Leisure practice and its relations to cognitive vitality for seniors attending community organizations

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Abstract:

The purpose of this study was to explore the relations between certain dimensions of leisure practice and cognitive vitality in seniors and identify which of their sociodemographic and health characteristics (SHC) are related to leisure practice. A cross-sectional analysis of leisure practice, cognitive performance, self-perceived memory and SHC was performed among 294 French-speaking Canadian seniors attending community centers (255 women, average age: 71), by multiple linear regressions and partial correlations controlled for SHC. Outcomes from the project show that the diversity of leisure was related to the Montreal Cognitive Assessment and the California Verbal Learning Test, the frequency of cognitive leisure was associated to the Stroop Test, and the frequency of social leisure showed no significant association. ''Paper and pencil games'', ''computer use'' and ''helping a sibling'' were related to various cognitive tests. Frequency of leisure (total) was related to gender and education, and diversity of leisure was related to education, age and depression. Study outcomes indicate that diversity of leisure was more related to cognitive vitality than frequency. Future studies should address leisure diversity as a way to promote cognitive vitality among seniors. Moreover, seniors' characteristics should be considered when seeking to facilitate their participation in leisure activities.

Key words: leisure, variety, diversity, seniors, cognition, promotion, community organization, vitality, frequency.

Word count : 4 560

Introduction

According to the World Alzheimer Report 2015, the number of people living with dementia will almost double by 2030, and double again by 2050 (Prince et al., 2015). Although average population age is increasing worldwide, the future increase in the incidence of dementia is projected to disproportionately affect lower and middle income countries. Considering the social (Etters, Goodall, & Harrison, 2008) and financial (Kelley, McGarry, Gorges, & Skinner, 2015) burden that dementia and other cognitive impairments represent, and the probability that it will be exacerbated in the future (Prince et al., 2015), strategies to lower the incidence of cognitive impairment in seniors are required. Preventing cognitive impairment may be the ultimate goal, but promoting cognitive vitality in healthy seniors seems to be a promising first step toward mitigating the worldwide problem of cognitive impairment upstream (Hughes, 2010). Adopting healthy lifestyle habits such as the practice of stimulating leisure activities shows promise as a way of promoting cognitive vitality (Ganzer & Zauderer, 2011) that could also protect seniors' cognitive functions (N. Scarmeas, Levy, Tang, Manly, & Stern, 2001), even in lower and middle income countries.

Leisure activities have been defined as those in which individuals participate for their own pleasure and which are independent from work and activities of daily living (Verghese, Wang, Katz, Sanders, & Lipton, 2009). Cognitive vitality is the 'development and preservation of the multidimensional cognitive structure that allows the older adult to maintain social connectedness, an ongoing sense of purpose, and the abilities to function independently, to permit functional recovery from illness or injury, and to cope with residual functional deficits' (Hendrie et al., 2006). Although certain studies have identified the benefits of leisure activities on cognition, many of these focused on leisure's preventive effects with cognitively impaired seniors (Akbaraly et al., 2009; Ertel, Glymour, & Berkman, 2008; Verghese et al., 2009; Wang et al., 2013; Zhu, Qiu, Zeng, & Li, 2017). However, some studies have been conducted among healthy community-dwelling

seniors (Dodge et al., 2008; Forbes et al., 2015; Fu, Li, & Mao, 2018), and have presented leisure activities as way to promote their cognitive vitality, which is the subject of this article.

Frequency is the most studied dimension of leisure practice. A higher *frequency* of leisure activities could increase the brain's ability to partially compensate for the cognitive decline associated with normal aging (Nikolaos Scarmeas & Stern, 2003). It has also been shown that the risk of dementia or Alzheimer's disease is lower for seniors who engage in higher amounts of leisure activities (Akbaraly et al., 2009; Karp et al., 2006; Okura et al., 2017; Wang et al., 2013; Zhu et al., 2017).

Leisure activities can also be categorized according to whether it involves cognitive, social or physical activity (Karp et al., 2006). Some studies suggest that participating in cognitive leisure activities such as crossword puzzles or reading could decrease the odds of developing dementia during the following five to 20 years (Gow, Mortensen, & Avlund, 2012; Iwasa et al., 2012; Sattler, Toro, Schönknecht, & Schröder, 2012). The protective effects of social leisure activities are more controversial (Wang, Xu, & Pei, 2012). In fact, certain studies have found no association between the engagement in social leisure activities and seniors' cognitive vitality (Akbaraly et al., 2009; Iwasa et al., 2012). Conversely, other studies have found a significant relation between engaging in social leisure activities and less cognitive decline (Fu et al., 2018; Wang et al., 2013) and a decreased risk of developing dementia (Karp et al., 2006). Finally, physical activity and cognitive vitality are closely related according to many studies (Angevaren, Aufdemkampe, Verhaar, Aleman, & Vanhees, 2008; Bherer, 2015; Wang et al., 2012), as physical activity could increase brain's vascularization and lead to better executive functions, as well as higher processing speed.

