern if certain sounds are incorrectly pronounced by a child if those sounds are typically mastered at a more advanced age.

Engaging the child in spontaneous conversation while keying on those sounds identified as errors in the screening examination will provide additional information about the nature of the error pattern. The child whose pronunciation errors persist in spontaneous conversation probably needs professional speech therapy.

■ *Estimating neuromotor status for speech:* After the assessment of sound production, the speech screening examination should include an evaluation of the neuromotor capability of the child's speech apparatus. The neuromotor development status of the speech musculature is assessed through oral diadochokinetic testing, the process of assessing the rapid, repetitive movements of selected parts of the speech musculature. Oral diadochokinetic testing is a modification of the digital diadochokinetic testing done by physicians in a neurological examination.

Diadochokinetic testing in speech requires the child to repeat selected syllables in rapid sequence, 15 times per syllable. The syllables used in diadochokinetic testing are "puh" (to assess lip activity), "tuh" (to assess tongue tip activity), "kuh" (to assess activity of the tongue base and possibly the soft palate), and "puh-tuh-kuh" (to assess overall coordination of the oral structures).

As a child repeats "puh, puh, puh . . . " as fast as possible 15 times, the dentist should examine the symmetry of lip movement and the consistency of contacts made by the lips. Since the bilabial sounds, such as "p" and "b", are learned early in the speech acquisition process (Table 1), a child who has difficulty (randomized lip activity) producing "puh" might have a neuromotor maturation lag for speech, and should have a more complete diagnostic examination by a speech therapist.

During repeated utterances of "tuh," a normal child under age 5 may demonstrate a pattern of tongue movement restricted to the horizontal plane of space, rather than the vertically directed tongue movements toward the incisive papilla area which are expected in a 7-year-old. The progression from tongue tip protrusion to tongue tip elevation for "tuh" is the apparent consequence of sensory and motor maturation. This maturation does not occur spontaneously in many children with neurologic deficits.

Up to age 7½, a mandibular assist (vertically directed movements of the mandible) is a normal accompaniment of "tuh" repetitions. The child who demonstrates a mandibular assist during speech diadochokinesis will usually fixate the tongue tip over the lower incisors, while the mandible moves the tongue vertically. By age 7½, however, a child should have experienced sufficient neuromotor maturation to produce rapid movements of the tongue, independent of the mandible. Consequently, the child with speech production errors who retains a mandibular assist during "tuh" productions after age 7½ may have a neuromotor development delay for speech. This is especially so if he also has difficulty in elevating the tongue tip during other speech tasks.

On "tuh," the dentist should attend to the consistency, direction, and symmetry of tongue movements. Randomized movements of the tongue should be minimal by age 5. Children 5 years and older who are able to elevate the tongue tip for accurate "tuh" repetitions and who show a consistent pattern of tongue contact at the inci-

Table 2 ■
Supplementary words and sentences for speech screening.

Test sounds	Key words	Test questions
k	kite	What can you fly on a windy day?
g	goat	What animal likes to eat tin cans?
y	yes	Do you like ice cream?
r	rabbit	What kind of animal is the Easter Bunny?
l	last	The opposite of first is_____.
j	jar	What does Mom keep peanut butter in?
th	thumb	This finger is called my_____.
th	there	If it's not here, then it must be_____.
s	socks	In the morning we put on our shoes and_____.
z	zoo	Lions and bears live at the_____.
ch	church	Where do some people go on Sunday?
sh	shoes	What do you wear on your feet?

sive papilla are considered to be progressing adequately for speech purposes. The child who does not show a consistent tongue tip elevation for "tuh" by age 5 may be progressing within normal limits, but will likely have less clarity in his speech when his speaking rate is increased. These children, therefore, should be encouraged to reduce their rate of speaking.

On "kuh" productions, the rate of repetition is expected to be slower, since the posterior tongue mass is larger and the sensory innervation of the tongue base is relatively sparse.[9] On "kuh," the dentist assesses if the child can produce this sequence and if the tongue is able to move with some efficiency on this task.

For repetitions of "puh-tuh-kuh," children of all ages have a varied range of ability. Children under 5 years rarely produce this sequence adequately and should not be encouraged to try it because it is like a tongue twister. Children 5 years and older who have difficulty in producing the "puh-tuh-kuh" sequence may be asked to rapidly produce 15 utterances of "pat-a-cake." This is a more familiar and meaningful pattern to children; it will frequently be successful in eliciting this changing sequence of sound repetitions. For the older child, the repetitive series, which combines a sequence involving contacts of lips, tongue, and soft palate, may reveal a speech difficulty of temporal coordination not readily evident in less difficult combinations. This type of child may exhibit differences in isolated sound and word production capability, as well as overall speech efficiency. Such children can profit from slower speaking rates, although often speech therapy is indicated.

■ *Will the child outgrow the speech problem?* In the screening situation, it is possible to obtain information about the child's potential for spontaneously improving his speech with maturation. In speech pathology, the special tests that are designed, in part, to provide information about spontaneous speech improvement are referred to as stimulability tests. These tests are based on the recognition that some children often spontaneously correct their own speech errors after stimulation from others in their environment during daily activity. Consequently, the procedure of stimulating a child with a correct verbal model for a sound-in-word item, and the assessment of the child's pronunciation of that word after such a verbal cue, will indicate his potential for improvement.

Stimulability testing is attempted only after the child has spontaneously counted, named the screening pictures, or answered the screening questions, and a record of his error productions has been made. The dentist then says each error item correctly to the child while the child watches the dentist's mouth and listens to the correct production. The child is then asked to repeat the particular number or word in imitation of the dentist, while the dentist compares the retrial production with the original response. A "stimulable" child is one who can improve his pronunciations through imitation of the verbal model provided.

In interpreting the results of stimulability testing, the dentist may find that the child is stimulable on some sounds, but not on others. Use of the sound development chart in Table 1 provides a means of determining whether the unstimulable errors involve sounds that are typically mastered at that patient's age.

Generally, stimulability screening testing provides a basis for the dentist to determine if the child may outgrow his problem or if speech therapy is indicated. The child who is stimulable (that is, improves pronunciation after imitation) will probably not require formal speech therapy, while the child who is not stimulable on sounds that should be mastered at his age will benefit from the specialized attention of speech therapy.

Summary

Screening for speech problems in the dental office involves less than five minutes. Procedures include the sampling of a child's pronunciations in counting activities, word responses to pictures or questions, and conversational speech situations. Use of a normative sound development chart will help judge each child's pronunciation skills. Oral diadochokinetic testing provides a means of evaluating the maturational level of the neuromotor components of the oral structures used in support of sound production. Finally, the child's ability to modify sound production after stimulation, that is, his "stimulability," adds important data for determining the child's potential for outgrowing his problem. The screening assessment of these several characteristics of speech performance, then, provides sufficient diagnostic criteria for the dentist to recommend those children for speech therapy whose error productions will not likely im-

prove through maturation alone. In instances where examination indicates that maturation should cause spontaneous improvement of speech, the dentist would then be able to inform the parents.

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