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Research Article

Cognitively Stimulating Leisure Activity and Subsequent Cognitive Function: A SHARE-based Analysis

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Abstract

Purpose of the Study: The aim of the inquiry was to examine whether cognitively stimulating leisure activity (CSLA) can delay or reduce cognitive decline in late life and whether its effect is moderated by education, age, or activity pattern.
Design and Methods: Employing secondary analysis of data on respondents aged 65 and older from the 4th and 5th waves of the Survey of Health, Ageing and Retirement in Europe (N = 16,572), the inquiry regressed cognitive function (memory, numeracy, and fluency) at Time 2 on frequency of engagement in CSLA at baseline, controlling for cognitive function scores at baseline and a range of confounders. The study also considered education by CSLA and age by CSLA interactions, as well as the effect of CSLA patterns.
Results: CSLA frequency was found to be positively related to subsequent cognitive functioning on all measures, 2 years later. The effect of CSLA on memory and fluency was stronger among those with lower education, whereas the age by CSLA interaction was not significant. Respondents who started CSLA after baseline showed better cognitive functioning at Time 2 than those who did not engage in CSLA at all and those who had engaged in such activity at baseline but stopped.
Implications: The study documents that CSLAs constitute a potential source for the delay or reduction of cognitive decline, regardless of one's age. As such, practitioners should recognize the value of this medium and encourage its greater use in appropriate settings.

Keywords: Memory, Numeracy, Fluency, Sudoku, Cognition, Analysis—regression models

Cognitive decline is a frequent concomitant of aging (Deary et al., 2009). Many believe it to be an undeniable part of the aging process, especially in the later stages of an ever increasing longevity (Kravitz, Schmeidler, & Beeri, 2012). However, age-related cognitive changes may vary across cognitive domains (Glisky, 2007). Functions such as working memory and processing speed tend to decline over the life span whereas semantic memory and knowledge start declining mainly in later life (Hedden & Gabrieli, 2004).

Can cognitive decline be delayed or reduced? The cognitive enrichment hypothesis maintains that cognitive functioning in old age can be influenced by a wide variety of behaviors and activities (Hertzog, Kramer, Wilson, & Lindenberger, 2008). Within this broad outlook, the "use it or lose it" perspective focuses on activities that are cognitively stimulating and suggests that they stimulate the mind and can preserve cognitive functions (Hultsch, Hertzog, Small, & Dixon, 1999). These activities may also influence cognitive functioning through cognitive reserve, which is the ability to tolerate brain pathology without developing clear clinical symptoms at the behavioral level (Reed et al., 2011; Saczynski et al., 2008). Protective factors such as education and a cognitively active lifestyle have been shown to account for this reserve and to allow for cognitive functioning to continue in older ages (Fratiglioni & Wang, 2007).

Research generally supports the notion of an association between cognitive activities and cognitive performance in late life. More frequent participation in cognitive activities has been shown to be related to better cognitive functioning and performance (Gallucci et al., 2009; Hultsch et al., 1999; Lachman, Agrigoroaei, Murphy, & Tun, 2010; Wilson et al., 2005). In particular, more cognitively complex activities, such as reading and involvement in clubs or organizations (Singh-Manoux, Richards, & Marmot, 2003), and intellectual activities (Elwood et al., 1999) are associated with better cognitive function. However, the NIH Consensus Development Conference Statement on Preventing Alzheimer's Disease and Cognitive Decline cites limited but inconsistent evidence, which suggests that "increased involvement in cognitive activities in later life may be associated with slower cognitive decline" (Daviglus et al., 2010, p. 10).

