In this study, tongue movements of normal 2-, 3-, and 4-year-old children were measured and compared. The 4-year-olds were also compared with 4-year-old children in a previous study (Schwartz J: Observation of Tongue and Jaw Movement in Normal Four- and Five-Year-Old Children, master's thesis, Washington University, School of Occupational Therapy, St. Louis, MO, 1982). Measures were taken on 56 children: 17 two-year-olds (8 females, 9 males), 19 three-year-olds (10 females, 9 males), and 20 four-year-olds (10 females, 10 males).

Two different tongue positions were quantified: First, the position of the tongue as the food was presented to the child at the moment when the food was 5 cm away from the lips and second, the position of the tongue as the food was swallowed. Younger children held their tongues in a more forward position when the food was presented to the child at the moment when the food was 5 cm away from the lips and second, the position of the tongue as the food was swallowed.

During swallowing there was also a progression, as age increased, from pursing the lips to puckering at the corners of the mouth. Many children kept their mouth open during swallowing. These results provide further normative data for the assessment of eating-impaired children.

Children with eating problems are often referred to occupational therapists for evaluation and treatment. Such children may have cerebral palsy, Down's syndrome, or cleft lip and/or palate, or they may have failed to reach developmental milestones within expected time limits. Eating evaluations remain largely descriptive because a standardized eating assessment scale does not exist. Without a base for comparison with normal development, the judgment about the severity of an eating problem remains mostly subjective.

The clinician needs reliable and valid methods to identify normal, as well as abnormal, eating behavior.

Schwartz (1), developed an assessment tool and, together with her associates, has published normative data for normal 4- and 5-year-old children (2). Findings suggested that the transition from infantile to adult swallowing had not yet been completed at these ages. Since the tongue is not always observable when swallowing occurs, oral facial movements were chosen as indicators of transitional phases of swallowing. Contractions of the orbicularis oris and facial muscles were defined as a “pursed lips” response, whereas “puckering at the corners of the mouth” was attributed to the actions of facial muscles (2). Puckering was interpreted as the more mature response. These two responses are still transitional responses because the adult swallow is characterized by the absence of contractions in the oral-facial region.

Schwartz and associates (2) found that children distinguished between different textures of foods in anticipation of receiving these foods. Tongue position upon presentation as well as upon swallowing was affected by food texture and by the age and gender of the child.

The assessment developed by Schwartz (1) has good sensitivity as shown with a group of 4- and 5-year-old children with Down's syndrome (3). It was demonstrated...
that many more Down's syndrome children than normal children placed their tongue on the teeth and on or beyond the lower lip. The type of food and the child's age also affected the tongue position as food was presented to children with Down's syndrome.

Subject selection criteria were the same as reported earlier (2).

Procedure
The sessions took place between 9 AM and 11:30 AM. The observations usually took place in a well-lighted, quiet room.

The children were seated on a chair with their feet flat on the floor. The investigator sat in front of the child. Some 2-year-olds sat in a high chair or in their mother's lap. Each child was observed once for 20 to 30 minutes.

Children were observed eating the following foods: applesauce, graham cracker, and raisins. The procedure for administering these foods has been described (2).

Two tongue positions were recorded: first, the tongue position when the food was 5 cm away from the mouth and second, the tongue position when the food was swallowed. The details of the procedure have been described (2).

Data were analyzed using descriptive statistics of frequencies and percentages. Comparisons were made between ages, gender, food types, and tongue positions. For the comparison of 4-year-old children from this study with the 4-year-old children of the study done by Schwartz and associates (2), a chi-square test of independence was used. A loglinear model was chosen so that many independent variables could be compared (5).

The method used to compute reliability accounted for within-subject and between-observer variability. Reliability was tested on 38 children by comparing the first five trials with the second five trials, all of which were administered by one observer. Comparisons were also made in 18 children between two observers when each administered five trials to any one child (1).

Results
Tongue Position as Food Is Presented
The first hypothesis for this category was that there would be no difference in the position of the tongue as differently textured foods were presented to the different age groups (2-, 3-, and 4-year-olds).

Table 1 illustrates percentage scores for the effects of food on position. The tongue was observed "behind teeth" most often for all three foods. Among this healthy, normal group of children, "on or beyond the lower lip" was seen least frequently; the other two categories ranged in between.

Both sexes responded most frequently with the tongue "behind teeth." The other three categories followed in similar order.

For the separate age groups, "behind teeth" was again the most frequently observed response. The order of the remaining categories in 2- and 4-year-olds was similar to those recorded before, but 3-year-olds had a higher frequency of "on or beyond the lower lip" than "retracted 5 mm or more."