Certain *specific leisure activities* have been related to better cognitive function in seniors. For example, puzzles, traveling, mathematical activities and reading have all been associated with better performance in cognitive assessments in seniors with no cognitive impairment (Dodge et al.,

2008; Parisi, Stine-Morrow, Noh, & Morrow, 2009). Reading, going to a restaurant or theater, visiting relatives (N. Scarmeas et al., 2001), and doing crossword puzzles (Verghese et al., 2009) could also lower the risk of developing dementia.

Diversity of leisure activities – which can be defined as the number of distinct activities engaged in over a given period of time – has also been related to cognitive functioning (Leung et al., 2011). A study by Wang et al. (2013) showed that taking part in two or more types of leisure activities (e.g. social and cognitive) was associated with improvement of cognitive functions within a period of 2.4 years in seniors who were at least 65 years of age. Moreover, participating in several types of leisure activities could have a greater protective effect against the incidence of dementia compared to frequently repeating the same activity (Karp et al., 2006).

Beyond the way seniors practice leisure activities, certain studies have addressed the factors that influence their practice. For instance, a higher level of education in seniors has been associated with greater participation in recreational activities (Akbaraly et al., 2009; Lifshitz-Vahav, Shrira, & Bodner, 2017). On the other hand, depression (Okura et al., 2017) and older age have been inversely related to engaging in leisure activities (Dodge et al., 2008). These results show that various factors may influence seniors' leisure participation. These discrepancies in the level of participation are likely to influence the benefits seniors draw from leisure activities. Therefore, all of these different factors should be considered when seeking to encourage seniors to participate in leisure activities.

In summary, engaging in leisure activities seems to positively influence seniors' cognitive vitality in various ways, but depending on the frequency and diversity of leisure practice. Although it has been less studied than frequency, diversity of leisure activities also shows promise not only for preventing cognitive decline, but also for improving cognitive function. Considering its potential to induce more benefits for seniors' cognitive vitality than performing the same leisure

activity repetitively, there is a need for more knowledge about the influence of diversity of leisure activities on cognitive vitality compared to other dimensions of leisure practice. The aim of the present study was to further explore the impact of cognitive and social leisure activities on the cognitive vitality of community-dwelling seniors attending community organizations.

More specifically, the objectives of this study were to: 1) explore the associations between seniors' cognitive vitality and various dimensions of leisure practice, i.e. *frequency*, *types* (social and cognitive), *specific activities* and *diversity* and 2) identify the sociodemographic and health-related characteristics of participants that influence their practice of leisure.

Materials and methods

Our study is part of a larger research project entitled *Jog your Mind* (Laforest et al., 2017; Parisien et al., 2016)*,* which was carried out between 2009 and 2013 in Montreal (Canada). The objective of this larger quasi-experimental research project was to explore the effect on seniors of participating in a cognitive health promotion program offered by community centers. Its methodology has been described in detail in another paper (Bier et al., 2015). The present exploratory study used a cross-sectional design and was conducted using only the data of the larger research project collected at baseline.

Population and recruitment

Twenty-three community organizations from the Greater Montreal area recruited people to participate in the study according to the following criteria: 1) be 60 years of age or older, 2) speak French, 3) consent to take part in the one-year study, 4) be willing to participate in a cognitive vitality program (ten weekly meetings of two hours' duration), 5) have not previously taken part in a similar program during the last year. Self-declared cognitive impairment or a diagnosis of

cognitive impairment were the exclusion criteria. The organizations used their usual marketing strategies (e.g. pamphlets, activity program, web) to recruit participants from among their members and the surrounding senior population. This recruitment method reflected the reality of community organizations, which was appropriate for the larger study (*Jog your mind*). The limitations it brought to our cross-sectional study will be presented at the end of the discussion.

Data collection

The project was approved by the Université de Montréal's (Canada) Ethical Review Board. Initially, participants answered a telephone questionnaire administered by the research coordinator. This was followed by a one-on-one interview with a trained interviewer, on the site of each community organization involved. The participant signed a consent form and received a symbolic financial compensation.

Studied variables and measuring instruments

The instruments presented here are described in detail elsewhere (Bier et al., 2015). Unless otherwise specified, the higher the score, the better the performance.