Study of the association between cognitive activities and subsequent cognitive performance among nonimpaired community-dwelling older adults is not widely reported. Some important insights in this direction may be drawn from the results of the ACTIVE trials, a major study in which some 2,832 persons in six American metropolitan areas, aged 65–94 years, randomly participated in cognitive training groups (memory, reasoning, or speed of processing) or not (control group). About 60% of the training group participants also received booster training close to a year later (Ball et al., 2002). It was found that cognitive training was associated with improved cognitive abilities up to 5 years following the initial intervention (Willis et al., 2006) and that memory training delayed the worsening of memory span as well as augmenting learning (Gross et al., 2013). However, some investigators claim that the ACTIVE trials find improvements mainly in the trained tasks (Park & Bischof, 2013; Park, Gutchess, Meade, & Stine-Morrow, 2007).

A challenge to studying the effect of self-reported cognitive activities on cognitive function has been the defining of such activities, insofar as many different activities involve cognition to some extent. This situation has led to the use of a wide array of such activities in different studies (Hertzog et al., 2008). As a possible solution to this dilemma, some authors suggest focusing on specific cognitive activities, such as crossword or number puzzles (Ihle et al., 2015; Lachman et al., 2010). One study which separated the influence of different types of cognitive activities on cognition found that engaging in Sudoku influenced episodic memory and grammatical reasoning among adults aged 65 and older. However, crossword puzzles, brain training computer games, and noncognitive training computer games did not have such an effect (Ferreira, Owen, Mohan, Corbett, & Ballard, 2015). Puzzles such as Sudoku may be related to preparatory attention, working memory, target detection, and monitoring of response accuracy (Chang & Gibson, 2011; Jin et al., 2012; Nombela et al., 2011).

Another issue in the study of cognitive activities and cognitive functioning involves reverse causality. It is unclear whether cognitive activity protects against cognitive decline or whether people with high cognitive function engage more often in cognitive activities (Hertzog et al., 2008; Hultsch et al., 1999; Singh-Manoux, 2003). This question has been addressed in several randomized controlled trials. For example, the ACTIVE trials found cognitive improvement among people who began to engage in cognitive training (Willis et al., 2006). Another randomized controlled trial found that starting to engage in cognitively stimulating activities at home, such as word-logic puzzles and simple mathematics activities, related to increased performance in a novel task measuring fluid intelligence (Tranter & Koutstaal, 2008). However, studies in large samples of community-dwelling adults have scarcely addressed this issue. Those that have referred to changes in cognitive activities but did not consider the influence of commencing cognitive activities as a protective factor (Wilson, Segawa, Boyle, & Bennett, 2012). Therefore, the current analysis looks at different patterns of cognitive engagement in order to examine whether beginning to engage in cognitive activities in late life has a protective influence.

Education is cited as another factor that may be related to lesser cognitive decline (Capitani, Laiacona, & Barbarotto, 1999; Dal Bianco, Garrouste, & Paccagnella, 2013; Singh-Manoux et al., 2011). There are also indications that the influence of education on cognition is moderated by cognitive activities and that such activities are actually more beneficial for those with low levels of education. These effects may suggest that for older adults with a low education level, adopting a cognitively active lifestyle could have a compensatory benefit for cognitive functioning. For example, frequent engagement in cognitive activities (reading, writing, doing word games or puzzles, and attending lectures) was found to attenuate the influence of education on episodic memory, so that the memory performance of those with lower education who engaged in frequent cognitive activities matched those with higher education (Lachman et al., 2010). Other studies have found similar results for more broadly defined cognitively stimulating leisure activities and intellectual/cultural activities, for example taking courses and party games (Ihle et al., 2015; Soubelet, 2011). However, all of these inquiries were cross-sectional. The current study attempts to expand these findings by measuring the interaction of education and cognitively stimulating activity in relation to cognitive decline.

Cognitive activities may also have a role in moderating the effect of age on cognitive decline. Although there is some contradicting evidence regarding such effects in relation to mnemonic training (Gross et al., 2012; Verhaeghen, Marcoen, & Goossens, 1992), the role of cognitive activities as a protective factor in different age groups is still unclear. Therefore, the current study also examines whether cognitive activity affects the association of older age and cognitive decline.

