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Dysphagia

Functional Oral-Motor Skills: Do They Change with Age?

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Abstract. Dysphagia, a difficulty eating or drinking, appears to increase with age and is a concern for our growing elderly population. Mastication, tongue mobility, and lip closure are skills of the oral phase of ingestion, and have been shown to deteriorate with age. However, it is not clear whether these changes affect *functional* feeding. It is also unclear whether dysphagia is the result of the aging process itself, or whether it is secondary to disease. Therefore, the purpose of this study was to identify changes during the oral phase of ingestion in a group of healthy seniors. Functional feeding skills and oral praxis abilities were measured in 79 healthy adults aged 60–97 years. The Modified Functional Feeding Assessment (FFAm) subscale of the Multidisciplinary Feeding Profile (MFP) and the Oral Praxis Subtest (OPS) of the Southern California Sensory Integration Test were administered respectively. An interview followed to obtain information on denture wear, use of hearing aids and glasses, and types of foods avoided. Seniors maintained functional feeding skills throughout the four decades studied. These skills were not age-dependent, but depended on whether or not subjects wore full dentures. Even though all of the seniors maintained functional feeding skills, more seniors in the younger group (7th decade 60%, 8th decade 67%) had difficulty with a variety of food textures such as soft, hard, fibrous, and some with tough skins, than the older group (9th decade 40%, 10th decade 44%). Oral praxis abilities were correlated significantly with age, but not with hearing aid use. Overall, healthy seniors maintained their functional feeding and oral praxis skills. Good health and natural dentition appear to be excellent indicators for functional feeding ability.

Key words: Functional feeding — Oral praxis — Seniors — Disease — Deglutition — Deglutition disorders.

Swallowing dysfunctions, also known as dysphagia, appear to increase as a person ages [1–3]. However, the true frequency of dysphagia in the geriatric population is unknown [4]. Some authors report that as few as 8% of people 60–95 years old have dysphagia [3]. Others indicate that 16% of older people living in the community have problems with dysphagia [5]. Bloem et al. [5] caution that the actual frequency may be higher than the findings suggest, because of the tendency of older persons to accept their problems as an inevitable consequence of aging. In turn, the probability of seeking help is low, resulting in underreporting of symptoms. It has been suggested that swallowing dysfunctions occur in one third to one half of elderly nursing home residents [6–8], but Siebens et al. [7] contend that dysphagia in residents of long-term chronic care facilities may be as high as 79%. The high frequency of swallowing dysfunctions is a great concern because of their impact on the quality of life of our growing elderly population [3,9].

Several authors have debated whether the changes associated with swallowing are the result of the aging process itself, or whether they are secondary to disease [2,4,10,11]. Strong correlations have been found between swallowing dysfunction and diagnoses often associated with aging, such as Parkinson's disease, stroke, cardiovascular disease, esophageal stenosis, Huntington's disease, and multiple sclerosis [1,5,12]. The increased use of medications in the elderly may also contribute to the high incidence of swallowing dysfunctions.

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Stoschus and Allescher [13] found that improper positioning or not drinking an adequate volume of water with medication can result in pill-induced esophageal injury, causing dysphagia. They further caution that side effects of drugs may alter smooth or striated muscle function or the sensitivity of the intestinal mucosa.

Much of what is presently known about swallowing impairment focuses on the pharyngeal phase of dysphagia because of the risks it poses for aspiration. The oral phase, however, is of equal importance. It is the phase when food is brought to the mouth, chewed, and combined with saliva to form a bolus which is moved to the back of the oral cavity and prepared for swallowing [14]. Oral phase performance including masticatory function, lip posture, tongue function, and the duration of the oral phase, are altered in older compared with younger groups [15–17]. However, there is no indication that these changes affect the aged person's *functional* eating abilities, nutritional status, or well-being. Although this study does not intend to directly measure subjects' nutritional status or well-being, functional eating abilities encompass these parameters.

