Age-Related Changes in the Social, Psychological, and Temporal Influences on Food Intake in Free-Living, Healthy, Adult Humans

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**Background.** Elderly humans often have a reduction in intake that can produce malnutrition and impaired health. As a result, there is a need to investigate age-related changes in the eating behaviors of free-living humans.

**Methods.** To address this issue, 7-day diet diary records that had been collected from 762 paid participants were reanalyzed, separating the participants into four age groups: 20–34 years, 35–49 years, 50–64 years, and 65 years and older.

**Results.** The elderly ate with fewer other people present and earlier in the day than younger people. The elderly were found to be as responsive as younger groups to social facilitation of intake, palatability, cognitive restraint, time of day, day of week, and location, but showed blunted responses to self-reported hunger.

**Conclusions.** There does not appear to be a decline with age in the ability of nonphysiological factors to influence the nutrient intakes of the elderly, but they may not have as great an influence due to lower absolute levels. This suggests that the deficient intakes in the elderly might be corrected or ameliorated by manipulation of nonphysiological factors, such as the number of other people present at meals, the palatability of meals, and the time of day and location of meals.

**Discussion.** The psychological state of the individual can also markedly affect intake. It is clear that these nonphysiological, social, psychological, and environmental stimuli can markedly alter the spontaneous nutrient intakes of free-living, healthy, adult humans. These factors may be useful for promoting intake in the elderly.
However, it has yet to be established if the elderly respond to these stimuli as younger people do or if they are impaired in their responses to nonphysiological stimuli as they are to physiological stimuli. Hence, it is important to study the influences of nonphysiological factors on the nutrient intakes of the elderly. To investigate this question, the present study reanalyzed data on the intakes of free-living individuals that we had acquired with 7-day diet diaries (10–26,33,35–39,41,42), separating individuals into four age groups: young adults (20–34 years), middle-aged adults (35–49 years), older adults (50–64 years), and the elderly (65 years and older).

**METHODS**

**Participants**

Data were collected from 762 participants, consisting of 348 men and 414 women who were paid $30 for their participation. The participants were divided into four age groups: 20–34.9 years, 35–49.9 years, 50–64.9 years, and 65 years and older. The mean ages and body sizes of the participants in the four age groups are presented in Table 1.

**Procedure**

Diet diary nutrient intake data were collected for a 7-day period from free-living adult humans who were paid for their participation. A detailed review of the diet diary method and the reliability and validity of the diet diary procedure is published elsewhere (41,42). The participants were given a small (8 × 18 cm) pocket-sized diary and were instructed to record in as detailed a manner as possible every item that they either ate or drank, the time they ate it, where they ate it, the amount they consumed, how the food was prepared, and the number of other people eating with them. Self-ratings were obtained at the beginning and again at the end of the meal of the participants’ degrees of hunger, thirst, depression, anxiety, and the attractiveness of the food on seven-point scales. The participants initially recorded this information for a day and were then contacted by the experimenter who reviewed the information, corrected any problems, and answered any questions. The participants were then asked to record their intake for 7 consecutive days. After this recording period, the participants were again contacted by the experimenter who reviewed the diaries, clarifying any ambiguities or missing data. Demographic information, including age, weight, height, medications taken, occupation, living arrangements (alone or with others), and exercise habits, was collected. The Three Factor Eating Questionnaire was administered to measure dietary restraint, disinhibition, and hunger (43). Only the Cognitive Restraint Scale scores were used in the present analysis.

**Data Analysis**

The foods reported in the diaries were assigned codes from a computer file containing the nutrient compositions of common food items. A computer file of more than 3500 food items was created from the U.S. Department of Agriculture Handbook Nos. 8 and 456 of the Nutritive Value of American Foods, from package labels, from personal communications with food industry sources, and from current published literature.