In sum, although small-scale clinical trials and some larger cross-sectional inquiries suggest that cognitive activity augments cognitive performance, there is still little reported longitudinal examination of this association using probability samples composed of community-dwelling older adults. The current study addresses this gap in the literature. Based upon the studies reviewed thus far, we consider three hypotheses:

1. Cognitively stimulating leisure activity (CSLA) is positively related to subsequent cognitive functioning among Europeans aged 65 and older, 2 years later.
2. Education and age moderate the positive effect of CSLA on subsequent cognitive functioning. We hypothesize that the effect will be larger for people with lower education (who have more room for improvement) and for those who are older (who have greater potential for age-related cognitive decline).
3. Commencement of CSLA after baseline is positively related to subsequent cognitive functioning.

Design and Methods

The current study was a secondary analysis of data collected in the framework of the Survey of Health, Ageing and Retirement in Europe (SHARE), a biennial panel survey of persons aged 50 and older and their spouses of any age, which began in 2004 and has since expanded to include some 20 European countries (and Israel), with more than 85,000 respondents (Börsch-Supan et al., 2013). The current analysis focused exclusively on respondents aged 65 and older who participated in the fourth (2010) and the fifth waves of the survey (2012–2013). The fourth wave served as the baseline in the current analysis because it was the first time that the SHARE questionnaire specifically measured engagement in CSLA. Pooling data from Waves 4 and 5 allowed us to examine the variables related to baseline cognitive activity and the relationship of such activity to cognitive functioning some 2 years later.

Respondents aged 65 and older at Wave 5 who participated in the two relevant waves of the survey initially numbered 22,496 persons who resided in 13 European countries (the respondents from the other seven SHARE countries did not participate in at least one of the two waves of data collection necessary for the current analysis). After removing respondents for whom data were missing on the respective cognitive function measures or on the CSLA frequency variables, as well as those for whom data were missing on health or financial status, the sample numbered 17,645 individuals. We removed an additional 1,073 persons who indicated that they had ever been diagnosed with stroke, Parkinson disease, Alzheimer's disease, dementia, or senility, all of which impact cognition. The final analytic sample stood, therefore, at 16,572.

Study Variables

The dependent variable was cognitive functioning in Wave 5, measured on three separate indicators: memory, numeracy, and fluency. The memory measure combines the results of immediate and delayed memory tests. SHARE uses a modified version of Rey's Auditory Verbal Learning Test—RAVLT, which tests short-term verbal learning and memory and information retention (Dal Bianco et al., 2013) and can be used as a measure of episodic memory (Cheke & Clayton, 2013). In the modified version, the interviewer reads out a list of 10 words, after which the respondent is asked to recall as many of them as s/he can. After 5–10 minutes, the respondent is asked to recall again the words from that list. The combined score ranges from 0 to 20. The measure for numeracy is based on a Serial Sevens test; respondents are asked to subtract 7 from 100, and then to continue on subtracting from the given answer four more times. The test is a measure of concentration and basic calculation skill (Karzmark, 2000). Respondents received one point for each correct answer. In cases of mistakes, subsequent responses were counted if they were correct in relation to the previous number (Scholey, Harper, & Kennedy, 2001). The numeracy variable therefore ranges from 0 to 5. Verbal fluency was measured by asking respondents to name as many distinct animals (real or mythical), without repetitions or proper nouns, in a 1-minute period. Due to outliers in a small number of cases (n = 81), scores above 45 were re-coded as 45. This test measures executive functioning and language ability (Clark et al., 2009; Dal Bianco et al., 2013).

The independent variable was CSLA. This was measured by a single question which asked whether the respondent had done word or number games such as crossword puzzles or Sudoku (or other such undertakings) in the 12 months prior to the interview. A subsequent probe which queried frequency of such engagement was re-coded as *almost every day* (4), *almost every week* (3), *almost every month* (2), and *less often* (1). Pairing these two probes yielded a frequency scale that ranged from 0 (*never*) to 4 (*almost daily*).

