Published in final edited form as:

Patient Educ Couns. 2010 July ; 80(1): 107–112. doi:10.1016/j.pec.2009.09.031.

Predictors of Nutrition Information Comprehension in Adulthood

Lisa M. Soederberg Miller, Tanja N. Gibson, and Elizabeth A. Applegate

University of California, Davis, CA, USA

Abstract

Objective—The goal of the present study was to examine relationships among several predictors of nutrition comprehension. We were particularly interested in exploring whether nutrition knowledge or motivation moderated the effects of attention on comprehension across a wide age range of adults.

Methods—Ninety-three participants, ages 18 to 80, completed measures of nutrition knowledge and motivation and then read nutrition information (from which attention allocation was derived) and answered comprehension questions.

Results—In general, predictor variables were highly intercorrelated. However, knowledge, but not motivation, had direct effects on comprehension accuracy. In contrast, motivation influenced attention, which in turn influenced accuracy. Results also showed that comprehension accuracy decreased- and knowledge increased -with age. When knowledge was statistically controlled, age declines in comprehension increased.

Conclusion—Knowledge is an important predictor of nutrition information comprehension and its role increases in later life. Motivation is also important; however, its effects on comprehension differ from knowledge.

Practice Implications—Health educators and clinicians should consider cognitive skills such as knowledge as well as motivation and age of patients when deciding how to best convey health information. The increased role of knowledge among older adults suggests that lifelong educational efforts may have important payoffs in later life.

Keywords

aging; health literacy; nutrition; health information; comprehension

1. Introduction

The ability to understand and use health information to make decisions regarding one's health, a set of skills often referred to as health literacy, has been shown to be related to many outcomes including medication adherence [1], health behaviors [2-4], healthcare costs [5], as well as health [6]. Unfortunately, health literacy skills have been shown to decline in later life [7-9].

© 2009 Elsevier Ireland Ltd. All rights reserved.

Corresponding author at: Department of Human and Community Development University of California, Davis One Shields Avenue Davis, CA 95616, USA 530-752-3955 (office) 530-752-5660 (FAX) lmsmiller@ucdavis.edu.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

I confirm all patient/personal identifiers have been removed or disguised so the patient/person(s) described are not identifiable and cannot be identified through the details of the story.

The present study was undertaken to attempt to identify predictors of comprehension of nutrition information within a sample of young, middle-aged, and older adults. Consumption of a healthy diet is important because it can delay the onset of, as well as reduce the impact of, diseases that are common in later life such as osteoporosis, obesity, high blood pressure, diabetes, heart disease, and certain cancers (DHHS, 2000; USDA, 2000). Yet, the Federal Interagency Forum on Aging-Related Statistics (Older Americans 2008) reported that the majority of middle-aged and older adults fail to eat an optimal diet. Given demographic predictions that 1 in 5 individuals will be over the age of 65 by the year 2030, it is important to identify factors that can promote the ability to understand health information across adulthood and into later life.

In defining our pool of potential predictors, we focused on motivational factors and knowledge. Past research has shown these factors to be very important; however, much of this work has examined the effects of motivation and knowledge independently and with a relatively limited range of adult ages. Thus, relationships among age, motivation, and knowledge are unclear as are their relative effects on comprehension. This type of information is important for future advances in the design of health education interventions.

1.1. Motivational Factors

Unhealthy behaviors are often attributable to beliefs, perceptions, and other motivational factors (e.g., [10-12]). Motivational factors such as these have been found to be related to healthy dietary behaviors (e.g., [13-16]). However, relatively few studies have examined the effects of motivation on individuals' willingness and ability to comprehend health information [17] and even fewer have addressed possible adult age differences in motivation or in motivational effects on health literacy skills.

Although there are many approaches to assessing motivation surrounding comprehension of health and diet information, we focus on three particularly promising measures: nutrition self-efficacy, nutrition interest, and dietary stage of change. Self-efficacy refers to perceptions surrounding one's abilities [18]. Within the area of nutrition, self-efficacy has been shown to be important for various health behaviors. For example, individuals who have relatively high levels of nutrition self-efficacy are more likely to attempt to use complex information such as food labels [19] and to adhere to a healthy eating plan [20-22]. Although beliefs regarding nutrition are related to health behaviors, it is unclear as to whether they are related to the comprehension of health information. If beliefs impact factors associated with increasing knowledge and awareness of health, interventions designed to increase skills and improve behavior would benefit from targeting beliefs as well as knowledge.