Meals were identified, and the compositions of the individual items composing the meal were summed. For a reported intake to be classified as an individual meal, it had to contain at least 209 kJ, or more stringently 418 kJ or 837 kJ. It also had to be separated in time from the preceding and following ingestive behaviors by at least 15 minutes. More stringent definitions of 45 and 90 minutes were also employed. Five different definitions of a meal were used combining these minimum criteria: 15 min/209 kJ, 45 min/209 kJ, 45 min/418 kJ, 45 min/837 kJ, and 90 min/209 kJ. The meals were characterized by their total caloric content; carbohydrate, fat, protein, and alcohol content; duration and rate of intake; the amount of time between meals; the before-meal and after-meal intervals; and the before-meal and after-meal subjective states of hunger, thirst, depression, and anxiety. The amounts ingested during the entire 7-day period were summed. The average of each of the meal characteristics and the mean daily intakes were then calculated for each participant. These individual means were then used to calculate overall group means.

To investigate diurnal rhythms, analysis was carried out on the amounts of nutrients ingested during three periods: morning (0600 to 1159), afternoon (1200 to 1859), and evening (1900 to 2400). These intervals were selected because they capture periods of peak intake and are bounded by periods of low intake as observed in prior studies for North American subjects (37). To investigate the influence of the day of the week on intake, analysis was carried out on the amounts of nutrients ingested during weekdays (Monday through Thursday) and weekends (Friday through Sunday) (21,39,40). The overall daily intakes and average meal sizes were calculated for the absolute amounts of total food energy, carbohydrate, fat, protein, and alcohol ingested during these periods.

Table 1. Mean (± Standard Error of the Mean) of the Demographic Descriptors of the Participants in the Four Age Groups

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>20–34 y</td>
<td>114</td>
<td>211</td>
</tr>
<tr>
<td>35–49 y</td>
<td>154</td>
<td>138</td>
</tr>
<tr>
<td>50–64 y</td>
<td>54</td>
<td>45</td>
</tr>
<tr>
<td>65 y</td>
<td>26</td>
<td>20</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age (y)</th>
<th>20–34</th>
<th>35–49</th>
<th>50–64</th>
<th>65+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>27.2 ± 0.4</td>
<td>39.3 ± 0.3</td>
<td>53.5 ± 0.4</td>
<td>73.3 ± 1.3</td>
</tr>
<tr>
<td>Women</td>
<td>26.7 ± 0.3</td>
<td>41.1 ± 0.3</td>
<td>54.5 ± 0.6</td>
<td>70.9 ± 0.9</td>
</tr>
<tr>
<td>Height (m)</td>
<td>1.76 ± 0.1</td>
<td>1.77 ± 0.1</td>
<td>1.75 ± 0.1</td>
<td>1.73 ± 0.1</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>82.8 ± 1.1</td>
<td>61.7 ± 0.8</td>
<td>66.7 ± 2.1</td>
<td>65.8 ± 2.9</td>
</tr>
<tr>
<td>BMI</td>
<td>25.3 ± 0.3</td>
<td>26.5 ± 0.3</td>
<td>27.0 ± 0.5</td>
<td>25.4 ± 0.7</td>
</tr>
</tbody>
</table>

Note: BMI = body mass index.
To investigate restraint, analysis was carried out on the amounts of nutrients ingested by participants who scored below the median score on the cognitive restraint scale (low restraint) and those who scored above the median (high restraint). The overall daily intakes and average meal sizes were calculated for the absolute amounts of total food energy, carbohydrate, fat, protein, and alcohol ingested for the low- and high-restraint groups.

For each participant, Pearson product moment correlations and regression slopes between a number of variables and the meal sizes were calculated individually. These variables included the following: the amounts ingested in the meals of food energy, carbohydrate, fat, protein, and alcohol; the beginning meal time; the number of other people present; the before-meal interval; and the self-ratings of hunger and food attractiveness (palatability) obtained before meal and after meal. Correlations were calculated for each participant. Because correlation coefficients are not normally distributed, they were first transformed to $z$ scores that are normally distributed prior to calculating group means or performing statistical analysis (44). The mean correlations and coefficients were then compared to 0 with a $t$ test.