An additional measure of CSLA addressed the pattern of engagement over the two waves. Pairing engagement (yes/no) in CSLA in Wave 4 with the same in Wave 5 allowed the identification of the following four patterns: neither wave (never), baseline only (stopped), began after baseline (started), and both waves (continued). Dummy variables (0–1) for each of the respective engagement patterns were created for inclusion in the multivariate analyses. Starting CSLA after baseline served as the reference category in the regressions.

Background, health, and social network variables, all of which may be related to cognitive function, were controlled as possible confounders. The background characteristics included age at Wave 5 (65–74 = 0; 75+ = 1) and gender (female = 0; male = 1), as well as education and subjective financial status. Level of education attained was based on the standardized coding of the International Standard Classification of Education (ISCED-97) that is utilized by SHARE and was measured in this analysis as (0) partial secondary schooling or less (ISCED-97 = 0–2) and (1) secondary schooling or more (ISCED-97 = 3–6). Financial status was tapped on a subjective measure that asked the extent to which the respondent experienced difficulty in making ends meet. The 4-point response scale of this measure (1 = *difficult*; 2 = *somewhat difficult*; 3 = *somewhat easy*; 4 = *easy*) has been found to work effectively as a relative income indicator that can be compared across countries in which incomes have differing purchasing power (Litwin & Sapir, 2009).

The health control variables included (a) self-rated health (0–4), in which a higher score indicates poorer health; (b) hearing difficulties (0–4); mobility difficulties (0–10); and depressive symptoms (0–12) derived from the Euro-D depression scale, a measure that was developed to enable cross-country comparisons in Europe (Prince et al., 1999). Hearing difficulties were included insofar as one of the cognitive measures required response to a list that was read to the participants.

The social network variables included the number of children (0–12), the number of grandchildren (0–20), and whether or not the respondent had a partner (spouse or registered partnership; 0 and 1). An additional variable made use of a unique network inventory that was employed in SHARE in Wave 4. Explained in detail in a previous publication (Litwin & Stoeckel, 2014), the inventory employed a name generator to identify up to six persons with whom the respondent discussed matters of importance in the prior 12 months (and another person who was important for any reason). The people mentioned constitute the most meaningful members in the respondent's interpersonal environment. In the current analysis, network size (0–7), that is, the number of persons nominated, was included as a control variable.

A final set of controls reflected baseline cognitive function. They were measured as the Wave 4 scores on the respective cognitive function indicators (memory, numeracy, and fluency) described earlier. Their inclusion allowed consideration of the cognitive outcome variables beyond the effect of their baseline levels.

Analyses

The analysis included univariate descriptions of the study variables and examination of the associations of the control and independent variables with CSLA frequency at baseline and with the cognitive function outcome variables at Wave 5. Next, the respective cognitive function outcome variables were regressed on the study variables by means of ordinary least squares regressions. In the first series of regressions, we focused on the association of baseline CSLA frequency with each of the outcome measures, after adjusting for the associations with the other study variables.

We also ran regressions in which baseline CSLA was interacted respectively with education and with age. In each such regression, the effect for the respective category of interest (educational level and age) was calculated by running the regression twice, reversing the dummy coding of the respective variables in the second regression in each set, as recommended by Figueiras, Domenech-Massons, and Cadarso (1998). (For example, in the first of the two regressions age 65–74 = 0 and 75+ = 1, whereas in the second, age 65–74 = 1 and 75+ = 0). This allows comparing the respective main effects of younger and older age in relation to the cognitive function outcome, after adjusting for the effect of the interactions.

Finally, a last regression was run in which the CSLA pattern dummy variables were entered instead of the CSLA frequency variable as the independent variable of interest. This allowed us to consider whether change in CSLA, and particularly the commencement of such activity, mattered in relation to subsequent cognition levels.