Second, we included an assessment of interest as an indicator of motivation. Affective measures such as interest in learning about health have been neglected in the health literature relative to cognitive and educational domains (e.g., [23-25]). Interest has been referred to as a "knowledge emotion" because it is thought to motivate knowledge accumulation (i.e., learning) within a particular area [26]. For the present study, we developed a measure of nutrition interest as another approach to assessing motivation.

Finally, we included an assessment of stage of change. The Transtheoretical Model [27] emphasizes the importance of an individual's readiness to make a change when encouraging individuals to adopt healthy behaviors. There are 6 stages: precontemplation (the individual has no intention of changing their behavior), contemplation (the individual intends to change within the next six months), preparation (the individual intends to take action within the next month), action (the individual has done something to change his/her behavior within the past six months) and maintenance (the individual has maintained the desired change for at least six months). We assumed that individuals in more advanced stages of change regarding adherence

to a healthy diet would be more willing to engage in a task designed to increase knowledge of diet and health.

1.2. Domain Knowledge

In addition to motivational predictors, we included an assessment of nutrition knowledge. Past research has shown that the amount of knowledge individuals possess regarding their health is closely tied to measures of health literacy as well as health outcomes (e.g., [2,3,28-32]). More specifically, nutrition knowledge is an important component of health literacy as evident in research showing that knowledge is positively related to dietary quality [22], even after controlling for sociodemographic variables such as income (e.g., [33,34]). There is some suggestion in the literature that prior knowledge may support the acquisition of nutrition knowledge which in turn may support better food choices. For example, knowledge of nutrition is related to accurate perceptions of food healthiness [35] as well as food choices [36]. Popkin et al. [37] found that those with more years of education showed the greatest improvement in diet quality over the course of several years. This finding is similar to others showing that prior nutrition knowledge and education lead to greater learning and behavior change [38,39].

Knowledge may be particularly important for nutrition comprehension among older adults because knowledge represents a crystallized ability, a type of ability that remains strong in later life. In contrast, fluid abilities, such as those assessed by executive function tasks and working memory tasks, show declines beginning in early to mid life [40]. This dual nature of cognitive aging has lead researchers to question whether knowledge can support cognitive performance in later life by mitigating age-related declines in fluid abilities. The research is ambiguous as to when and how such mitigation occurs. However, several studies have shown that age differences in performance would be larger if older adults had fewer crystallized abilities to draw upon (e.g., [41]). Thus, research suggests that knowledge is an important component of health literacy and a potentially important source of mitigation in later life.

1.3. Allocation of Attention during Reading Comprehension

The manner in which attention is allocated while adults read is the focus of considerable research (for reviews, see [42];[43]). In this study, we were interested in the allocation of attention during reading as a way of indexing the degree to which readers invest in the comprehension task (rather than how attention is allocated to different reading processes). To do this, we focused on a set of reading processes referred to as conceptual integration or wrap up [44]. When readers encounter concepts and predicates, they link them together to form idea units, and these in turn are then joined with other idea units (presented in the same and different clauses and phrases) to make larger units of meaning. The amount of time allocated to integrating concepts increases as a function of the number of new concepts introduced in the clause or sentence [45,46]. Another factor that influences conceptual integration time is the amount of prior relevant knowledge an individual possesses (see [47], for a discussion of this complex issue). Finally, an individual's motivational disposition may increase his or her attention to conceptual integration (e.g., [48,49]). In general, conceptual integration appears to be an effortful process that is sensitive to both knowledge and motivation.

To recap, the goals of the present study were 1) to examine age-related changes in nutrition knowledge, motivation, attention allocated during comprehension, and comprehension accuracy of nutrition information and 2) to explore relationships among knowledge, motivation, attention, and comprehension accuracy across a wide age range of adults.

2. Methods

2.1. Participants

Participants were 93 adults between the ages of 18 and 80, with 30 younger (ages 18-35, $M = 23.15$, $SD = 4.6$), 31 middle-aged (ages 36-59, $M = 59.7$, $SD = 6.7$), and 32 older (ages 62-80, $M = 71.1$, $SD = 6.2$) adults. Participants were recruited from the campus and surrounding community and were paid a small stipend. Based on information obtained during an initial telephone interview, individuals with neurological impairment and those who were non-native speakers of English were excluded from the study. Measures of basic cognitive ability were included to determine whether our sample showed the expected age-related decline in working memory and stability or age-related increase in vocabulary. Working memory capacity was assessed by the loaded sentence span task [50] and the computation span [51]. Vocabulary was assessed via the Advanced Vocabulary Test of the Kit of Factored-Referenced Tests (KFRT: [52]). Age was negatively associated with working memory span, $r = -.42$, $p < .001$, and positively associated with vocabulary, $r = .57$, $p < .001$, reflecting the expected age-related changes in fluid and crystallized abilities.

