Health Psychology
2015, Vol. 34, No. 1, 83–88

0278-6133/15/$12.00 http://dx.doi.org/10.1037/hea0000046

BRIEF REPORT

Age Differences in the Association of Physical Activity, Sociocognitive Engagement, and TV Viewing on Face Memory

Jennifer J. Heisz
McMaster University, Hamilton, Ontario, Canada

Susan Vandermorris
Baycrest Health Sciences, Toronto, Ontario, Canada

Johnny Wu
Rotman Research Institute, Toronto, Ontario, Canada

Anthony R. McIntosh and Jennifer D. Ryan
Rotman Research Institute, Toronto, Ontario, Canada and Baycrest Health Sciences, Toronto, Ontario, Canada

Objective: Physical and sociocognitive lifestyle activities promote aspects of cognitive function in older adults. Very little is known about the relation between these lifestyle activities and cognitive function in young adults. One aspect of cognitive function that is critical for everyday function is episodic memory. The present study examined the relationship between lifestyle activities and episodic memory in younger and older adults. ***Method:*** Participants were 62 younger (mean age = 24 years) and older adults (mean age = 74 years). The augmented Victoria Longitudinal Study Activities Questionnaire was used to quantify level of engagement in physical activity, sociocognitive activity, and TV viewing. Episodic memory was assessed using the old–new face recognition paradigm in which memory for younger and older faces was tested. ***Results:*** Compared to younger adults, older adults reported being less physically and sociocognitively active while engaging in more passive behaviors such as TV viewing. A positive association was observed between physical activity and episodic memory for young adults but not for older adults. Interestingly, TV viewing was negatively associated with episodic memory in older adults but not younger adults. No relationship was found between sociocognitive activity and episodic memory for either younger or older adults. Although the own-age effect was observed for older adults, face age did not interact with lifestyle activities. ***Conclusion:*** The positive cognitive benefits of physical activity extend to younger adults; however, the interplay between physical activity and cognition may differ across the life span. Furthermore, TV viewing may be particularly detrimental to cognitive performance later in life.

Keywords: cognitive function, memory, aging, exercise, lifestyle

Older adults can maintain aspects of their cognitive function for longer into their life span by being physically active (Hertzog, Kramer, Wilson, & Lindenberger, 2008), engaging in socially and cognitively stimulating activities (Brown et al., 2012; Ghisletta, Bickel, & Lövdén, 2006; Mitchell et al., 2012; Small, Dixon, McArdle, & Grimm, 2011) and watching less TV (Lindstrom et al., 2005). Very few studies have examined the effects of these lifestyle activities on cognition in young adults. An assumption is that young adults are performing at peak physical and cognitive levels with little room for improvement; however, a sedentary lifestyle may put young adults at risk because of evidence for the positive effects of physical activity on cognition.

For young adults, little is known about the effects of sociocognitive activities (e.g., socializing with friends, volunteering) or TV viewing on cognition, and the benefits of cognitive training on a specific task do not necessarily transfer to other cognitive domains (Owen et al., 2010). In contrast, there is some evidence linking exercise and general cognitive function: Adolescents enrolled in three or more physical education classes per week have better academic performance (Kim & So, 2012) and young adults with better physical fitness have higher IQs (Åberg et al., 2009). However, few studies have examined specific aspects of cognition, although there is evidence that exercise improves episodic memory in young adults (Pereira et al., 2007).

For older adults, the rich literature linking lifestyle activities and cognitive function is mixed. Engagement in sociocognitive activities does not necessarily protect older adults against typical age-

This article was published Online First January 27, 2014.

Jennifer J. Heisz, Department of Kinesiology, McMaster University, Hamilton, Ontario, Canada; Susan Vandermorris, Baycrest Health Sciences, Toronto, Ontario, Canada; Johnny Wu, Rotman Research Institute; and Anthony R. McIntosh and Jennifer D. Ryan, Rotman Research Institute and Baycrest Health Sciences.