Results

The sample was comprised of 16,572 European adults aged 65–100 years (mean = 73.5), from 13 countries: Austria, Belgium, Czech Republic, Denmark, Estonia, France, Germany, Italy, Netherlands, Slovenia, Spain, Sweden, and Switzerland. As Table 1 reveals, men constituted about 44% of the sample. Sixty percent completed high school or more and the average participant made ends meet somewhat easily. Respondents reported their health as relatively good on all the health measures. Almost two thirds had a partner. The average number of children was about two, and the number of grandchildren was between three and four. Participants named two to three persons in their close social networks, on average.

The mean baseline memory score was about 9 on a scale of 0–20. Average numeracy was high (4.5 out of 5), whereas mean fluency was about 20 on a scale of 0–45. Half the sample engaged in CSLA at baseline. Among those engaged in such activity, more than 60% did so almost every day (not shown in table). Looking at CSLA over the two waves revealed that about 40% were active in both waves, almost 40% were inactive in both waves, some 9% stopped the activity midway, and close to 11% began it midway.

Table 1 also presents several bivariate correlations. As may be seen, the frequency of engagement in CSLA at baseline was associated with all but one of the study variables (number of grandchildren). Frequency of CSLA was positively related to education, financial status, and social network size and negatively related to age, male gender, poor health, number of children, and having a partner. It was also positively related to baseline cognitive function.

Cognitive function at Time 2 correlated with all the variables. On the whole, the respective cognitive functions (memory, numeracy, and fluency) were associated positively with education, financial status, having a partner, and social network size. They were negatively related to age, poor health, number of children, and number of grandchildren. Gender showed an inconsistent relationship to the respective measures. Not surprisingly, cognitive function at Time

Table 1. Univariate Description of Study Variables and Their Associations With CSLA at Baseline and With Subsequent Cognitive Function (*N* = 16,572)

Variables	Min	Max	Mean/%	*SD*	Baseline CSLA	Memory	Numeracy	Fluency
Aged 75 and older	0	1	*38.39*		−0.04***	−0.28***	−0.09***	−0.24***
Education level	0	6	2.87	1.43	0.15***	0.33***	0.22***	0.34***
High school or more	0	1	*59.82*		0.16***	0.29***	0.21***	0.31***
Male gender	0	1	*44.41*		−0.15***	−0.10***	0.07***	0.01
Financial status	1	4	3.05	0.93	0.10***	0.13***	0.13***	0.15***
Poor perceived health	1	5	3.21	1.01	−0.06***	−0.23***	−0.11***	−0.22***
Hearing difficulties	1	5	2.81	1.02	−0.07***	−0.16***	−0.05***	−0.14***
Mobility limitations	0	10	1.64	2.20	−0.05***	−0.19***	−0.12***	−0.20***
Depressive symptoms	0	12	2.26	2.07	−0.06***	−0.16***	−0.14***	−0.18***
Number of children	0	13	2.19	1.33	−0.02**	−0.02**	−0.02**	−0.02*
Number of grandchildren	0	20	3.49	3.03	0.01	−0.04***	−0.02*	−0.03***
Partner	0	1	*65.78*		−0.03***	0.05***	0.05***	0.08***
Social network size	0	7	2.57	1.59	0.09***	0.13***	0.04***	0.11***
Baseline cognitive function								
Memory	0	20	9.14	3.31	0.21***	0.56***	0.21***	0.39***
Numeracy	0	5	4.46	0.96	0.13***	0.20***	0.36***	0.20***
Fluency	0	45	20.42	6.73	0.23***	0.40***	0.20***	0.61***
CSLA	0	1	*49.84*			0.21***	0.13***	0.22***
CSLA frequency	0	4	1.75	1.83		0.20***	0.13***	0.22***
CSLA pattern								
Neither wave	0	1	*39.43*			−0.22***	−0.13***	−0.24***
Time 2 only	0	1	*10.73*			0.01	0.00	0.01
Baseline only	0	1	*9.22*			−0.03***	−0.01	−0.02**
Both waves	0	1	*40.62*			0.23***	0.13***	0.24***