Oral diseases and conditions of the dentition and supporting structures may affect the physical, social, and psychological components of life [18] and result in oral functional impairments, tooth loss, and/or malalignment of teeth or dentures. Consequently, many older adults change the composition of meals, take longer to complete a meal, are discouraged from eating with others, and feel social discomfort. Although prosthodontic care is often prescribed in order to improve chewing and appearance, dentures (especially poorly fitting ones) limit the wearer's masticatory abilities [19,20]. Furthermore, it is possible that oral sensory perception declines in the presence of complete dentures, affecting food acceptability and potentially dietary intake. Although the literature indicates that there may be a decline in eating functions as a person ages, the concomitant increase in chronic long-term impairments has not been separated from their possible contribution to ingestive problems. Therefore, the purpose of this study was to determine the effect of aging on functional feeding skills of the oral phase of ingestion in a sample of healthy older persons and to explore the relationship between denture use and foods avoided during meals.

Methods

Sample

A total of 79 seniors (27 males, 52 females) between 60 and 97 years of age [mean age was 78 years ± 11 (S.D.)] participated in the study. They were recruited over a 3-year period (1993–1996) and comprised seniors living in their own home (with or without community assistance, n = 60), or in a seniors residence (n = 19). All participants were oriented to time, place, and person, as indicated by the recruiter's (same as the examiner) discussion with the senior. All were able to feed themselves and did not have any severe cognitive or motor impairments that could have interfered with their feeding activity. Seniors were included if they wore glasses correcting their visual problems, or if they wore (a) hearing aid(s) to correct their hearing impairment. Written consent to participate was obtained from each senior prior to entry into the study.

Materials

To identify feeding status, a reliable and valid assessment tool was required, but no such oral-motor assessment was available for an elderly population at the time of study. The Multidisciplinary Feeding Profile (MFP) by Kenny et al. [21], is reliable and valid for the pediatric population and is normed on feeding behaviors, not age [22]. Its modified Functional Feeding Assessment (FFA_m) subscale was therefore used [23]. It includes seven domains of ingestion: spoon feeding, biting, chewing, cup and straw drinking, swallowing, and drooling, and each domain contains 4–9 behaviors which are scored on an ordinal scale from 1 (poor) to 5 (normal) [23]. The FFA_m dichotomizes behaviors within each of these domains as normal and abnormal.

Preliminary testing of a small group (n = 20) of healthy seniors aged 60–90 indicated that while general feeding skills remained intact, there appeared to be changes in oral motor planning skills (oral praxis). Hence, the Oral Praxis Subtest (OPS) of the Southern California Sensory Integration Test (SCSIT) was used in addition to the FFA_m, so that oral praxis skills could be examined more directly [24,25]. The OPS consists of 19 oral gestures that the subject imitates after demonstration by the examiner. As with the MFP [21], validity and reliability of the OPS [24] have been established with a pediatric population, but have not yet been examined in a geriatric population.

Procedure

Each senior was given an appointment to have either lunch, dinner, or a snack with the examiner. All were seated in their customary position and videotaped during the meal. The camera was positioned approximately 2 m away from the senior such that a semiprofile view was obtained of the mouth and neck region. After the meal, an interview was conducted for approximately 15 min. Information obtained included medications taken for Parkinson's disease, conditions of the cardiovascular system, diabetes, rheumatoid- or osteoarthritis, and ''other'' conditions (anemia, asthma, diverticulosis, stomach ulcer, stress incontinence).

Dentition was categorized as full dentition, full dentures (upper and lower), or partial dentures (either full upper and partial lower, full lower and partial upper, upper and lower partial, or bridges). Denture fit was categorized as good or loose. Use of eyeglasses was recorded to verify that the individual was able to see food and drink in front of him/her. Hearing ability was determined by noting whether the senior wore (a) hearing aid(s), whether the examiner's voice had to be raised, and/or whether the senior asked the examiner to repeat questions. The types of food avoided by participants were also noted. Seniors were asked to list foods they found difficult to chew or any that they avoided completely. The last procedure was the administration of the OPS [24,25]. The examiner ensured that there was sufficient light so that the subject could see him/her and that instructions were given slowly and clearly for persons with hearing deficits.