2.2. Materials

Motivational measures consisted of Food Pyramid Self-Efficacy Scale (Moseley, 1999), Nutrition Interest Scale [53], and a nutrition stage of change measure modeled after Prochaska and DiClemente [54]. The Food Pyramid Self-Efficacy Scale is a 22-item measure designed to assess individuals' perceptions of their ability to follow a healthy dietary plan as specified by the food pyramid under a wide variety of circumstances (e.g., while watching television, when feeling restless or bored). Items showed good internal consistency as indexed by a Cronbach alpha of .91 and were averaged to form an overall score of self-efficacy. The Nutrition Interest Scale [53] is a 6-item measure designed to assess individuals' interest in learning about nutrition (e.g., how interested are you in knowing the difference between food facts and fallacies?). Items for this measure showed good internal consistency, $\alpha = .82$, and were averaged to form an overall score of interest. The stage of change measures consisted of three items, fruits and vegetables, fat, and junk food, each of which required individuals to select 1 of 6 responses that "best represents your perspective/behavior on eating—." The junk food item, for example, had options ranging from "I haven't given any thought at all to cutting junk food out of in my diet" to "I have been consciously avoiding junk food for longer than the last 6 months." These three items showed adequate internal consistency, $\alpha = .72$, and were averaged to form an overall score of stage of change. A composite motivation measure was calculated by standardizing each score and averaging across them.

To assess prior knowledge of nutrition, we developed a nutrition knowledge test based on a variety of areas such as knowledge of the relationships between nutrition and health, knowledge of nutrition principles (e.g., which foods are good sources of various nutrients), and procedural knowledge (knowing how to make informed food choices) [31]. The 15 items showed a Cronbach alpha of .68. This value is comparable to knowledge assessments in other health domains (e.g., Wolf et al., 2005). Values in this modest range likely reflect underlying differences in knowledge subdomains (cf. Parmenter & Wardle).

There were 4 nutrition texts that were written at grade levels between 8 and 10 as assessed by Flesch-Kincaid criteria. Texts were grouped into two sets, each between 1300 and 1400 words total. The first set of passages focused on whole grains (e.g., how to identify foods with whole grains and why they are important for health); the second set dealt with fruits and vegetables (how to identify high-nutrient fruits and vegetables and why they are important for health). Participants were randomly assigned to one of the two text conditions.

We developed 38 multiple-choice comprehension questions for each set of passages. We included between 3 and 6 questions for each topic within a passage, with longer topics having slightly more questions. Cronbach alpha was .85 (across passages and trials), indicating adequate internal consistency across questions.

2.3. Procedure

Participants completed the battery of nutrition motivation measures, followed by the knowledge test, and the comprehension tasks. Participants read nutrition texts at their own pace on a computer screen and answered multiple-choice questions¹. To encourage deeper learning, participants read the texts and completed the questions a second time. Participants completed measures of vocabulary and working memory during a second visit to the lab, one week later.

Texts were presented on a computer screen using the moving-window technique such that words appeared one at a time. With each button press, the “window” moved from the current word in the text to the next word in a left-to-right and downward pattern, as with naturalistic reading. Participants controlled the rate of presentation of text by pressing the space bar. Research has shown that this method is a reliable and valid way to assessing reading across age groups [42,55]. Multiple-choice questions were presented on the computer screen and participants selected one of four marked buttons to indicate their answer. We also manipulated the location of the comprehension questions, either immediately after each subtopic or at the end of each passage. However, analyses showed that this variable had little impact on comprehension and so we present the findings collapsed across this variable.

3. Results

3.1. Exploration of Group Differences in Attention and Comprehension Accuracy across Trials

Attention allocated while comprehending the passages was assessed using a resource allocation approach in which reading times for each individual were regressed onto characteristics of the text to obtain regression coefficients representing the extent to which time was allocated to each text characteristic [56-58]. This was done separately by trial (first and second reading pass). Text characteristics were: 1) number of letters to denote word coding; 2) whether or not the word fell at the beginning of a new line to control for eye movement time to begin a new line; and 3) whether or not the word fell at a sentence boundary (0/1) to capture conceptual integration. Word reading times were regressed onto these characteristics to obtain regression weights reflecting attention allocation to conceptual processing (while controlling for word position and word length). The resulting standardized coefficients represent the amount of time allocated to the text characteristic per standardized unit of change in that characteristic. Table 1 shows the means for each trial by age group. Regression coefficient betas were analyzed in a 3(Age: young, middle, old) $\times$ 2(Trial: first reading, second reading) ANOVA with Trial as the within-subjects measure. As expected, there was a main effect of Trial, $F(1,90) = 82.6$, $p < .001$, $\eta^2 = .48$, showing a reduction in attention allocated to conceptual integration across trials (i.e., facilitation from rereading). The main effect of Age and its interaction with Trial were nonsignificant, $F < 1$, for both.