**RESULTS**

Although quantitative differences were apparent between the results obtained for the five different meal definitions, the patterns of results were equivalent. Thus, only the minimum $209 \text{ kJ/45 min}$ definition is presented as representative. All presented results are significant, with $p < .05$ unless otherwise indicated.

**Social Facilitation of Intake**

The number of other people present at the meals and the correlations and slopes of the regressions between the num-
AGE AND INTAKE INFLUENCES

The number of people and the size of the meals ingested for the four age groups are presented in Figure 1. There was an overall significant difference between the number of other people present at the meals $[F(3,758) = 6.32; p < .05]$, with the elderly group eating with significantly fewer people present than the 35–49 year group $[t(336) = 3.33; p < .05]$. There were significant positive correlations between the number of other people present and the meal size for all of the age groups. But, there were no significant differences between the age groups for either the correlations or the slopes.

Psychological Influences on Intake—Hunger

The self-ratings of hunger before the meals and the correlations and slopes of the regressions between the hunger ratings and the size of the meals ingested for the four age groups are presented in Figure 2. The before-meal hunger self-ratings significantly differed between age groups $[F(3,733) = 13.70; p < .05]$, with the elderly group having significantly lower ratings than either the 20–34 $[t(350) = 4.33; p < .05]$ or 35–49 year $[t(330) = 2.15; p < .05]$ groups. There were significant positive correlations present for all groups between the before-meal hunger ratings and the meal size. Both the correlations $[F(3,733) = 3.95; p < .05]$ and the slopes of the regressions $[F(3,733) = 3.40; p < .05]$ significantly differed between the age groups. The elderly group had significantly smaller correlations than all of the other three groups $[t(350) = 2.02; t(330) = 2.06; t(143) = 3.15; p < .05$, respectively] and significantly smaller regression slopes than either the 35–49 $[t(330) = 2.51; p < .05]$ or 50–64 year $[t(143) = 3.06; p < .05]$ groups.

The self-ratings of hunger after the meals and the correlations and slopes of the regressions between the hunger ratings and the size of the meals ingested for the four age groups are presented in Figure 3. There was an overall significant difference between the number of other people present at the meals $[F(3,758) = 6.32; p < .05]$, with the elderly group eating with significantly fewer people present than the 35–49 year group $[t(336) = 3.33; p < .05]$. There were significant positive correlations between the number of other people present and the meal size for all of the age groups. But, there were no significant differences between the age groups for either the correlations or the slopes.

Cognitive Restraint and Daily Energy Intake

The mean cognitive restraint scores for male and female participants (left panel), the mean daily intake of the macronutrients and alcohol for participants classified as low (score <6.5) and high (score >6.5) in restraint for male (center panel) and female participants (right panel) for the 20–34 years, 35–49 years, 50–64 years, and 65 years and older age groups.
groups are also presented in Figure 2. The after-meal hunger self-ratings significantly differed between age groups \(F(3,733) = 5.89; p < .05\) with the elderly group having significantly lower hunger (higher satiety) ratings than all of the other three groups \(t(350) = 0.99; t(330) = 2.27; t(143) = 2.69; p < .05\), respectively. There were significant negative correlations present for all groups between the meal size and the after-meal hunger ratings. Both the correlations \(F(3,733) = 7.80; p < .05\) and the slopes of the regressions \(F(3,733) = 7.79; p < .05\) significantly differed between the age groups. The elderly group had significantly smaller correlations than all of the other three groups \(t(350) = 3.24; t(330) = 4.75; t(143) = 1.99; p < .05\), respectively] and significantly smaller regression slopes than all of the other three groups \(t(350) = 2.87; t(330) = 4.56; t(143) = 2.69; p < .05\), respectively.