The second hypothesis was that there would be no difference upon food presentation between the 4-year-old children in this study and the 4-year-old children in the study done by Schwartz and associates (2). Table 2 illustrates the results.
Response patterns were similar although percentages were not identical. "Behind teeth" was the most frequent category for both investigators, followed by "retracted 5 mm," "on top of teeth," and "on or beyond lower lip." There were significant differences for all tongue position categories between the two studies (p < .05).

Tongue Position Upon Swallowing

It was first hypothesized that there would be no difference in the position of the tongue as differently textured foods were swallowed by the children of the various age groups (2-, 3-, and 4-year-olds; see Table 3).

The most common response for the two categories of raisins was "puckers in corners of mouth," followed by "tongue behind incisors" and "lips pursed" in that order. For graham cracker and applesauce, the most frequent responses were "lips pursed" followed by "puckers in the corners of the mouth."

Males and females responded in the same sequence of categories. "Puckers in the corners of the mouth" was most frequent, followed by "lips pursed" and "tongue behind incisors," in that order.

For all three age groups, the sequence of more than 75% of the responses was the same. That is, for the 2-, 3-, and 4-year-olds, "puckers in corners of mouth" was the most frequent response, followed by "lips pursed" and "tongue behind incisors," in that order.

For the 2- and 3-year-olds, there was little difference in the frequency of responses between "puckers in corners of mouth" and "lips pursed." The 3-year-olds responded just as frequently in the "tongue behind incisors" category. Four-year-old children showed a definite preference for puckering, followed by the "lips pursed" response. Overall, the majority of responses—62.6% for the 2-year-olds, 50.9% for the 3-year-olds, and 69.7% for the 4-year-olds—were found in the categories of pursing and puckering. (In both these responses the mouth is closed.) "Lips pursed" showed a decrease with age, as did "on or beyond lower lip."

The second hypothesis stated that there would be no difference in the 4-year-old children of this study and the 4-year-old children of the study done by Schwartz and associates (2) during the swallowing of the food. Table 4 shows that the data of the current study differed from those reported by Schwartz and associates. Under "lips pursed," 31.9% of the observations in this study were recorded, whereas 59.0% were recorded by Schwartz and associates. For "puckers in corners of mouth," 58.4% of the responses were recorded in this study, while 29.1% were recorded by Schwartz and associates. "Tongue on top of teeth" was comparable in both studies. The statistical analysis showed that the categories "lips pursed" and "puckers in corners of mouth" were significantly different (p < .0001), but that the category "tongue on top of teeth" was not.

Observer Reliability

Reliability was computed for the investigator by comparing the first five trials with the second five and between the investigator and an observer over five trials each. The first procedure was necessary to...
Table 3
Effect of Position, Food, Gender, and Age on Tongue Position Upon Swallowing in Normal 2-, 3-, and 4-Year-Old Children

<table>
<thead>
<tr>
<th>Position</th>
<th>Food</th>
<th>Sex</th>
<th>Age (Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R1</td>
<td>R2</td>
<td>GC</td>
</tr>
<tr>
<td>Tongue not observed, lips pursed</td>
<td>16.4</td>
<td>19.2</td>
<td>32.0</td>
</tr>
<tr>
<td>Tongue not observed, puckers observed in</td>
<td>35.9</td>
<td>39.1</td>
<td>29.1</td>
</tr>
<tr>
<td>corners of mouth</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tongue on top of teeth</td>
<td>11.8</td>
<td>10.3</td>
<td>10.0</td>
</tr>
<tr>
<td>Tongue on or beyond lower lip</td>
<td>4.6</td>
<td>4.9</td>
<td>4.8</td>
</tr>
<tr>
<td>Tongue behind incisors, jaws open</td>
<td>27.4</td>
<td>21.6</td>
<td>20.4</td>
</tr>
<tr>
<td>Other</td>
<td>3.9</td>
<td>4.9</td>
<td>3.7</td>
</tr>
</tbody>
</table>


demonstrate that children responded consistently over 10 trials. Since the investigator sat directly in front of the child, it was not possible for another observer to make observations from the same viewpoint. Therefore, reliability between the investigator and an observer was established by having each administer five of the total of ten trials for each food. For this study, the investigator tested ten children with one observer (observer A) and eight children with another observer (observer B).

For “tongue position upon presentation,” the reliability of the investigator for the average of all foods was .82. For “tongue position upon swallowing,” the reliability of the investigator for the average of all foods was .44. When the reliability of the investigator’s and another observer’s assessment of “tongue position upon swallowing” was compared, the reliability was 0.50 for observer A and 0.84 for observer B. These figures indicate satisfactory agreement among independent observers. The low reliability of observer A may be partly due to her limited experience in working with children. Further testing of the category “tongue position upon swallowing” is in progress to ascertain the validity of this category.