The proportion of correct responses on the comprehension task was also analyzed in a 3(Age: young, middle, old) $\times$ 2(Trial: after first reading, after second reading) ANOVA with Trial as the within-subjects measure. Means and standard deviations are presented in Table 1. There

¹The administration of comprehension questions was also manipulated such that half of the participants received questions in one group at the end of the text whereas the other half received questions after each subtopic. Because this variable had no effect on accuracy or efficiency, we dropped it from further analyses.

was a main effect of Trial, $F(1,88) = 93.1, p < .001, \eta^2 = .51$, such that comprehension accuracy increased from Trial 1 to Trial 2. There was a main effect of Age, $F(2,88) = 8.1, p < .001, \eta^2 = .16$. However, a nonsignificant, Age $\times$ Trial interaction, $F < 1$, indicated that age differences were comparable for the first and second trial.

3.2. Associations between Age and Motivation, Knowledge, and Attention

Zero-order correlations among key variables were conducted to examine age effects associated with each variable as well as relationships among all predictors. A summary score for attention was calculated by summing across the two reading trials to obtain an estimate of total attention to the nutrition texts. A summary score for motivation was calculated by averaging across the zscores for self-efficacy, interest, and stage of change. Older adults showed higher levels of motivation, $r = .34, p < .001$, and nutrition knowledge, $r = .24, p < .05$, than did younger adults, however, younger and older adults allocated similar amounts of attention, $r = .15, p > .10$. Knowledge and motivation were positively correlated, $r = .44, p < .001$, and attention was related to motivation, $r = .23, p < .05$, but not to knowledge, $r = .11, p > .10$.

3.3. Structural Equation Model of Age, Motivation, Knowledge, and Attention Predicting Comprehension

Structural equation modeling was used to examine the fit of a model in which knowledge, motivation, and attention were interrelated as suggested by their zero-order correlations. In particular, we tested a model in which age predicted knowledge, motivation, and accuracy, knowledge predicted motivation and accuracy, motivation predicted attention, and attention predicted comprehension accuracy. Self-efficacy, interest, and stage of change were used as indicators for the latent construct of motivation. Items on the knowledge test and comprehension accuracy were parceled into two groups to create two indicators for the latent construct of knowledge. The latent construct of attention was derived from estimates obtained during the initial processing and reprocessing of the nutrition information. Estimates were obtained using maximum likelihood with AMOS 17.0. Comparative Fit Index (CFI; [59]) and Root Mean Square Error of Approximation (RMSEA; [60]) were used to evaluate the models. CFI indicates the degree of fit between an independent model and the observed data; values over .90 typical reflect good fit. RMSEA is an index of fit based on the error of approximation in the population; values less than .05 indicate a good fit and values under .10 are adequate. The model, shown in Figure 1, yielded an excellent fit to the data, $\chi^2(29) = 33.0, p = .28$, CFI = .986, RMSEA = .039. The figure shows standardized path coefficients and indicator factor loadings; all of which were significant, $p < .05$.

We ran one additional model to determine whether the magnitude of the age-comprehension path coefficient changed when knowledge was no longer included in the model. This was done to examine the possibility that knowledge mitigates age-related declines in comprehension accuracy. The fit of this model was good, $\chi^2(17) = 16.5, p = .49$, CFI = 1.0, RMSEA = .00, and yielded an age-comprehension path coefficient of $-.45$ which is smaller than the same relationship when knowledge was included in the model, coefficient = $-.68$. The increased magnitude of the relationship between age and comprehension when controlling for knowledge indicates that, without an age-related increase in knowledge, the age declines in comprehension would be larger. This finding is consistent with the migration model suggesting that knowledge stores can protect older adults from further declines [61].

4. Discussion and Conclusion

4.1. Discussion

The present study was undertaken to gain a clearer understanding of factors that support comprehension of nutrition information in adulthood. We were particularly interested in

examining the roles of knowledge and motivation, as well as attention as a mechanism underlying comprehension. Our finding that knowledge supports the comprehension of nutrition information is consistent with past research showing that nutrition knowledge is related to perceptions of food healthfulness and attitudes [35], healthy dietary behaviors [62-65], and health literacy [28,29]. Our finding that nutrition motivation supports comprehension is consistent with past research showing that motivation is important for adherence to healthy dietary behaviors [13,14,20,66]. The present study adds to the existing literature in a three ways: we included an assessment of attention to begin to address the mechanisms underlying health comprehension, we showed that the role of nutrition knowledge increases in later life, and we provided insight into the relationships among attention, knowledge, motivation, and comprehension accuracy as described below.