Analyses

Each videotape was analyzed by two independent observers using the FFA_m [23]. Raw data of the FFA_m were converted to a percent score (% competence) because of unequal numbers of behaviors in each domain. Percent competence was calculated for each normal/abnormal feeding behavior by using the following formula:

$$\% \text{ Competence} = \frac{x - \min}{\max - \min} \times 100$$

where x is the observed value for a behavior, and max and min are the highest (4 or 5) and lowest (1) values that can be attributed to the behavior, respectively. Means for each domain and a grand mean for the 7 domains were then computed. Mean domain competencies were then classified according to severity of the eating impairment based on earlier observations with children: normal 91%–100%, mild impairment 71%–90%, moderate impairment 51%–70%, and severe impairment less than 50% competence. Frequency distributions by age (decades) were established and compared using an analysis of variance to determine whether there were any significant changes in eating performance with age. Pearson correlations were performed to identify feeding domains that were correlated. Finally, an analysis of variance was performed to determine whether denture wear affected FFA_m results, and post-hoc testing (*t*-test for independent samples) established whether denture fit affected FFA_m results.

Results of the OPS were scored using the competence formula above, and Spearman correlations were used to determine if there were any significant associations between age and performance on the test. There is reason to believe that gestures 1–11 are easier to perform (simple movements) than gestures 12–19 (repetitive movements). Therefore, comparisons were made between results of gestures 1–11 (A) and 12–19 (B) using Kruskal-Wallis tests.

Use of eyeglasses and hearing aids was calculated by decade, and frequencies were computed for each. Frequency of foods avoided was obtained for a subsample of the group (n = 45) to establish whether there was an association between the amount and types of food avoided, age, and existing dentition. Analyses of variance determined significant differences for oral praxis skills. An alpha-level of 0.05 was chosen to determine significance for all statistical analyses.

Results

Functional Feeding Performance

There were 20 seniors aged 60–69, 21 aged 70–79, 20 aged 80–89, and 18 aged 90–99 years. Figure 1 illustrates that there were no significant differences when comparing the mean performance of functional feeding behaviors by decade ($F_{3,75} = 1.102$ $p = 0.354$). The FFA_m competence scores approached maximum values with very little variability (96.1 ± 5.7%), indicating that this group of seniors was functioning in the normal range of 91%–100%. It appeared, however, that some of the individual eating skills were more difficult to perform in the later decades. Straw drinking–*normal* ($F_{3,74} = 2.894$, $p < 0.041$) and cup drinking–*abnormal* ($F_{3,74} = 2.716$, $p < 0.051$) significantly changed by decade. Differences in biting–*normal* approached significance ($F_{3,72} = 2.549$, $p < 0.062$). Matrix analyses indicated that straw and cup drinking performance improved between the 7th and 10th decades ($p < 0.051$), whereas biting skills declined between the 9th and 10th decades ($p < 0.038$).

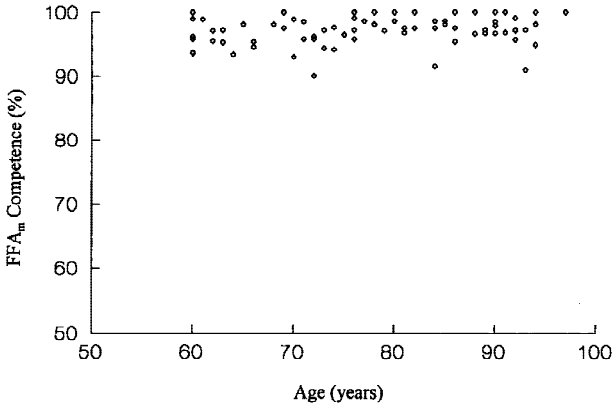

Fig. 1. Competence (%) of functional feeding in healthy seniors 60–97 years of age (n = 79).