**Psychological Influences on Intake—Palatability**

The before-meal ratings of the palatability of the meals and the correlations and slopes of the regressions between the palatability ratings and the size of the meals ingested for the four age groups are presented in Figure 3. The before-meal palatability ratings did not significantly differ between age groups. There were significant positive correlations present for all groups between the before-meal palatability ratings and the meal size. Neither the correlations nor the slopes of the regressions significantly differed between the age groups.

The after-meal ratings of palatability and the correlations and slopes of the regressions between the palatability ratings and the sizes of the meals ingested for the four age groups are also presented in Figure 3. In contrast to the before-meal ratings, the after-meal palatability ratings significantly differed between age groups \(F(3,620) = 4.52; p < .05\), with the elderly group having significantly higher palatability ratings than all of the other three groups \(t(282) = 3.19; t(287) = 3.55; t(141) = 3.01; p < .05\), respectively]. There were significant positive correlations present for all groups between the meal size and the after-meal palatability ratings. However, neither the correlations nor the slopes of the regressions significantly differed between the age groups.

**Psychological Influences on Intake—Cognitive Restraint**

The cognitive restraint scores and the mean amounts of daily intake of carbohydrate, fat, and protein for the low- and high-restraint participants of the four age groups are presented in Figure 4. The women had significantly higher restraint scores than the men \(F(1,442) = 24.96; p < .05\), and there were significant differences between the age groups \(F(3,442) = 9.43; p < .05\), but no significant interaction. The significant age effect was due to the fact that the youngest group (20–34 years) had significantly lower restraint than the 50–64 years group. The elderly did not significantly differ in restraint between the genders or age groups.

As has been previously reported (36), cognitive restraint is associated with a reduction in daily intake for both men [total energy, \(F(1,213) = 15.16\); carbohydrate, \(F(1,213) = 3.31\]; fat, \(F(1,213) = 20.95\); protein, \(F(1,213) = 5.42\). alcohol, \(F(1,213) = 5.33, p < .05\] and women [total energy, \(F(1,220) = 4.67\); fat, \(F(1,220) = 6.48\); protein, \(F(1,220) = 5.46, p < .05\]. Although there were significant differences in daily intake between the age groups for both men [total energy, \(F(3,213) = 6.10\); carbohydrate, \(F(3,213) = 3.81\]; fat, \(F(3,213) = 4.75\); protein, \(F(3,213) = 7.19, p < .05\] and women [total energy, \(F(3,220) = 3.28\]; fat, \(F(3,220) = 2.97\); protein, \(F(3,220) = 3.73, p < .05\], there were no significant Age × Restraint interactions. Hence, the elderly responded to cognitive restraint with a reduction in intake as occurred in the younger participants.

**Environmental Influences on Intake—Time of Day**

The mean meal sizes eaten in the morning, midday, and evening periods for the four age groups are presented in Figure 5. There are large obvious and significant differences between the sizes of the meals ingested during the three periods [total energy, \(F(2,1410) = 635.02\); carbohydrate, \(F(2,1410) = 155.20\); fat, \(F(2,1410) = 470.73\); protein, \(F(2,1410) = 860.47, p < .05\]. However, there were no significant age effects or Age × Time Period interactions. A consequence of the increasing meal sizes over the day is a significant correlation between the time of day and the meal size. The correlations and the slopes of the regressions for the four age groups are presented in Figure 6. There are no significant differences between any of the age groups in neither the correlations or the slopes for the relationship between the time of day and the size of the meal ingested. Hence, there are considerable diurnal changes in meal size, but these changes do not significantly differ with age.

As is displayed in the left panel of Figure 6, there were significant differences in the time of day that, on average,
the age groups ate $F(3,758) = 25.62; p < .05$. The youngest age group ate significantly later than all of the other groups $t(615) = 5.33; t(422) = 6.53; t(389) = 5.35; p < .05$ for the 35–49, 50–64, and 65 and older groups, respectively. The elderly and the 50–64 years groups ate significantly earlier than either the youngest group or the 35–49 years age group $t(336) = 3.35; t(389) = 3.39; p < .05$, respectively. This pattern was even present within time periods. The elderly group ate earlier than the youngest group during the morning, midday, and evening periods $t(389) = 2.79; 1.97; 5.84; p < .05$, respectively and earlier than the 35–49 years group in the evening $t(336) = 3.09; p < .05$. Hence, the 20–34 years age group appears to eat the latest, while the elderly appear to eat the earliest of all the age groups.