The Canadian Institutes of Health Research and the Canada Research Chairs Program to Jennifer D. Ryan provided funding for this research.

Correspondence concerning this article should be addressed to Jennifer J. Heisz, Department of Kinesiology, McMaster University, 1280 Main Street West, Hamilton, Ontario, Canada, L8S 4K1. E-mail: heiszjj@mcmaster.ca

related decline in cognitive function (Brown et al., 2012) yet less time watching TV in midlife may reduce risk of Alzheimer's disease later in life (Lindstrom et al., 2005). Physical exercise improves processing speed, spatial processing, and executive control (i.e., the selection, planning, and coordination of complex cognitive events) for older adults (Hertzog et al., 2008); however, little is known about the impact of physical activity and episodic memory in older adults, although the typical age-related atrophy in brain regions that mediate episodic memory (i.e., the hippocampus) is reduced, and in some cases reversed, following an aerobic exercise intervention (Erickson et al., 2009).

A critical step in understanding the interplay between age, cognition, and lifestyle is to evaluate these effects simultaneously in young and older adults. Few studies have used such an approach, although at least one study failed to find exercise-related improvements in executive control for younger adults (Hillman et al., 2006). Episodic memory represents a logical cognitive target for this purpose given evidence that physical and cognitive activities promote hippocampal neurogenesis in nonhuman animals (van Praag, Kempermann, & Gage, 2000). Interestingly, both baseline and lifestyle-related neurogenesis decline dramatically with age (Van Praag, Shubert, Zhao, & Gage, 2005), suggesting that the positive effects of an active lifestyle on episodic memory may be less potent in older than younger adults.

The ability to recognize faces is an important aspect of episodic memory function that is both dependent on hippocampal integrity and declines with age (Anastasi & Rhodes, 2006; Burgess, Maguire, & O'Keefe, 2002; Heisz & Ryan, 2011). However, older adults have better recognition memory for faces of people that belong to the same age cohort, that is, the own-age effect (Anastasi & Rhodes, 2006). It is unclear whether younger and older adults experience similar lifestyle-related benefits for face recognition or whether the benefits extend to recognition of all face types.

The aims of the present study were to examine whether face memory is related to an individual's engagement in lifestyle activities (physical activity, sociocognitive activity, TV viewing) and to determine whether any observed relations are age-dependent. The typical own-age effect in face memory was expected. Face memory was expected to improve with level of engagement in physical and sociocognitive activities but decline with amount of TV viewing. Given the age-related reduction in hippocampal neurogenesis, a key question was whether different relationships between lifestyle and memory would be observed for younger versus older adults.

Method

Participants

Sixty-two healthy adults (31 younger) participated in this study. One older adult did not complete the experiment and was excluded from the analyses. Table 1 provides a description of the participants. Vision of all the participants was normal or corrected to normal.

Procedure

The experiment took place during a 1.5-hr session. Episodic memory was tested using a face recognition paradigm. Stimuli consisted of 120 gray-scale faces (60 young, 60 old). During the study phase, faces were presented individually for 5 s each and presented one, three, or five times to obtain a range of memory performance at test. The testing phase consisted of a random selection of the studied faces plus new faces for a total of 60 faces. The participants determined, in a self-paced manner, if the current face was studied or new. After the experiment, participants completed benchmark measures of general cognitive status: Montreal Cognitive Assessment (Nasreddine et al., 2005) and American National Adult Reading Test (Blair & Spreen, 1989). Participants also completed the augmented Victoria Longitudinal Study Activities Questionnaire rating their frequency of engagement in specific lifestyle activities during the past 2 years, with the response options: 0 (never), 1 (less than once a year), 2 (about once a year), 3 (2 or 3 times a year), 4 (about once a month), 5 (2 or 3 times a month), 6 (about once a week), 7 (2 or 3 times a week), and 8 (daily) (Jopp & Hertzog, 2010). Physical activity was computed as the sum of six exercise-related questions (max score = 48), including aerobics, resistance training, stretching, sport, and outdoor-activities. Sociocognitive activity was computed as the sum of 47 questions about social and cognitive activities (max score = 376), including games, crafts, social private/public, religious, developmental, experiential activities, and technology use. Separate correlation analyses on the relation between social versus cognitive activities and face memory were similar to the relation between sociocognitive activities (i.e., the sum of social and cog-