Descriptive and control variables

Sociodemographic (age, gender, education, self-reported income, living alone) and health characteristics (self-perceived health, hearing impairment, depression) were assessed using questions from national surveys (Daveluy et al., 2000), as well as a questionnaire designed for this study. To identify depressive symptoms, the Mini-Geriatric Depression Scale (four-question version) was used (Clément, Nassif, Léger, & Marchan, 1997).

Participation in leisure activities

A modified version of the Florida Cognitive Activities Scale (FCAS) (Schinka et al., 2005) was used to document the monthly frequency of various leisure activities. The original English version of the FCAS comprises 25 questions for which the participant reports the number

of times he/she performed each activity during the past four weeks. The original FCAS showed good psychometric properties (Schinka et al., 2005). This instrument was translated into French and modified to include only cognitive and social leisure (17 items). A pilot trial was conducted by our research team among 15 seniors in order to test the adapted 17-item questionnaire, which showed moderate test-retest reliability ($r = .59$, p = .021). The score was converted into frequency of specific leisure activities (range from 0 to 28), frequency of cognitive leisure activities (range from 0 to 238), frequency of social leisure activities (range from 0 to 42) (Karp et al., 2006), total frequency (range from 0 to 476) and diversity of leisure activities (range from 0 to 17). For this present study, we did not evaluate the relationships between physical leisure activities and cognitive vitality because they have been thoroughly described in another paper (Desgagnés-Cyr et al., 2015).

Cognitive vitality

Cognitive abilities

In order to measure cognitive abilities, three assessment tools were used: the Montreal Cognitive Assessment (MoCA) (Nasreddine et al., 2005), the Stroop test (Golden, 1978), and the California Verbal Learning Test II (CVLT) (Delis, Kramer, Kaplan, & Ober, 2000).

The MoCA is composed of 13 items (e.g. copy a cube, repeat a sentence) assessing global cognitive function (range from 0 to 30). A score under 26 indicates that the person may have cognitive impairments.

The Stroop test assesses abilities related to inhibition. For this test, we used the third subtest, for which the time required to complete the task is measured as an indicator. The participant is presented with a list of color names, most written in a color different from the one they represent. To complete the subtest, the participant must name the color in which the color names are written

as quickly as possible (e.g. 'green' is the answer for the color name 'red' written in green). A shorter completion time means a better performance.

The CVLT-II is used to assess verbal memory and learning skills. The 'learning curve' item involves the immediate recall by the participant of a list of 16 words that is repeated 5 times (range from 0 to 80). The 'retention' item involves testing the delayed recall of the list of 16 words from the first item after the participant has recalled another list of words that was used as a distractor (range from 0 to 100), and the 'semantic' item assesses the use of memory strategies (e.g. grouping words that are fruits) to recall words (range from 0 to 4).

Cognitive efficiency in daily living

The Rivermead Behavioural Memory Test (RBMT) (Wilson, Cockburn, Baddeley, & Hiorns, 1989), in its French-language version validated by Vanier (1994), was used to assess memory from an ecological perspective. This test consists of 12 everyday memory tasks, such as recognizing names, faces, a story or a path. The score ranges from 0 to 24.

The Multifactorial Memory Questionnaire (MMQ) (Troyer & Rich, 2002), translated and validated in French by Fort, Adoul, Holl, Kaddour, and Gana (2004), assesses the participant's perception of his/her own memory skills. The questionnaire comprises 20 questions, such as: 'Do you happen to forget to pay a bill in time?' in which the person answers from zero (never) to four (always). The score ranges from 0 to 80. A higher score indicates poorer performance.

Finally, participants were asked to indicate how they perceived their own memory on a scale designed for the study that ranged from one (very bad) to ten (perfect).

Statistical analysis

Univariate analyses were carried out to describe the sample, identify potential outliers and verify the normality of distributions.

Objective 1 (Explore associations between cognitive vitality and dimensions of leisure activities): Given the sample size constraints and exploratory nature of the study, multiple linear regression were computed to explore the associations between 'results variables' such as cognitive abilities or cognitive efficiency in daily living, and 'explanatory variables' related to leisure activities (frequency, diversity). The frequency of leisure activities was considered according to types (cognitive/social). Partial correlations were used to explore the associations between specific leisure activities and cognitive vitality. The multiple linear regressions and partial correlations were controlled for sociodemographic and health characteristics (age, gender, education, self-reported income, living alone, self-perceived health, hearing impairment, depression).

Objective 2 (identify the participants' characteristics that influenced participation in leisure): Partial correlations were used to analyze the associations between participation in leisure (total frequency and diversity) and sociodemographic and health characteristics. In each of the eight correlations, the data were controlled for the seven other sociodemographic and health characteristics.