4.1.1. Associations among Age, Motivation, Knowledge, and Attention—We found that nutrition motivation and knowledge were indeed related such that greater motivation was associated with more knowledge. This finding is intuitive and suggests that those who have a desire to eat a healthy diet will also likely have an understanding about what constitutes a healthy diet (or, put another way, those who have accumulated knowledge of nutrition will also likely want to eat a healthy diet). We are unaware of any prior research that has examined connections between motivation and knowledge within a health domain, however, this finding is consistent with research within the educational literature showing that interest and domain knowledge are related to each and to learning [67].

Data from the present study showed that motivation and knowledge did not overlap completely and that they had different relationships with attention. Knowledge was uncorrelated with attention and there was no evidence that controlling for age moderated this relationship. Past research suggests that the relationships among age, prior knowledge, and attention are complex (e.g., [47,68]) and it is possible that our sample size may have limited our ability to detect complex patterns. Nevertheless, in the present study, individuals with prior knowledge spent comparable amounts of time integrating concepts as did those with less knowledge. In contrast, nutrition motivation was positively associated with attention suggesting that those who report being more motivated to follow a healthy diet are more likely to allocate attention to conceptual integration while reading.

In general, age differences in nutrition knowledge and motivation were positive. Older adults had higher nutrition knowledge levels than did younger adults, indicating that nutrition knowledge follows a similar trajectory as other crystallized abilities [40]. There were also age-related increases in nutrition motivation suggesting that knowledge and motivation may be yoked across the lifespan.

4.1.2. Predictors of Comprehension—By far the largest contributions to comprehension accuracy were knowledge and age. Knowledge had a powerful positive association with nutrition accuracy whereas age had a negative association, especially when knowledge was controlled. This pattern is consistent with the migration model [61] which asserts that knowledge mitigates age-related declines in performance because older adults migrate into higher knowledge groups. When knowledge is statistically removed, age declines are greater. This finding suggests that, although knowledge cannot be the sole factor in nutrition education programs [69], its role in educating older adults should not be underestimated.

Few if any studies have assessed attentional processes used to comprehend health information. Our finding that attention was positively associated with nutrition comprehension accuracy, however, is consistent with past research in the cognitive literature showing that those who invested more effort in integrating concepts while reading short passages showed greater performance on memory and comprehension measures (e.g., [70]). In the present study,

motivation showed no direct effect on comprehension accuracy. Rather, motivation appears to increase attention while reading nutrition texts, and this in turn supports greater comprehension accuracy.

4.2. Conclusion

The ability to understand nutrition information is a core factor underlying health literacy skills as they relate to an individual's ability to understand requirements of a healthy diet. Although neither prior knowledge nor new information is sufficient to ensure adherence to a healthy diet, particularly within low socioeconomic groups [38], we suggest that these factors are a necessary component of health eating habits. Findings from the present study suggest that raising awareness of nutrition relies on prior knowledge and motivation together with a willingness to engage in learning tasks. More specifically, motivation appears to influence adults' willingness to attend to nutrition information and this in turn supports comprehension and learning. The findings also suggest that the role of prior knowledge in raising nutrition awareness grows in importance in later life by mitigating further age-related declines in the accuracy of nutrition comprehension.

4.3. Practice Implications

These findings suggest that interventions designed to increase nutrition awareness and knowledge in adulthood should consider motivational factors because they help sustain attention to key aspects of the message. Also, the increased role of prior knowledge among older adults suggests that small incremental increases in learning may be important (cf. [71]). For example, each module could be designed to introduce new content (e.g., building blocks of nutrition and health) and/or practices (e.g., how to shop for "superstar" vegetables) in an incremental fashion with some repetition of information from earlier modules and allow ample opportunities for practicing mastery of content (e.g., recognizing concepts, completing information from memory, applying concepts to simple than more complex situations). In this way, new learning will be bolstered by prior learning (i.e., knowledge) which will maximize retention and increase likelihood of transfer to everyday food choices among older learners.

Acknowledgments

The authors wish to thank Jeannette de Dios and Hana Chuong for their assistance with participant recruitment and data collection. This research was supported by National Institutes of Health [R01AG19196].