Table 1
Mean (and Standard Deviation) Demographic Information for Younger and Older Adults

Variable	Younger adults (n = 31) M (SD)	Older adults (n = 30) M (SD)	t(59)	Sig.
Age (years)	24 (4.3)	74 (6.9)		
Age range (years)	19–33	65–85		
Gender (female/male)	16/15	15/15		
Education (years)	17.0 (3.1)	16.6 (3.4)	0.49	
Physical activity	26.3 (7.2)	22.1 (11.1)	1.77	.08
Sociocognitive activity	156.9 (25.3)	138.3 (28.0)	3.10	.009
TV viewing	16.7 (6.7)	21.9 (6.4)	−2.72	.003

Note. Independent-samples t tests were used to examine age differences in education, physical activity, sociocognitive activity, and TV viewing. Physical activity (Max score = 48), sociocognitive activity (Max score = 376), and TV viewing (Max score = 32) reflect frequency of engagement in arbitrary units. See the *Method* section for addition information regarding how these variables were computed.

Table 2
Mean (and Standard Error) Face Memory Performance (Hits–False Alarms) for Younger and Older Adults Viewing Young and Older Faces

	Younger adults M (SE)	Older adults M (SE)
Young faces	.76 (.03)	.56 (.04)
Older faces	.74 (.03)	.74 (.03)

nitive activities) and face memory, which is detailed below, and thus these two lifestyle activities were grouped to form one variable that represents sociocognitive activities. TV viewing was computed as the sum of four questions (max score = 32), including news, documentary, educational, comedy/adventure, and game shows.

Statistical Analyses

To obtain an index of face memory, responses to all faces regardless of exposure amount (one, three, or five) were averaged together and face memory was computed as the mean number of hits minus false alarms (i.e., correctly identified studied faces minus incorrectly identified new faces) separately for younger and older faces. Age differences in face memory were analyzed using a mixed-design analysis of variance (ANOVA) with one between-subjects variable of participant age (younger, older) and one within-subjects variable of face age (younger, older). Age-differences in lifestyle activities were assessed by independent samples *t*-tests contrasting physical activity, sociocognitive activity, and TV viewing for younger versus older adults. Pearson correlation tests examined the relationship between these activities. Associations between face memory and lifestyle activities were assessed using Pearson