Overall performance on the FFA_m did not vary with age, but was related to whether or not subjects wore dentures ($F_{2,76} = 4.310$, $p < 0.017$; see Table 1). A matrix of pairwise comparisons showed that only seniors with full dentition and those with full dentures differed significantly ($p < 0.021$). Nine of 20 seniors, 11/21, 8/20, and 6/18 in each decade, respectively wore full dentures. Further analysis comparing type of dentition (partial and full dentures) with fit (good/loose) showed no significant differences for partials vs. fit ($t = 0.073$, $df = 3.9$, $p = 0.945$) and full dentures vs. fit ($t = 0.645$, $df = 8.3$, $p = 0.536$), indicating that full denture wear was associated with lower FFA_m results, but denture fit was not.

There was a significant association between the FFA_m score and foods avoided ($F_{3,41} = 3.619$, $p < 0.021$). Matrix analyses indicated that hard foods (cookies, nuts, apples, raw onions) were significantly more often avoided than soft foods (breads, cakes; matrix of pairwise mean difference: −2.995, $p < 0.035$). Other foods reported as difficult to bite or chew were those with tough skins (lima beans, corn) and fibrous foods (pineapple, fibrous meat).

None of the seniors with full dentition avoided foods, except 3 out of 5 in their 8th decade; these 3 avoided hard apples only. Among seniors who wore partials or full dentures 70.6 ± 16.5% (range 50%–100%) avoided foods. A larger portion of seniors in their 7th and 8th decade (60% and 67%, respectively) avoided foods, compared with the seniors in their 9th and 10th decade (40% and 44%, respectively). Seniors in their 7th decade avoided hard and fibrous foods, those in their 8th and 9th decade avoided hard, fibrous, soft foods, and foods with tough skins, whereas seniors in their 10th decade only avoided hard and fibrous foods.

Table 1. Healthy seniors wearing dentures (full, partial or bridge) by decade compared with those with natural dentition (%)

	Age (years)			
	60–69	70–79	80–89	90–99
Dentures	16 (80.0)	16 (76.2)	14 (70.0)	14 (77.8)
Natural teeth	4 (20.0)	5 (23.8)	6 (30.0)	4 (22.2)

Pearson's correlations indicated a significant relationship between biting-*normal* and spoon feeding-*normal* ($r = 0.328$, $p < 0.004$); cup drinking-*normal* and spoon feeding-*normal* ($r = 0.383$, $p < 0.001$); cup drinking-*abnormal* and spoon feeding-*abnormal* ($r = 0.403$, $p < 0.000$); biting-*abnormal* and spoon feeding-*abnormal* ($r = 0.542$, $p < .000$); chewing-*normal* and chewing-*abnormal* ($r = 0.336$, $p < 0.003$); and biting-*normal* and spoon feeding-*abnormal* ($r = -0.239$, $p < 0.039$).

There were 5/20 seniors in their 7th decade who took prescribed medications for any of the conditions described above, 5/21 in their 8th decade, 5/20 in their 9th decade, and 5/18 in their 10th decade. One resident in her 60s had a diagnosis of diabetes and arthritis, but only took medication for diabetes, and another senior in her 80s had diabetes but took medication for diabetes and arthritis. All participants' medical conditions were well controlled.