References

1. Murray MD, et al. Health literacy predicts medication adherence. *American Society for Clinical Pharmacology and Therapeutics* 2004;PII-92:76.
2. Dolan NC, et al. Colorectal Cancer Screening Knowledge, Attitudes, and Beliefs Among Veterans: Does Literacy Make a Difference? *J Clin Oncol* 2004;22(13):2617–2622. [PubMed: 15226329]
3. Kalichman SC, et al. Health literacy and health-related knowledge among persons living with HIV/AIDS. *American Journal of Preventive Medicine* 2000;18(4):325–331. [PubMed: 10788736]
4. Williams MV, et al. Inadequate literacy is a barrier to asthma knowledge and self-care. *Chest* 1998;114(4):1008–1015. [PubMed: 9792569]
5. Marwick C. Patients' lack of literacy may contribute to billions of dollars in higher hospital costs. *J Amer Med Assoc* 1997;278:971–972.
6. Schillinger D, et al. Association of health literacy with diabetes outcomes. *J Amer Med Assoc* 2002;288:475–482.
7. Benson JG, Forman WB. Comprehension of written health care information in an affluent geriatric retirement community: Use of the test of functional health literacy. *Gerontology* 2002;48:93–97. [PubMed: 11867931]

8. Gazmararian JA, et al. Health literacy among Medicare enrollees in a managed care organization. *J Amer Med Assoc* 1999;281:545–551.
9. Rudd, R.; Kirsch, I.; Yamamoto, K. *Literacy and Health in America*. Educational Testing Service; Princeton, NJ: 2004.
10. Leventhal, H., et al. Health risk behaviors and aging. In: Birren, JE.; Schaie, KW., editors. *Handbook of the psychology of aging*. Academic Press; San Francisco, CA: 2001. p. 186-214.
11. Rosenstock, IM.; Strecher, VJ.; Becker, MH. The health belief model and HIV risk behavior change. In: DiClemente, RJ.; Peterson, JL., editors. *Preventing AIDS: Theories and Methods of Behavioral Interventions*. Plenum Press; New York: 1994. p. 5-24.
12. Bandura A. Health promotion by social cognitive means. *Health Education & Behavior* 2004;31:143–164. [PubMed: 15090118]
13. Hagler AS, et al. Psychosocial correlates of dietary intake among overweight and obese men. *American Journal of Health Behavior* 2007;31:3–12. [PubMed: 17181457]
14. Kristal AR, et al. Psychosocial Correlates of Healthful Diets: Baseline Results from the Working Well Study. *Preventive Medicine* 1995;24(3):221–228. [PubMed: 7644443]
15. Laforge RG, Greene GW, Prochaska JO. Psychosocial factors influencing low fruit and vegetable consumption. *Journal of Behavioral Medicine* 1994;17(4):361–374. [PubMed: 7966258]
16. Shaikh AR, et al. Psychosocial Predictors of Fruit and Vegetable Consumption in Adults: A Review of the Literature. *American Journal of Preventive Medicine* 2008;34(6):535–543. e11. [PubMed: 18471592]
17. Wilson BJ. Designing Media Messages About Health and Nutrition: What Strategies Are Most Effective? *Journal of Nutrition Education and Behavior* 2007;39(2, Supplement 1):S13–S19. [PubMed: 17336800]
18. Bandura, A. *Self-efficacy: The exercise of control*. W. H. Freeman; New York: 1997.
19. Satia JA, Galanko JA, Neuhouser ML. Food nutrition label use is associated with demographic, behavioral, and psychosocial factors and dietary intake among African Americans in North Carolina. *Journal of the American Dietetic Association* 2005;105(3):392–402. [PubMed: 15746826]
20. Brug J, Lechner L, de Vries H. Psychosocial determinants of fruit and vegetable consumption. *Appetite* 1995;25:285–296. [PubMed: 8746967]
21. Moseley MJ. Reliability and validity of the Food Pyramide Self Efficacy Scale: Use in coronary artery bypass patients. *Progress in Cardiovascular Nursing* 1999;14:130–135. 142. [PubMed: 10689724]
22. Rimal RN. Closing the knowledge-behavior gap in health promotion: The mediating role of self-efficacy. *Health Communication* 2000;12(3):219–237. [PubMed: 10938914]
23. Ackerman PL. Domain-specific knowledge as the “dark matter” of adult intelligence” Gf/Gc, personality and interest correlates. *Journal of Gerontology: Series B: Psychological Sciences & Social Sciences* 2000;55B:P69–P84.
24. Alexander PA, Jetton TL, Kulikowich JM. Interrelationship of knowledge, interest, and recall: Assessing a model of domain learning. *Journal of Educational Psychology* 1995;87:559–575.
25. Schiefele U. Interest, learning, and motivation. *Educational Psychologist* 1991;26:299–323.
26. Paul JS. Interest: The Curious Emotion. *Current Directions in Psychological Science* 2008;17(1):57–60.
27. Prochaska, JO.; DiClemente, CC. The transtheoretical approach. In: Norcross, JC.; Goldfried, MR., editors. *Handbook of psychotherapy integration*. Oxford University Press; New York: 2005. p. 147-171.
28. Gazmararian JA, et al. Health literacy and knowledge of chronic disease. *Patient Educ Couns* 2003;51:267–275. [PubMed: 14630383]
29. Williams MV, et al. Relationship of Functional Health Literacy to Patients’ Knowledge of Their Chronic Disease: A Study of Patients With Hypertension and Diabetes. *Arch Intern Med* 1998;158(2):166–172. [PubMed: 9448555]
30. Wolf MS, et al. Development of a brief survey of colon cancer screening knowledge and attitudes among veterans. *Preventing Chronic Disease: Public Health Research, Practice, and Policy* 2005;2:1–10.