Environmental Influences on Intake—Day of the Week

The mean daily intakes for the weekdays and weekends for the four age groups are presented on the left side of Figure 7. There are large obvious and significant differences between intakes on weekdays compared with weekends [total energy, $F(1,755) = 100.21$; carbohydrate, $F(1,755) = 24.87$; fat, $F(1,755) = 73.62$; protein, $F(1,755) = 31.63$; alcohol, $F(1,755) = 107.12$; $p < .05$] and between age groups [total energy, $F(3,755) = 4.34$; fat, $F(1,755) = 5.15$; protein, $F(1,755) = 3.74$; $p < .05$]. The mean meal sizes for the weekdays and weekends for the four age groups are presented on the right side of Figure 7. Similar to overall intakes, meal sizes are larger on weekends [total energy, $F(1,755) = 147.45$; carbohydrate, $F(1,755) = 75.83$; fat, $F(1,755) = 99.21$; protein, $F(1,755) = 51.93$; alcohol, $F(1,755) = 85.86$; $p < .05$] and differ between age groups [total energy, $F(3,755) = 3.80$; fat, $F(3,755) = 4.05$; alcohol, $F(3,755) = 3.21$; $p < .05$]. Hence, as has been previously reported (21,39,40), intake on weekends is significantly higher than on weekdays.

The elderly do not appear to have as large a difference between weekday and weekend intake as do younger groups. Whereas intakes are significantly higher on the weekends for the 20–34 years age group [total energy, $t(322) = 4.95$; carbohydrate, $t(322) = 2.18$; fat, $t(322) = 3.29$; protein, $t(322) = 2.70$; alcohol, $t(322) = 6.68$; $p < .05$], the 35–49 years age group [total energy, $t(290) = 8.20$; carbohydrate, $t(290) = 2.18$; fat, $t(290) = 3.82$; protein, $t(290) = 5.81$; alcohol, $t(290) = 7.40$; $p < .05$] and the 50–64 years age group [total energy, $t(98) = 3.72$; carbohydrate, $t(98) = 2.48$; fat, $t(98) = 3.57$; alcohol, $t(98) = 4.33$; $p < .05$], there were no significant differences for the elderly group except for fat intake [$t(45) = 2.36; p < .05$]. Similarly, meal sizes are significantly higher on the weekends for the 20–34 years age group [total energy, $t(322) = 6.82$; carbohydrate, $t(322) = 5.09$; fat, $t(322) = 4.76$; protein, $t(322) = 3.96$; alcohol, $t(322) = 6.26$; $p < .05$], the 35–49 years age group [total energy, $t(290) = 9.18$; carbohydrate, $t(290) = 5.95$; fat, $t(290) = 8.07$; protein, $t(290) = 6.34$; alcohol, $t(290) = 6.91$; $p < .05$], and the 50–64 years age group [total energy, $t(98) = 4.66$; carbohydrate, $t(98) = 3.52$; fat, $t(98) = 4.29$; protein, $t(98) = 2.50$; alcohol, $t(98) = 3.20$; $p < .05$]. There were no significant differences for the elderly group except for fat intake [$t(45) = 2.39; p < .05$].