Notes: CSLA = cognitively stimulating leisure activity.
$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

2 was strongly related to cognitive function at baseline. As for CSLA, the table shows that baseline CSLA (yes/no) related positively to all three measures of cognitive function at Time 2, as did baseline CSLA frequency. The pattern of CSLA over the two waves was also related. Those who had not engaged in such activity in either wave showed negative correlations with cognitive function at Time 2, whereas those who had engaged in CSLA in both waves were positively related. Respondents who stopped CSLA midway showed small negative associations, but those who began midway showed no association at the bivariate level.

Initial regressions (not shown) underscored that baseline CSLA was positively related to recall, numeracy, and fluency after controlling for the study variables (β = 0.062, β = 0.055, and β = 0.067, respectively). Table 2 presents the results of the analyses in which the three cognitive function measures at Time 2 were regressed on baseline CSLA frequency, education, and age dummy variables and the respective interactions, controlling for all the other variables. Model 1 in the table shows that the interaction between education and CSLA frequency was mostly significant. In order to interpret the interaction results, we note that for memory and numeracy at Time 2, the coefficients for CSLA frequency were β = 0.085 and β = 0.089, respectively, among respondents with low education. Reversing the coding of the education variable and running the same regression revealed that among respondents with higher education, the associations between CSLA frequency at baseline and memory and numeracy at Time 2 were weaker although still significant (β = 0.049 and β = 0.034 respectively, not shown in table). This means that the effect of CSLA on subsequent memory and numeracy was greater among those with lesser education than among those with higher education, even though it was positive in both cases.

Model 2 in Table 2 shows the same analysis, but with the age–CSLA interaction term entered instead of the interaction with education. Age was negatively associated with all three Time 2 cognitive functions and baseline CSLA frequency was positively associated, after taking the interaction and the confounders into account. However, the interaction of age and CSLA frequency was not significant. Thus, the positive effect of CSLA on subsequent cognitive function did not differ by age.

Table 3 presents the regression that examined the associations in relation to CSLA pattern. The reference category among the CSLA pattern dummies was “engaging in CSLA in Time 2 only,” that is, those who started the activity midway. The results repeat the previous findings in which education was positively related to cognitive function at Time 2 and age was negatively related. Turning to the CSLA

Table 2. Associations of CSLA at Baseline, Education, and Age With Subsequent Cognitive Function: OLS Regressions

	Memory		Numeracy		Fluency	
Variables[a]	*B* (*SE*)	β	*B* (*SE*)	β	*B* (*SE*)	β
Model 1						
Education level	0.852*** (0.064)	0.122	0.213*** (0.020)	0.108	1.122*** (0.121)	0.080
Baseline CSLA	0.158*** (0.020)	0.085	0.047*** (0.006)	0.089	0.265*** (0.037)	0.071
Education × Baseline CSLA	−0.067** (0.024)	−0.034	−0.029*** (0.008)	−0.052	−0.023 (0.046)	−0.006
Observations	16,572		16,572		16,572	
R^2	.374		.181		.434	
Model 2						
Age	−0.905*** (0.063)	−0.128	−0.105*** (0.020)	−0.053	−1.353*** (0.118)	−0.096
Baseline CSLA	0.119*** (0.015)	0.064	0.024*** (0.005)	0.046	0.243*** (0.029)	0.065
Age × Baseline CSLA	−0.006 (0.024)	−0.003	0.012 (0.008)	0.018	0.019 (0.045)	0.004
Observations	16,572		16,572		16,572	
R^2	.373		.180		.434	

Notes: CSLA = cognitively stimulating leisure activity; OLS = ordinary least squares.
[a]Adjusted for baseline cognitive function (memory, numeracy, and fluency), gender, financial status, perceived health, hearing difficulties, mobility limitations, depressive symptoms, number of children, number of grandchildren, partner, social network size, and country.
*p < .05. **p < .01. ***p < .001.