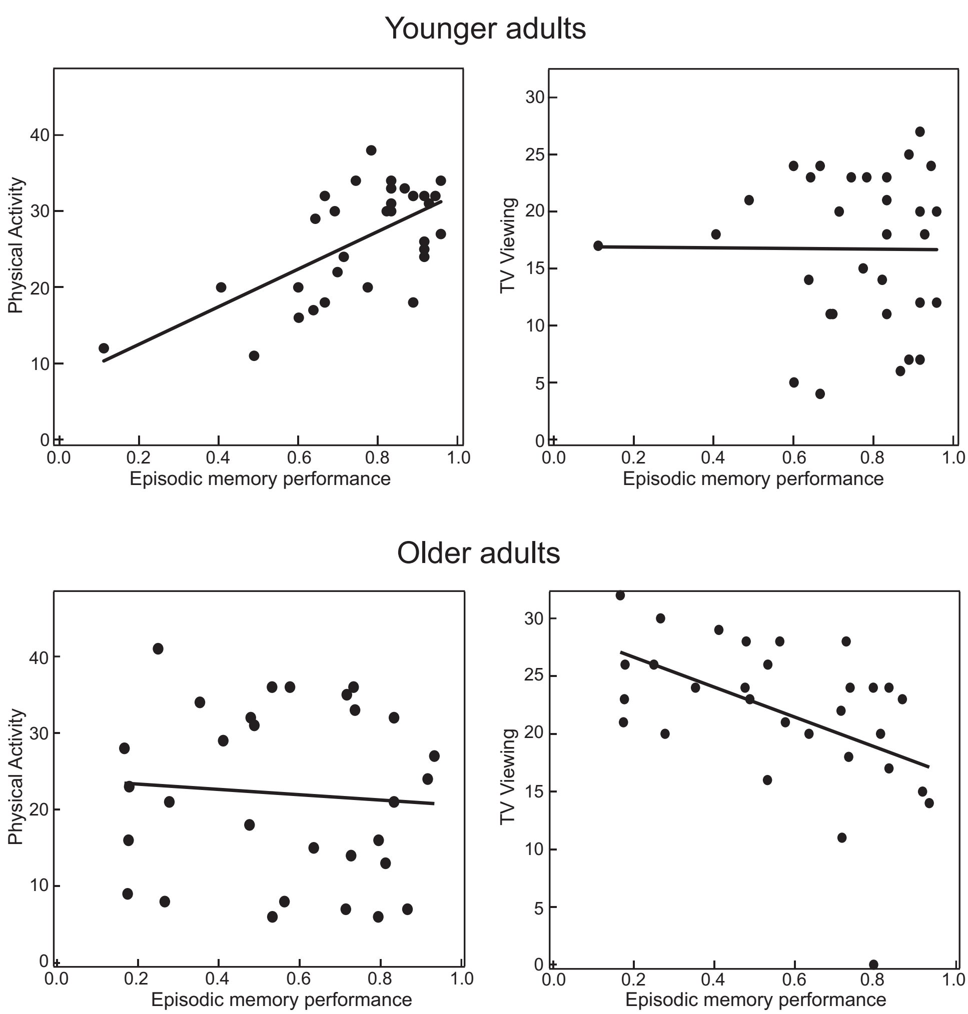

Figure 1. A strong positive correlation between face memory and physical activity was observed for younger adults (r^2 = .41) but not for older adults (r^2 = .00). A strong negative correlation between face memory and TV viewing was observed for older adults (r^2 = .25) but not for younger adults (r^2 = .01). The figure depicts the memory results for young faces but a similar pattern of results was observed for older faces.

correlation tests for each activity, separately for younger and older adults; post hoc three-step hierarchical multiple regression analyses were performed on significant correlations to control for demographic factors of age and gender (Model 1) and determine whether a particular lifestyle activity (Model 2) predicted face memory over and above the other two lifestyle activities (Model 3).

Results

Age Differences in Face Memory

Table 2 presents mean face memory for younger and older adults. The ANOVA on face memory revealed a main effect of participant age, $F(1, 59) = 5.035$, $p < .05$, $\eta_p^2 = .08$, with younger adults outperforming older adults. The main effect of face age was significant, $F(1, 59) = 11.39$, $p < .001$, $\eta_p^2 = .16$, as was the interaction of face age with participant age, $F(1, 59) = 17.33$, $p < .001$, $\eta_p^2 = .23$. To explain this interaction, post hoc paired-samples *t*-tests contrasting memory for younger versus older faces revealed an own-age effect for older adults, with superior memory for older faces compared to younger faces, $t(29) = -4.95$, $p = .001$, $d = .98$; in contrast, an own-age effect was not observed for younger adults, $t(30) = 0.61$, *ns*.

Age Differences in Lifestyle Activities

Compared to younger adults, older adults reported being marginally less physically active, significantly less sociocognitively active, and watched significantly more TV (see Table 1). Engagement in physical and sociocognitive activities were positively correlated with each other—younger: $r(29) = .48$, $p < .01$, older adults: $r(28) = .36$, $p <.05$. TV viewing did not correlate with either physical or sociocognitive activity.