There is evidence that the differences between intake on weekdays compared with weekends are due to the fact that there is greater social facilitation of intake on the weekends (21,39) and that meals occur later in the day on weekends. This is true for the 20–34 years group who eat on average 31 minutes later on the weekends $[t(322) = 6.99; p < .05$] and with 61% more other people $[t(322) = 4.50; p < .05$] and 35–49 years group who eat on average 23 minutes later on the weekends $[t(290) = 5.41; p < .05$] and with 34% more other people $[t(290) = 6.14; p < .05$] and the 50–64 years group who eat on average 22 minutes later on the weekends $[t(98) = 4.66; p < .05$] and with 41% more other people $[t(98) = 4.29; p < .05$].

Daily Energy Intake on Weekdays and Weekends

The mean daily intakes for the weekdays and weekends for the four age groups are presented on the left side of Figure 7. There are large obvious and significant differences between intakes on weekdays compared with weekends [total energy, $F(1,755) = 100.21$; carbohydrate, $F(1,755) = 24.87$; fat, $F(1,755) = 73.62$; protein, $F(1,755) = 31.63$; alcohol, $F(1,755) = 107.12$; $p < .05$] and between age groups [total energy, $F(3,755) = 4.34$; fat, $F(1,755) = 5.15$; protein, $F(1,755) = 3.74$; $p < .05$]. The mean meal sizes for the weekdays and weekends for the four age groups are presented on the right side of Figure 7. Similar to overall intakes, meal sizes are larger on weekends [total energy, $F(1,755) = 147.45$; carbohydrate, $F(1,755) = 75.83$; fat, $F(1,755) = 99.21$; protein, $F(1,755) = 51.93$; alcohol, $F(1,755) = 85.86$; $p < .05$] and differ between age groups [total energy, $F(3,755) = 3.80$; fat, $F(3,755) = 4.05$; alcohol, $F(3,755) = 3.21$; $p < .05$]. Hence, as has been previously reported (21,39,40), intake on weekends is significantly higher than on weekdays.
Environmental Influences on Intake—Location

The mean meal sizes eaten at home, in full-service restaurants, and at fast food restaurants for the four age groups are presented in Figure 8. There are large obvious and significant differences between the sizes of the meals ingested in the three locations [total energy, F(2,1489) = 153.48; carbohydrate, F(2,1489) = 50.30; fat, F(2,1489) = 167.51; protein, F(2,1489) = 111.86; alcohol, F(2,1489) = 27.14; p < .05] and between age groups [total energy, F(3,1489) = 8.78; fat, F(3,1489) = 6.10; alcohol, F(3,1489) = 4.24; p < .05]. However, there were no significant age effects or Age × Location interactions.

The elderly did not differ from the other age groups in the average size of their meals at home except for the fat content where the elderly ingested significantly less fat than either the 20–34 years [t(249) = 2.13; p < .05] or the 35–49 years [t(280) = 2.55; p < .05] groups. However, at both full-service and fast food restaurants, the elderly ate significantly smaller meals. They ate smaller meals at full-service restaurants than the 20–34 years group [total energy, t(180) = 2.82; fat, t(180) = 2.32; protein, t(180) = 3.96; p < .05] and the 35–49 years group [total energy, t(203) = 1.99; fat, t(203) = 2.03] and smaller meals at fast food restaurants than the 20–34 years group [total energy, t(201) = 3.00; fat, t(201) = 2.78] and the 35–49 years group [total energy, t(226) = 2.10; fat, t(226) = 2.20]. Hence, although the elderly’s tendency to eat smaller meals than younger groups was apparent in restaurants, they still ate considerably more at restaurants than at home.