31. Guthrie, JF.; Derby, BM.; Levy, AS. What people know and do not know about nutrition. In: Frazao, E., editor. America's eating habits: Changes and consequences. USDA/ERS; Washington, DC: 1999. p. 243-280.
32. Secker J, et al. Theories of change: What works in improving health in mid-life? *Health Education Research* 2004;20:392-401. [PubMed: 15507489]
33. Variyam JN, Golan E. New health information is reshaping food choices. *Food Review* 2002;25:13-18.
34. Wardle J, Parmenter K, Waller J. Nutrition knowledge and food intake. *Appetite* 2000;34(3):269-275. [PubMed: 10888290]
35. Crites SL, Aikman SN. Impact of nutrition knowledge on food evaluations. *European Journal of Clinical Nutrition* 2005;59:1194-1200.
36. Guenther PM, et al. Sociodemographic, knowledge, and attitudinal factors related to meat consumption in the United States. *Journal of the American Dietetic Association* 2005;105:1266-1274. [PubMed: 16182644]
37. Popkin BM, Zizza C, Siega-Riz AM. Who is leading the change? US dietary quality comparison between 1965 and 1996. *American Journal of Preventative Medicine* 2003;25:1-8.
38. Beydoun MA, Wang Y. Do nutrition knowledge and beliefs modify the association of socio-economic factors and diet quality among US adults? *Preventive Medicine* 2008;46:145-153. [PubMed: 17698186]
39. Hendrie G, Cox D, Coveney J. P17: Nutrition Knowledge as a Predictor of Nutrient Intake and Diet Quality. *Journal of Nutrition Education and Behavior* 2008;40(4, Supplement 1):S49-S50.
40. Schaie, KW. Intellectual development in adulthood: The Seattle longitudinal study. Cambridge University Press; New York: 1996.
41. Meinz EJ. Experience-based attenuation of age-related differences in music cognition tasks. *Psychology and Aging* 2000;15:297-312. [PubMed: 10879584]
42. Stine-Morrow EAL, Miller LMS, Hertzog C. Aging and Self-Regulation in Language Understanding. *Psychological Bulletin* 2006;132:582-606. [PubMed: 16822168]
43. Stine-Morrow, EAL.; Miller, LMS. Aging, self-regulation, and learning from text. In: Ross, BH., editor. *Psychology of learning and motivation*. in press
44. Just MA, Carpenter PA. A theory of reading: From eye fixations to comprehension. *Psychological Review* 1980;87:329-354. [PubMed: 7413885]
45. Haberlandt K, Graesser A. Processing of new arguments at clause boundaries. *Memory & Cognition* 1989;17:186-193.
46. Haberlandt K, Graesser AC. Buffering new information during reading. *Discourse Processes* 1989;12:479-494.
47. Miller LMS, Gagne DD. Adult age differences in read and rereading processes associated with problem solving. *International Journal of Behavioral Development* 2008;32:34-45.
48. Miller LMS, West RL. The effects of age, control beliefs, and feedback on self-regulation of reading and problem solving. *Experimental Aging Research*. in press.
49. Miller LMS, Gagne DD. The effects of age and control beliefs on resource allocation during reading. *Aging, Neuropsychology, and Cognition* 2005;12:129-148.
50. Stine EAL, Hindman J. Age differences in reading time allocation for propositionally dense sentences. *Aging and Cognition* 1994;1:1-12.
51. Salthouse TA, Babcock RL. Decomposing adult age differences in working memory. *Developmental Psychology* 1991;27:763-776.
52. Ekstrom, RB.; French, JW.; Harmon, HH. Educational Testing Service; Princeton, N. J.: 1976. Manual for the kit of factor-referenced cognitive tests.
53. Passwater, GD. Nutrition knowledge and interest questionnaire. Teachers College; New York: 1981.
54. Prochaska JO, DiClemente CC. Stages and processes of self-change of smoking: Toward an integrative model of change. *Journal of Consulting and Clinical Psychology* 1983;51:390-395. [PubMed: 6863699]
55. Haberlandt, K. Components of sentence and word reading times. In: Kieras, DE.; Just, MA., editors. *New methods in reading comprehension research*. Erlbaum; Hillsdale, NJ: 1984. p. 219-251.