Table 3. Associations of CSLA Pattern, Education, and Age With Subsequent Cognitive Function: OLS Regressions

	Memory		Numeracy		Fluency	
Variables[a]	*B* (*SE*)	β	*B* (*SE*)	β	*B* (*SE*)	β
Age	−0.905*** (0.047)	−0.128	−0.080*** (0.015)	−0.040	−1.294*** (0.089)	−0.092
Education level	0.717*** (0.049)	0.103	0.160*** (0.016)	0.081	1.032*** (0.093)	0.074
CSLA pattern (base = second wave)						
Neither wave	−0.324*** (0.073)	−0.046	−0.052* (0.024)	−0.026	−0.760*** (0.140)	−0.054
Baseline only	−0.258** (0.095)	−0.022	−0.023 (0.031)	−0.007	−0.521** (0.180)	−0.022
Both waves	0.285*** (0.073)	0.041	0.080*** (0.024)	0.041	0.548*** (0.139)	0.039
Observations	16,572		16,572		16,572	
R^2	.376		.181		.437	

Notes: CSLA = cognitively stimulating leisure activity; OLS = ordinary least squares.
[a]Adjusted for baseline cognitive function (memory, numeracy, and fluency), gender, financial status, perceived health, hearing difficulties, mobility limitations, depressive symptoms, number of children, number grandchildren, partner, social network size, and country.
*p < .05. **p < .01. ***p < .001.

pattern variables, it can be seen that not engaging in such activity in either wave was negatively associated with the respective cognitive functions in Time 2, when compared with the reference category. This same trend was evident, albeit it to a lesser degree, for memory and fluency (but not for numeracy) among those who stopped CSLA midway (i.e., baseline only), when compared with those who began such activity midway. In contrast, those who engaged in CSLA in both waves were positively related to all three of the cognitive functions at Time 2 when compared with those who started CSLA midway.

Discussion

This study examined the relationship between CSLA and cognitive function 2 years later in a sample of community-dwelling Europeans aged 65 and older. The data were drawn from the fourth and fifth waves of SHARE. The activity in question was doing word or number games, such as crossword puzzles or Sudoku. The cognitive function outcomes were memory, numeracy, and fluency.

The first study hypothesis posited that CSLA is positively related to subsequent cognitive functioning, 2 years later. This hypothesis was fully confirmed. That is, even after controlling for initial levels of memory, numeracy, and fluency, as well as for socioeconomic background, health, social network variables, and country, the frequency of CSLA at baseline was seen to maintain a positive association with each of the cognitive function outcome measures 2 years later. Thus, it seems that CSLA can indeed impact cognition in late life, above and beyond the effects of a wide range of factors known to be related. Our results thus confirm and augment those of prior studies (e.g., Gallucci et al., 2009; Hultsch et al., 1999; Ihle et al., 2015; Singh-Manoux et al., 2003; Wilson et al., 2005).

The second hypothesis addressed the question as to whether education and age moderate the effect of CSLA on subsequent cognitive functioning. The findings revealed that education did intervene in the cognitive activity—cognitive function nexus. The results of the interaction term clearly showed that the effect of word games and/or Sudoku on subsequent memory and fluency was stronger among those with lower education. This finding echoes that of the SeniorWISE study in Texas in which participants with less education made the greatest gains on cognition after having received cognitive training (McDougall, Becker, Vaughan, Acee, & Delville, 2010).

The implication is that CSLA can provide subsequent benefits to all older persons, including those with lesser schooling. This was also the conclusion of the cross-sectional study by Lachman and colleagues (2010) and the study by Ihle and associates (2015). Soubelet (2011) similarly found, in this regard, that the risk of cognitive decline in persons having lesser education can be diminished by means of engagement in intellectual and cultural activities across adulthood. A unique contribution of the present study is its confirmation of this association using longitudinal data from a large population-based survey.