Performance of Oral Praxis Skills

Figure 2 illustrates performance on the OPS by age (total OPS score, items 1–19). Wide variability was observed between 60 and 69 years (range 76%–100%), and was maintained through the four decades examined (age 90, range 47%–97%). Although most of the seniors performed in the normal (91%–100%) to mildly impaired range (71%–90%), there was poor performance in oral praxis skills in some seniors after age 70 (Fig. 2). Results for the group, however, were not significant ($F_{3,67} = 2.336$, $p = 0.082$). There were no age-associated changes in either the simple items (1–11, A: $F_{3,67} = 2.428$, $p = 0.073$) or the more complex items (12–19, B: $F_{3,67} = 1.786$, $p = 0.158$). When stratified by decade, comparisons of A vs. B indicated poorer performance on B in each decade (7^{th}, $t = 3.549$, $df = 19$, $p < 0.002$; 8^{th}, $t = 4.592$, $df = 19$, $p < 0.000$; 9^{th}, $t = 3.589$, $df = 14$, $p < 0.003$; 10^{th}, $t = 2.733$, $df = 15$, $p < 0.015$).

Having a hearing aid was significantly associated with decade ($F_{3,74} = 2.996$, $p < 0.036$), but a matrix pairwise comparison of mean differences (0.336, $p < 0.068$; 7th vs. 10th decade) just failed to be significant. Pearson's correlations further indicated a significant negative correlation of OPS scores and age ($r = -0.315$, $p < 0.007$); even when the lowest point at age 88 was deleted from the correlation, results remained significant ($r = -0.306$, $p < 0.030$). However, there was no association between OPS and use of hearing aids ($r = -0.107$, $p = 0.483$). The number of hearing aids used by seniors by decade was 1/20 at age 60–70, 3/21 at age 71–80, 7/20 at age 81–90, and 9/18 at age 91–99. Approximately the same percentage of men (22.2%) and women (23.1%) wore hearing aids.

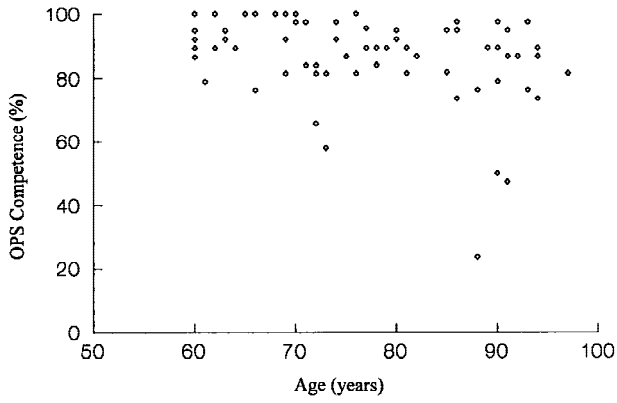

Fig. 2. Competence (%) of oral praxis skills (OPS) in healthy seniors 60–97 years of age (n = 79).

Correlations between FFA, OPS, and Age

There was a significant, although weaker, positive correlation between age and performance on the FFA_m, indicating that functional feeding skills are maintained through the decades ($r = +0.290$, $p < 0.014$). There was no significant correlation between the FFA_m and OPS ($r = +0.085$, $p < 0.480$, Fig. 3), indicating that the two tests measure different domains of oral-motor behavior.

Reliability

Reliability was determined by asking whether one of the observers scored tests consistently different than the others. One such observer was found ($F_{6,151} = 6.878$, $p < 0.000$) who analyzed 18 subjects. None of the other 6 observers differed, suggesting that satisfactory reliability was achieved.

Discussion

Functional eating skills, as measured by the FFA_m in a cross-sectional design, did not deteriorate in seniors between the ages of 60 and 97 years, although seniors wearing full dentures performed more poorly than those with full dentition. These findings are supported by Slagter et al. [19,20], who found that masticatory abilities are greatly reduced in individuals who wear den-