Associations Between Face Memory and Lifestyle

For younger adults, face memory correlated with physical activity but not sociocognitive activity or TV viewing (see Figure 1 and Table 3). Physical activity was significantly related to memory for younger faces and marginally, but not significantly, related to memory for older faces. To further examine the relation between physical activity and face memory (averaged across face age) in younger adults, a post hoc hierarchical regression analysis revealed that physical activity predicted face memory over and above age, gender, sociocognitive activities and TV viewing (see Table 4). For older adults, memory for both younger and older faces negatively correlated with TV viewing but was unrelated to physical or sociocognitive activity (see Figure 1 and Table 3). To further examine the relation between TV viewing and face memory (averaged across face age) in older adults, a post hoc hierarchical multiple regression analysis revealed that TV viewing predicted face memory over and above age, gender, physical, and sociocognitive activities (see Table 5).

Table 4
Summary of Hierarchical Regression Analysis for Variables Predicting Face Memory in Young Adults

	Model 1	Model 2	Model 3
	Beta	*Beta*	*Beta*
Variable			
Age	.03	.13	.19
Gender	.23	.13	.10
Physical activity		.56**	.63**
Sociocognitive activity			−.17
TV viewing			−.08
R^2	.05	.35	.39
R^2 change	.05	.30	.04
F change	.78	12.29**	.77

** $p < .01$.

Discussion

We examined the association between lifestyle and age on episodic memory and found a positive relation between physical activity and face memory: Young adults who were more physically active had better face memory, consistent with the existing literature showing a direct benefit of exercise on episodic memory in younger adult populations (Pereira et al., 2007). Critically, older adults' face memory was not related to physical activity but was negatively related to TV viewing, suggesting that the interplay between physical activity and cognition is altered across the life span.

Table 3
Pearson Correlations Between Face Recognition Memory and Lifestyle Activities

	Younger adults		Older adults	
	$r(29)$	p	$r(28)$	p
Phys				
Young faces	.64	.001	−.08	
Older faces	.34	.06	.06	
SC				
Young faces	.21		−.26	
Older faces	.14		−.16	
TV				
Young faces	−.01		−.50	.01
Older faces	−.17		−.48	.01

Note. Phys = physical activity; SC = sociocognitive activity; TV = TV viewing.

Table 5
Summary of Hierarchical Regression Analysis for Variables Predicting Face Memory in Older Adults

	Model 1	Model 2	Model 3
	Beta	*Beta*	*Beta*
Variable			
Age	−.34	−.30	−.32
Gender	−.16	−.15	−.18
TV viewing		−.50**	−.45*
Physical activity			.01
Sociocognitive activity			−.20
R^2	.17	.42	.46
R^2 change	.17	.25	.04
F change	2.85	11.34**	.81

* $p < .05$. ** $p < .01$.

Age-related changes in hippocampal function during memory tasks (Grady, McIntosh, & Craik, 2003) may prevent older adults from cognitively benefiting from exercise-related neurogenesis in the hippocampus. Despite evidence that exercise mitigates age-related hippocampal atrophy to improve spatial processing (Erickson et al., 2011), the link between hippocampal volume and memory performance is weak and not always observed (Van Petten, 2004). Instead, some researchers have posited that this dissociation between hippocampal volume and memory function is explained by the underactivation of the hippocampus by older adults during memory tasks and the recruitment of other brains regions to compensate for diminished hippocampal function (Grady et al., 2003). Consequently, the neurogenic effects of exercise may not translate into functional gains in older adults because the hippocampus is engaged less during processing.

Older adults watched more TV and were less involved in physical-sociocognitive activities than younger adults. Like some previous studies (Brown et al., 2012), we failed to find an association between sociocognitive activities and cognitive performance in either young or older adults. However, older adults who watched more TV had poorer memory, despite their engagement in other activities. Interestingly, the same negative relation between TV viewing and face memory was not observed for young adults, suggesting that TV viewing may be particularly detrimental for older adults. Indeed, TV viewing in midlife is predictive of Alzheimer's disease later in life (Lindstrom et al., 2005), suggesting that TV viewing may accelerate the trajectory of age-related cognitive decline.