Moreover, we should point out that both education and a cognitively active lifestyle have been shown to account for brain reserve. This, in turn, allows for cognitive functioning to continue in older ages (Fratiglioni & Wang, 2007). The results from our study showing an interaction effect of education and CSLA further attest to the mutual contribution of these factors. They also suggest that the two can compensate for each other in enhancing brain reserve.

A word is required about the cognitive function for which the interaction of CSLA with education was not significant, namely, fluency. This particular function reflects not only the extent of animal names that one knows but also executive functioning—the ability to organize the names in relevant conceptual sets so as to facilitate their quick retrieval. It could be that the activity/education interaction is relevant mostly for memory, concentration, and arithmetic ability, but has less of an effect on executive cognitive functions.

The second hypothesis also addressed the possible moderation of cognitive function by the interaction between CSLA and age. This was not found. Rather, the lack of a significant effect of the interaction term in each of the cognitive outcome measures in this case underscores that age does not compromise the role of such activity. Stated differently, practitioners should not hesitate to encourage engagement in CSLA by their older clients.

The third and final hypothesis considered whether there is any benefit to starting CSLA in late life. We posited, in this regard, that the commencement of CSLA after baseline would be positively related to subsequent cognitive functioning, and this hypothesis was indeed confirmed. Specifically, the regression of memory, numeracy, and fluency at Time 2 on cognitive activity pattern showed that in all but one of the cases, the pattern variable was significant. Compared with those who did not engage in CSLA in either wave, respondents who had started such activity midway showed better cognitive functioning at Time 2. The same was found for memory and fluency in comparison with those who had stopped such activity midway (And, as expected, those who had engaged in CSLA in both waves scored better on all three outcome measures).

The findings suggest, therefore, that starting such activity can be beneficial. Thus, our findings repeat in natural community settings what was essentially found in the clinical trials that were reviewed earlier. As recalled, the ACTIVE trials demonstrated that cognitive training was associated with better cognitive abilities up to 5 years following the training (Gross et al., 2013; Willis et al., 2006). Our analysis shows, correspondingly, that even self-initiated cognitive stimulation is related to better cognitive performance at follow-up.

A few limitations of the current study should be noted, nevertheless. First, the cognitive activity variable included word games and Sudoku within a single probe. Thus, the relative contribution of each separate activity could not be assessed. However, this is a minor issue insofar as most studies in this domain combine these activities with other activity measures. The current study is unique, therefore, in that it relates exclusively to these CSLAs. A second limitation stems from the fact that data were available for two waves only. Inclusion of more waves of observation will allow more diversified inquiry into cognitive decline trajectories and their CSLA correlates. This will become possible when future waves of SHARE will be released for public use. A third possible limitation is related to the fact that the CSLA data were self-reported. Although we assume that the reporting was accurate, based upon extensive interviewer training, the potential for over- or under-estimation of self-reported data must be noted as a caveat.

The limitations notwithstanding, the current analysis has several strengths. First, it is based upon longitudinal data. Second, it employs a large community-dwelling sample that allows consideration of different patterns of engagement in CSLAs in relation to subsequent cognitive function. Third, it controls for social network ties, the lack of which might also impact cognition (Hertzog et al., 2008).

In sum, as populations age and life expectancies increase, there is growing concern among professionals, as well as among the public at large, about the quality of late life. One key area of worry in this regard is the maintenance of cognitive function. Consequently, the question as to whether cognitive decline can be delayed or reduced has important implications for aging well. The results of the present study document that CSLAs are significantly related to better cognitive function in older age. Moreover, they can constitute a potential source for the delay or reduction of cognitive decline, even after a short period of engaging in such activities and regardless of one's age. As such, practitioners should recognize the value of CSLAs and encourage their adoption and their expansion in appropriate settings.

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