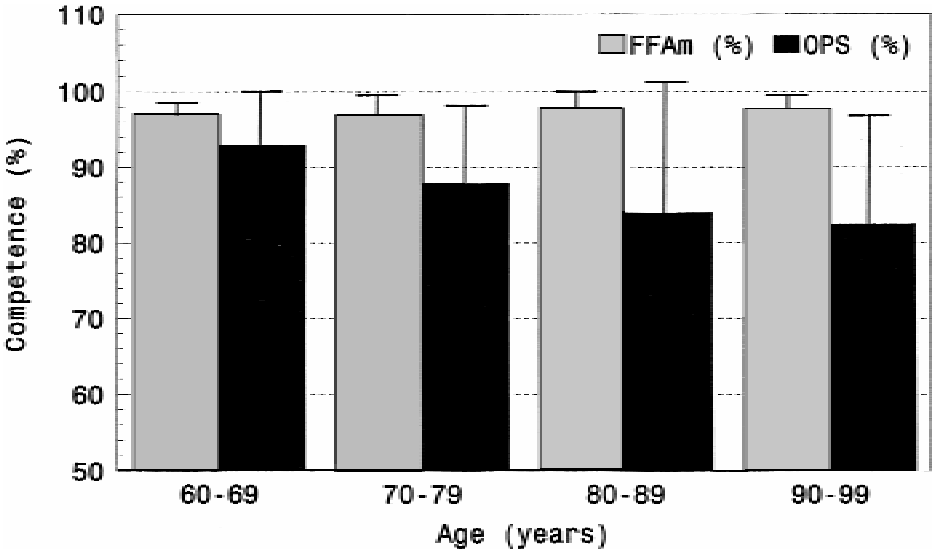

Fig. 3. Mean competence (%) of functional feeding (light bars) and oral praxis skills (dark bars) by decade of healthy seniors 60–97 years of age (n = 79).

tures. It must be remembered, however, that even those seniors in this study who wore full dentures performed in the normal range, as measured by the FFA_m. Our data further indicate that poorer eating performance was not associated with poor denture fit. One limitation of our data is the fact that there were only 4 seniors out of 34 who complained of loosely fitting dentures, and that the definition of fit was based on the seniors own perception. Given these limitations, the possibility that mastication may be influenced by denture fit, comfort, or changes in oral sensation remains to be further explored. Uncomfortable dentures may not be worn as often, resulting in an avoidance of foods that are more difficult to bite into or chew. Such an interpretation is supported by the significant differences shown in normal biting behaviors between the two oldest age groups and the fact that one of the seniors did not wear her full dentures for eating because they fitted loosely.

The finding that functional eating abilities of the oral and externally observable pharyngeal phase did not decline with age in healthy seniors is in contrast to the traditional view that people are more likely to experience swallowing dysfunction of the pharyngeal phase as they get older [1,3]. Our results suggest that feeding problems are not a direct consequence of the aging process. Seniors in their 80s and 90s, who had their own teeth and were in good health, not only had intact oral-motor skills, but they consumed and enjoyed a wide variety of foods. Seniors in their 60s and 70s avoided more foods than those in their later decades, and seniors in their 70s avoided the widest variety, including soft, hard, and fibrous food, as well as some with tough skins.

In order of decreasing frequency, apples and other fruits were the most frequently mentioned because of an inability to bite through the tough skins. Apples also change into pulp and juice (a heterogeneous texture) through chewing, making the bolus more difficult to control. Certain meats were the second most frequent foods avoided because of their fibrous and often dry texture. Some participants indicated that meat fibers tended to get stuck in their throat. Biting through hard foods such as cookies was described as requiring extra force. Dryness may also be a deterrent, as shown by the participants who needed to swallow the cookie with liquid (juice, coffee, water). The added moisture needed indicates greater difficulty in moving the bolus to the back of the mouth to initiate the swallow. However, of the 79 participants, only 2 complained of having a dry mouth; both were in their 70s and took diuretics for the control of high blood pressure.