56. Graesser, AC.; Riha, JR. An application of multiple regression techniques to sentence reading times. In: Kieras, DE.; Just, MA., editors. *New methods in reading comprehension research*. Erlbaum; Hillsdale, N. J.: 1984. p. 183-218.
57. Haberlandt K, Graesser A. Component processes in text comprehension and some of their interactions. *Journal of Experimental Psychology: General* 1985;114:357–374.
58. Lorch R, Myers J. Regression analyses of repeated measures data in adults. *Journal of Experimental Psychology: Learning, Memory, and Cognition* 1990;16:149–157.
59. Bentler PM. Comparative fit indexes in structural models. *Psychological Bulletin* 1990;107:238–246. [PubMed: 2320703]
60. Browne, MW.; Cudeck, R. Alternative ways of assessing fit. In: Bollen, KA.; Long, JS., editors. *Testing structural equation models*. Sage; Newbury Park, CA: 1993. p. 136-162.
61. Salthouse, T. Interrelations of aging, knowledge, and cognitive performance. In: Staudinger, UM.; Lindenberger, U., editors. *Understanding human development: Dialogues with lifespan psychology*. Kluwer; Dordrecht, Netherlands: 2003. p. 265-287.
62. Blaylock J, Smallwood D, Variyam JN. Dietary fiber: Is information the key? *Food Review* Jan-Apr; 1996 :24–30.
63. Ha E-J, Caine-Bish N. Effect of Nutrition Intervention Using a General Nutrition Course for Promoting Fruit and Vegetable Consumption among College Students. *Journal of Nutrition Education and Behavior* 2009;41(2):103–109. [PubMed: 19304255]
64. Klohe-Lehman DM, et al. Nutrition Knowledge Is Associated with Greater Weight Loss in Obese and Overweight Low-Income Mothers. *Journal of the American Dietetic Association* 2006;106(1): 65–75. [PubMed: 16390668]
65. Worsley A. Nutrition knowledge and food consumption: Can nutrition knowledge change food behavior? *Asia Pacific Journal of Clinical Nutrition* 2002;11:S579–S585. [PubMed: 12492651]
66. Greene GW, et al. Change in Fruit and Vegetable Intake Over 24 Months in Older Adults: Results of the SENIOR Project Intervention. *Gerontologist* 2008;48(3):378–387. [PubMed: 18591363]
67. Lawless KA, Kulikowich JM. Domain knowledge and individual interest: The effects of academic level and specialization in statistics and psychology. *Contemporary Educational Psychology* 2006;31 (1):30–43.
68. Miller LMS, et al. Adult age differences in knowledge-driven reading. *Journal of Educational Psychology* 2004;96:811–821.
69. Contento IR. Nutrition education: Linking research, theory, and practice. *Asia Pac J Clin Nutr* 2008;17 (1):176–179. [PubMed: 18296331]
70. Miller LMS, Stine-Morrow EAL. Aging and the effects of knowledge on on-line reading strategies. *Journal of Gerontology: Psychological Sciences* 1998;53B:P223–P233.
71. Gans, KM., et al. *International Journal of Behavioral Nutrition & Physical Activity*. BioMed Central; 2009. Effectiveness of different methods for delivering tailored nutrition education to low income, ethnically diverse adults; p. 1-11.

Figure 1.

Core structural equation model with key variables predicting comprehension of nutrition information.

Table 1
Means and Standard Deviations of Motivation, Knowledge, Attention, and Comprehension by Age Group

Measure	Young (18-34)		Middle (35-59)		Old (60-85)	
	M	SD	M	SD	M	SD
Motivation	-.41	.86	.13	.55	.18	.77
Knowledge	7.47	2.99	11.10	2.20	9.31	2.21
Trial 1						
Attention	.22	.11	.23	.12	.23	.09
Comprehension	.84	.02	.84	.02	.76	.02
Trial 2						
Attention	.15	.10	.17	.12	.18	.10
Comprehension	.90	.02	.90	.01	.83	.02

Note: Motivation is the average of the zscores of self-efficacy, interest, and stage of change; knowledge was number of questions correct out of 14; attention was time allocated to conceptual process; comprehension was proportion of correctly answered questions, averaged across both passages.