DISCUSSION

The diet-diary technique, used in the present study, is a self-report methodology that is not absolutely accurate. There is evidence to suggest that it is reasonably reliable and valid (45–49) (see 41,42 for review). However, it appears to underestimate intake (50–55). It is important to keep in mind, when evaluating the problems that might arise from inaccurate measures, how the inaccuracy might affect the analysis being performed. Underestimation influences the magnitude of the estimates of intake. This is not a problem if the degree of underestimation is equivalent for all participants. However, it is possible that underestimation differs systematically between subjects, such that certain participants (e.g., elderly) might tend to underestimate more than others. Under these conditions, the age group differences in absolute levels might be attributable to differential underestimation. However, it should affect overall levels but not the relative differences between subjects’ intakes on different occasions or in different locations. Hence, underestimation should not be able to account for the differences observed between the intakes of the elderly in different locations, at different times of the day or week, or at different palatability levels. Also, underestimation should not affect the correlations calculated individually for each subject, as correlations are magnitude independent. Hence, the levels of the correlations and slopes of the regressions for the various variable relationships with meal size should not be affected by underestimation and should thereby not account for the present results. There still are probably unsystematic, random errors of measurement. But, these should obfuscate significant relationships, not produce them. The fact that significant relationships were found with a technique that includes considerable error suggests that the effects reported may actually be underestimated.

The present reanalysis of the 7-day diet diary data strongly suggests that the healthy elderly in real-world environments are just as responsive to a number of social, psychological, and environmental stimuli as younger adult humans. The elderly appear to be equivalently responsive to social facilitation of food intake as younger people as evidenced by significant positive correlations and regression slopes between the number of other people present and the meal size. However, social facilitation may be less of an influence on the intakes of the elderly, because with age there is a reduction in the number of other people with whom the individual eats. This was apparent in the healthy elderly who participated in the diet diary studies, but may be much more evident in the unhealthy and/or institutionalized elderly (56,57). This suggests that the anorexia of aging may at least in part be due to a reduction in the social facilitation of intake. But, it also indicates that, because the elderly appear to be responsive to this factor, changes in the social climate of meals for the elderly might work to increase nutrient intakes. Indeed, it has been found that, among the noninstitutionalized elderly, those who ate with others had the most satisfactory diets (58), loneliness was associated...
with deficient dietary intake (59), and with a home-delivered meal program, simply having the delivery person stay with the elderly individual while he or she ate significantly increased intake (60).

Of the three psychological factors investigated in the present study, two factors, palatability and cognitive restraint, appear to affect the elderly equivalently to younger individuals, while one factor, hunger, appears to have an impaired ability to affect intake in the elderly. In the present study, the elderly report themselves to be less hungry before meals and less sated after meals as has been observed in laboratory settings (61). The elderly also appear to have weaker relationships between self-rated hunger and the amounts ingested in the meals than younger individuals. This suggests that the elderly may have blunted hunger sensations and thereby not feel hunger as intensely as younger people, that the nutrient intakes of the elderly are less affected by their subjective hunger, and that, in turn, their subjective state of hunger is less affected by the amount of food that they ingest.

Hunger may not, in actuality, be purely a psychological factor and may instead be a physiological factor. Indeed, hunger may be thought of as a subjective state produced by an internal assessment of the state of nutrient depletion/repletion of the individual. This indeed appears to be the case for the degree of stomach filling. We have found that the estimated contents of the stomach at the beginning of the meal are significantly negatively related to the amount eaten in the meal (15) and to the subjective state of hunger (25). However, multiple regression analysis of the simultaneous effects of stomach content and hunger on meal intakes strongly suggests that stomach content acts to influence intake indirectly by affecting the subjective state of hunger, which in turn affects intake (25). Hence, hunger may simply be a subjective reflection of the state of the individual’s nutrient stores and not a purely psychological factor. This, in turn, suggests that the lack of responsiveness to hunger evidenced by the elderly may be another instance of impaired physiological responsiveness with aging.

The results of the present analysis suggest that palatability is equivalently effective in promoting intake in the elderly as in younger individuals. The elderly did not differ from the younger groups in the before-meal palatability ratings or in the correlations or regression slopes between palatability and the size of the subsequent meal. It is interesting that, even with the gustatory and olfactory sensory losses that occur with aging (62,63), there does not appear to be a decline in the attractiveness of the food. This suggests that presenting the elderly with highly palatable foods may be important in maintaining or facilitating nutrient intakes. Indeed, it has been demonstrated that flavor enhancement is effective in increasing nutrient intakes in the elderly (63,64).