Young adults had better face memory than older adults; however, this difference was minimized for older faces, consistent with an own-age bias for older adults (Anastasi & Rhodes, 2006). The relation between the three lifestyle factors and memory did not differ by stimulus type; for example, older adults who watched more TV had poorer face memory for all faces, suggesting a global decline.

This is the first study to reveal age-dependencies in the relationship between memory and lifestyle; however, some limitations include (a) self-reports were used to assess lifestyle activities, which may not perfectly estimate activity level and (b) the cross-sectional design limits conclusions regarding the causality of the relationship between lifestyle and face memory. Future studies should use interventions to directly examine the effect of lifestyle on memory across the life span.

This is the first study to show a relation between physical activity and memory in younger adults that was not present in older adults. Younger adults who were more physically active had better face memory, suggesting that young sedentary adults could improve their memory through exercise. In contrast, older adults' face memory was negatively related to TV viewing, suggesting that this form of sedentary behavior may be particularly detrimental later in life. In prescribing activity intervention for older adults, health care professional should monitor their patients' TV viewing.

References

Åberg, MaI, Pedersen, N. L., Torén, K., Svartengren, M., Bäckstrand, B., Johnsson, T., . . . Kuhn, H. G. (2009). Cardiovascular fitness is associated with cognition in young adulthood. *Proceedings of the National Academy of Sciences, USA, 106,* 20906–20911.

Anastasi, J. S., & Rhodes, M. G. (2006). Evidence for an own-age bias in face recognition. *North American Journal of Psychology, 8,* 237–252.

Blair, J. R., & Spreen, O. (1989). Predicting premorbid IQ: A revision of the National Adult Reading Test. *Clinical Neuropsychologist, 3,* 129–136. doi:10.1080/13854048908403285

Brown, C. L., Gibbons, L. E., Kennison, R. F., Robitaille, A., Lindwall, M., Mitchell, M. B., . . . Benitez, A. (2012). Social activity and cognitive functioning over time: A coordinated analysis of four longitudinal studies. *Journal of Aging Research,* 2012 (461592), 1–12.

Burgess, N., Maguire, E. A., & O'Keefe, J. (2002). The human hippocampus and spatial and episodic memory. *Neuron, 35,* 625–641. doi:10.1016/S0896-6273(02)00830-9

Erickson, K. I., Prakash, R. S., Voss, M. W., Chaddock, L., Hu, L., Morris, K. S., . . . Kramer, A. F. (2009). Aerobic fitness is associated with hippocampal volume in elderly humans. *Hippocampus, 19,* 1030–1039. doi:10.1002/hipo.20547

Erickson, K. I., Voss, M. W., Prakash, R. S., Basak, C., Szabo, A., Chaddock, L., . . . White, S. M. (2011). Exercise training increases size of hippocampus and improves memory. *Proceedings of the National Academy of Sciences, USA, 108,* 3017–3022. doi:10.1073/pnas.1015950108

Ghisletta, P., Bickel, J.-F., & Lövdén, M. (2006). Does activity engagement protect against cognitive decline in old age? Methodological and analytical considerations. *The Journals of Gerontology: Series B: Psychological Sciences and Social Sciences, 61B(5*), P253–P261. doi:10.1093/geronb/61.5.P253

Grady, C. L., Mcintosh, A. R., & Craik, F. I. (2003). Age-related differences in the functional connectivity of the hippocampus during memory encoding. *Hippocampus, 13*(5), 572–586. doi:10.1002/hipo.10114

Heisz, J. J., & Ryan, J. D. (2011). The effects of prior exposure on face processing in younger and older adults. *Frontiers in Aging Neuroscience, 3*(15), 1–6. doi:10.3389/fnagi.2011.00015

Hertzog, C., Kramer, A. F., Wilson, R. S., & Lindenberger, U. (2008). Enrichment effects on adult cognitive development can the functional capacity of older adults be preserved and enhanced? *Psychological Science in the Public Interest, 9*(1), 1–65.