One of the reasons why younger seniors may have avoided more foods than the older ones may be that minor physiological feeding problems exist, but are not yet diagnosed clinically. We suggest that individuals may compensate behaviorally for physiological changes of the oral-motor system by avoiding foods/liquids that are perceived as too difficult to chew or drink. For example, one of the participants unconsciously tilted her head back following each sip of fluid, so that gravity helped clear the oral cavity [26]. Drinking remained functional, even though oral transit may have been impaired. Several examples of this phenomenon have been described [1,2].

Skills, such as drinking, are generally more difficult to master than others because of the need to coordinate breathing with swallowing [27]. Noteworthy in our study is the fact that abnormal cup drinking behaviors were more frequent in seniors in their 60s compared with those in their 80s and 90s. Tongue thrusting was the most frequent abnormal behavior during cup drinking.

This may be a habitual or compensatory behavior. Oral sensation may be diminished and so make ingestion more challenging. Thus, the tongue may be extended in an attempt to seek tactile cues. However, it is not clear whether tongue thrusting is related to denture wear, poor eye-hand coordination leading to difficulty directing the spoon/cup towards the mouth, or an undiagnosed, underlying condition. Not every denture wearer had a tongue thrust and seniors with natural dentition also showed the behavior.

Straw-drinking competence scores were also lower in the younger than the older seniors. The straw-drinking behavior that was most difficult for seniors 60–69 years old was the one requiring continuous drawing up of fluid through the straw. The complexity of this task may make it especially useful to reveal difficulties. However, it is also possible that this group may find it socially unacceptable to take several sips at once, although continuous cup drinking was demonstrated in this group.

Several moderate correlations were found between FFA_m domains. Generally, these associations occur because of similarities in the tasks. Biting and spoon feeding were correlated. Both require an ability to grade the oral behavior, i.e., one must know how much force is needed to bite through something hard, or how much pressure to apply when occluding around the bowl of a spoon. Cup drinking and spoon feeding are both dependent on lip control to hold the lips in contact with the utensil. Cup drinking-*abnormal* and spoon feeding-*abnormal* were correlated, as well as spoon feeding-*abnormal* and biting-*abnormal.* Tongue thrust is measured in all of these domains. Chewing-*normal* and -*abnormal* both examine whether the tongue moves unilaterally or bilaterally within the oral cavity. Finally, biting was negatively correlated with abnormal spoon feeding. If biting is functional, abnormal behaviors such as tongue thrusting must decrease or the tongue may get bitten.

Healthy seniors as a group did not exhibit a significant decline in oral praxis skills with age, similar to what was shown with functional feeding skills, and scores of the FFA_m and OPS were not correlated. We suggest that these two tests measure different domains of oral-motor performance. The oral praxis subtest measures oral-motor planning abilities, whereas the FFA_m examines whether the subject can complete the oral phase of ingestion in a functional manner.

Although a significant negative correlation between OPS scores and age exists, no significant correlation was found between OPS scores and use of a hearing aid. There was further no significant decline in OPS scores across decades when stratified by sections (A and B), but there were significant differences in each decade between section A and B. This suggests that skills in section B may be more difficult to perform than those in A. We argue further that hearing difficulty was not a problem for the performance of the more complex items in section B, otherwise we would have expected a significantly poorer performance in section B across the decades. Finally, the significance of oral praxis in functional feeding is not known.

Hearing is related to the social aspects of meal time, as it allows individuals to enjoy each other's company. Social interaction while eating has been shown to increase the amount and quality of food eaten, and to improve one's overall well-being [28–30]. Thus, some older adults may be at risk for a lower quality of life through the increase in hearing loss, and its attendent problems of social isolation, after age 60.

In conclusion, healthy individuals maintain functional feeding and oral praxis skills beyond their 90s. When difficulties were identified, they were related to denture wear rather than age. These difficulties manifest themselves as a decrease in the number and types of foods that can be eaten by the individual, and may ultimately affect quality of life. Good health and natural dentition appear to be excellent indicators for functional feeding ability.

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