In contrast to the before-meal ratings, the ratings of palatability after the meal were higher for the elderly than the younger groups. There is a decline in the attractiveness of foods after ingestion of these foods called sensory-specific satiety (65,66). This is evident in the younger groups, but was not present in the elderly. This suggests that the elderly are resistant to sensory-specific satiety, and, as a result, palatable foods may be better able to facilitate intake in the elderly than in the young.

The healthy elderly in the present study showed low levels of dietary restraint, as did the younger subjects, and appeared to be equally responsive to this psychological factor in its influence on intake. It has been demonstrated previously that cognitive restraint is associated with a significant reduction in the nutrient intakes of free-living adults (36). Hence, dietary restraint, if present, should be discouraged in the elderly.

Environmental stimuli, like social and psychological factors, can also be quite effective in promoting intake in the elderly. Over the course of the day, there is an increase in meal size and a decrease in the interval after the meal until the next meal (37). This is apparent in all age groups and suggests that the satiating properties of nutrients diminish over the day. The elderly do not appear to differ from younger groups in their responsiveness to the time of day, having equivalent correlations and slopes of the regressions between the time of day and the meal size. However, the elderly appear to eat earlier in the day than the younger groups. This could be one of the reasons for the reduced intake in the elderly. They are primarily eating during periods of high relative satiating values of foods and not eating late in the day when the food is less satiating. This suggests that promoting nighttime intake in the elderly may be a useful strategy to increase intake.

There are large and significant differences between intake on weekends relative to weekdays with overall intake and meal sizes larger on the weekends (21,39,40). It is unlikely that there are endogenous rhythms that are responsible for the weekly intake rhythm, but rather, it appears that social and behavioral differences may be responsible for the differences in intake. In particular, on weekends, people tend to eat later in the day, and, as reported above, meals ingested late in the day tend to be larger (37). Also, more people tend to be present at meals on the weekends, and meals ingested with larger numbers of people tend to be larger meals (21,39). This suggests that the differences between weekend and weekday intake are due to the differences in time of day of intake and the social context.

The differences between weekend and weekday intake for the elderly are smaller than for younger individuals. Overall intakes, meal sizes, and macronutrient intakes, with the exception of fat, are not significantly different between weekends and weekdays for the elderly. This suggests that the differences between the elderly and the younger groups in their weekend intakes are due to differences in the time of day and social context of the meals. If this is indeed the case, then this would further support the idea that intake in the elderly could be supplemented by manipulating the time of day and social context of their meals.

A final environmental factor whose influence on intake was investigated in the present study was the location of the meal. Eating in restaurants, either traditional, full-service restaurants or fast food restaurants, was associated with a marked increase in intake. Although the elderly ate smaller meals in restaurants and at home than the younger groups, the differences between home and restaurant meals were just as apparent with the elderly as with younger groups.
Because the elderly tend to visit restaurants less frequently than younger people (67,68), this suggests that intake in the elderly might be promoted by increasing the use of restaurants. Indeed, it was demonstrated that when the setting for meals for the institutionalized elderly was altered to incorporate more restaurant-like qualities, eating behavior was significantly improved and intake increased by 25% (69). Even simply adding soothing music with dinner can significantly increase intake in the institutionalized elderly (70). Improving the ambiance of food consumption has been shown to have long-term effects of increasing body weight and protecting the health of the institutionalized elderly (71).

In summary, although there is much evidence that the elderly have deficiencies in the physiological systems that influence intake in younger people, the present findings indicate that the elderly are very responsive to social, psychological, and environmental stimuli. Hence, there does not appear to be a decline with age in the ability of nonphysiological factors to influence the nutrient intakes of the elderly. This suggests that the deficient intakes in the elderly might be corrected or ameliorated by manipulation of nonphysiological factors, such as the number of other people present at meals, the palatability of meals, and the time of day and location of meals. It remains for future manipulative studies to test this hypothesis.

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