Discussion
Tongue Position as Food Is Presented

There were some differences in the age groups when food was presented to 2-, 3-, and 4-year-old children. Categories showing these differences were those in which the tongue was on or beyond the teeth. The 2- and 3-year-old children responded more frequently in these categories than did the 4-year-olds. Thus, maturation progresses from an anterior tongue position to a position behind or even retracted from the teeth.

A possible reason for the forward movement of the tongue in the younger children may be linked to the timing of dentition. Cohen (6) suggests that “growth rotation of the mandible may be secondary to that of the tongue,” which means that the tongue grows first, and then the space in the oral cavity expands as the mandible grows. The 2-year-olds and some 3-year-olds did not have a full complement of primary teeth. It is possible that the younger children had experienced tongue growth but not yet mandible growth and therefore held the tongue in a more forward position.

This argument may also explain a discrepancy with the study done by Schwartz and associates (2), who suggested that “tongue retracted 5 mm” was an immature response found more often in 4-year-old children than in 5-year-olds. Five-year-olds are beginning another stage of dentition and, like the younger children (2- and 3-year-olds), may hold their tongues in a more forward position.

A similar anatomical and functional position was observed in 4- and 5-year-old children with Down’s syndrome (3). Anterior
Tongue positions were predominant when food was anticipated. Thus, similar tongue responses result during normal maturation and certain pathologic conditions.

There may also be an element of learning involved in the category "tongue retracted 5 mm." The highest rating for this category was in raisin 1 for the 4-year-olds. For this particular food, the children may be holding their tongue back in anticipation of the raisin being placed behind the teeth. This was the only food placed in that position. The 2- and 3-year-olds may not be as facile in this response as are the older children. The learned response was not found with the graham cracker because a portion of the cracker was bitten off rather than placed behind the teeth by the investigator. The children anticipated the graham cracker differently than raisin 1. This finding agrees with the finding by Schwartz and associates (2) that children distinguish between different types of food before the food enters the mouth.

It was also proposed that there would be no difference between the 4-year-olds in this study and those in the study done by Schwartz and associates (2). Comparisons showed that, although the responses fell in the same sequence of categories, there were significant differences between the two groups. In general, more children held their "tongue behind teeth" in this study than in the previous one (2). Fewer children in this study presented their "tongue on top of teeth" than in the other (2).

The differences between the studies could be partly due to the different sample groups or to the different investigators. It was observed that children often held their tongue behind their teeth while the experimenter approached the child with the food. Some children would then very rapidly extend their tongue to the teeth or to the lower lip at the moment the food was placed in their mouth.

Thus, it is possible that Schwaab (4) recorded the tongue position that was observed longest over any one trial, while Schwartz and associates (2) may have recorded the most forward tongue position that the child exhibited. Each investigator may have had a different interpretation of the categories that led to the discrepancy. The question of comparability among different testers for this area of the assessment tool will be addressed as this long-term project continues.

**Tongue Position Upon Swallowing**

It was proposed that there would be no difference in the position of the tongue as differently textured foods were swallowed by the children of the various age groups.

Proffit and associates (7) associated open-mouth swallowing with a more immature response. They proposed that the transition phase between infantile and adult swallowing includes teeth-apart swallows and later progresses to teeth-together swallows. This trend was seen in the responses for applesauce, the only pureed food used. This progression may indicate a more mature manner of handling a pureed food than is found in the handling of the solid foods, or it may simply be necessary to keep from spilling food during swallowing. It is also possible that it is more difficult to swallow solid foods than pureed foods.

Pursing of the lips decreased as this long-term project continues.
The most common tongue position that 2- to 4-year-old children use when they anticipate food was found to be the “tongue behind teeth” position.

and 3-year-olds is replaced by the “behind teeth” response at 4 years of age. During swallowing, pursing predominates in 2- and 3-year-olds. A large group of children still swallow with their mouths open. The present study provides normative data for children 2 to 4 years old and identifies maturational patterns of the tongue during eating. Children who fail to achieve age-appropriate eating skills may be seriously compromised in their growth and development (8). Although therapists have responded to the call for therapeutic intervention (9, 10), there is still a lack of established norms against which aberrant behavior can be compared or treatment effectiveness measured. Our data provide a crucial first step in providing therapists with a normative data base for evaluation and more precise treatment planning.

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REFERENCES