Hillman, C. H., Motl, R. W., Pontifex, M. B., Posthuma, D., Stubbe, J. H., Boomsma, D. I., . . . De Geus, E. J. C. (2006). Physical activity and cognitive function in a cross-section of younger and older community-dwelling individuals. *Health Psychology, 25,* 678–687. doi:10.1037/0278-6133.25.6.678

Jopp, D. S., & Hertzog, C. (2010). Assessing adult leisure activities: An extension of a self-report activity questionnaire. *Psychological Assessment, 22,* 108–120. doi:10.1037/a0017662

Kim, S. Y., & So, W. Y. (2012). The relationship between school performance and the number of physical education classes attended by Korean adolescent students. *Journal of Sports Science and Medicine, 11,* 226–230.

Lindstrom, H. A., Fritsch, T., Petot, G., Smyth, K. A., Chen, C. H., Debanne, S. M., . . . Friedland, R. P. (2005). The relationships between television viewing in midlife and the development of Alzheimer's disease in a case-control study. *Brain and Cognition, 58,* 157–165. doi:10.1016/j.bandc.2004.09.020

Mitchell, M. B., Cimino, C. R., Benitez, A., Brown, C. L., Gibbons, L. E., Kennison, R. F., . . . MacDonald, S. W. S. (2012). Cognitively stimulating activities: Effects on cognition across four studies with up to 21 years of longitudinal data. *Journal of Aging Research,* 2012 (461592), 1–12.

Nasreddine, Z. S., Phillips, N. A., Bédirian, V., Charbonneau, S., Whitehead, V., Collin, I., . . . Chertkow, H. (2005). The Montreal Cognitive Assessment, MoCA: A brief screening tool for mild cognitive impairment. *Journal of the American Geriatrics Society, 53,* 695–699. doi:10.1111/j.1532-5415.2005.53221.x

Owen, A. M., Hampshire, A., Grahn, J. A., Stenton, R., Dajani, S., Burns, A. S., . . . Ballard, C. G. (2010). Putting brain training to the test. *Nature, 465,* 775–778. doi:10.1038/nature09042

Pereira, A. C., Huddleston, D. E., Brickman, A. M., Sosunov, A. A., Hen, R., Mckhann, G. M., . . . Small, S. A. (2007). An in vivo correlate of exercise-induced neurogenesis in the adult dentate gyrus. *Proceedings of the National Academy of Sciences, USA, 104,* 5638–5643. doi:10.1073/pnas.0611721104

Small, B. J., Dixon, R. A., Mcardle, J. J., & Grimm, K. J. (2011). Do changes in lifestyle engagement moderate cognitive decline in normal aging? Evidence from the Victoria Longitudinal Study. *Neuropsychology, 26,* 144–155.

Van Petten, C. (2004). Relationship between hippocampal volume and memory ability in healthy individuals across the lifespan: Review and meta-analysis. *Neuropsychologia, 42,* 1394–1413. doi:10.1016/j.neuropsychologia.2004.04.006

Van Praag, H., Kempermann, G., & Gage, F. H. (2000). Neural consequences of environmental enrichment. *Nature Reviews Neuroscience, 1,* 191–198. doi:10.1038/35044558

van Praag, H., Shubert, T., Zhao, C., & Gage, F. H. (2005). Exercise enhances learning and hippocampal neurogenesis in aged mice. *The Journal of Neuroscience, 25,* 8680–8685. doi:10.1523/JNEUROSCI.1731-05.2005

Received April 18, 2013
Revision received October 18, 2013
Accepted October 25, 2013 ■