Results

Characteristics of participants

A total of 294 seniors were enrolled in the study. The sample included a majority of women (87%) and 97 % of the participants spoke French as their first language. The average age was 71 years (SD = 7.3) and the average number of years of education was 13 years. When participants were asked to rate their own memory capacity on the numeric scale designed for the study, an average of 5.6/10 (SD = 2.7) was obtained. The sample's characteristics are presented in Table 1.

Table 1: Characteristics of participants

	n=294	
	Mean (SD)	n (%)
Sociodemographic data		
Age (years), mean	71.0 (7.3)	
Education (years)	12.5 (3.7)	
Sex (female)		255 (86.7)
Mother tongue (French)		286 (97.3)
Economic resources perception		
At ease or sufficient income		273 (92.8)
Poor or very poor		19 (6.5)
Living alone		180 (61.2)
Health data		
Health perception		
Excellent, very good or good		247 (84)
Passable or bad		46 (15.7)
Symptoms related to depression (score: 1-4 / 4)		59 (20,1)
Hearing impairment (yes (1) or no (0))	7.2 (8.4)	247 (84)
Cognition		
California Verbal Learning Test		
Learning Curve	47.1 (12.4)	
Retention	85.6 (25.2)	
Semantic	1.1 (1.3)	
Memory perception (1-10)	6.8 (1.5)	
Montreal Cognitive Assessment (MoCA)	25.7 (3.4)	
Multifactorial Memory Questionnaire	23.5 (10.2)	
Rivermead Behavioural Memory Test (RBMT)	20.1 (3.5)	
Stroop Test	151.3 (51.7)	

Table 2 shows the data related to the participants' practice of various leisure activities in the past four weeks. On average, participants engaged in cognitive leisure on 84 occasions (SD = 34.5) and in social leisure on 12 occasions (SD = 13.0) each month. The most frequently practiced specific activities were: 'read newspapers, books or magazines' and 'using the computer'. Regarding the diversity of leisure activities, results indicated that the sample took part in an average of 8 different activities each month (SD = 2.5).

Table 2: Particpants' leisure activities

Frequency of participation within the last 28 days	Mean (SD)
Cognitive activities	
1. Knowledge games or board games	2.8 (6.3)
2. Crossword puzzles, sudokus and other paper and pencil games	11.5 (12.4)
3. Watch news reports or quiz programs on television	12.2 (10.4)
4. Read newspapers, books or magazines	23.2 (9.3)
5. Write a letter	2.1 (5.3)
6. Do original art or craft work	4.0 (8.3)
7. Cook new recipes	2.6 (4.7)
8. Take a class, attend a conference	1.7 (3.6)
9. Software to enhance memory	1.8 (6.4)
10. Computer	14.6 (13.0)
11. Cultural activities	2.2 (3.3)
12. Renovation or decoration projects	1.3 (3.2)
13. Try new routes (walking or driving)	2.9 (5.6)
14. Play a musical instrument	0.9 (3.9)
Total	83.6 (34.5)
Social activities	
15. Volunteering	3.2 (6.7)
16. Help a sibling	7.2 (9.1)
17. Take part in a group	1.8 (4.3)
Total	12.1 (13.0)
Total frequency	88.5 (36.2)
Diversity (0-17/17)	7.7 (2.5)

Objective 1: Relation between leisure dimensions and cognitive vitality

Results of regression models including leisure and cognitive variables are presented in Table 3. With regard to activity types, *frequency* of social activities was not related to any cognitive vitality test. However, *frequency* of cognitive activities was significantly correlated with inhibition abilities (Stroop) (β= -.19, p =-.05*).

Three specific leisure activities were significantly correlated to some variables pertaining to cognitive vitality (see Table 4 for results). Engaging in 'paper-and-pencil games' was associated with a better perception of memory skills (r = .14, p = .022) and stronger inhibition skills (Stroop) (r = -.17, p = .005). 'Computer use' was also correlated with performance on tests assessing memory in everyday living contexts (RBMT) (r =.13, p = .041), global cognitive function (MoCA) (r = .18, p = .004) and inhibition abilities (Stroop) (r = -.19, p = .002). Finally, 'helping a relative' was associated with a better perception of one's own memory (r = .15, p = .01) and memory abilities (MMQ) (r = -.15, p = .015).

A greater diversity of leisure activities was related to better global cognitive function (MoCA) (β = 0.28, p = .004) and verbal memory (CVLT-Learning Curve) (β = 0.97, p = .006).

Table 3. Regressions between cognitive variables and participation in leisure activities

Outcome variables	Complete model [a]		
	Standardized Coefficient β (p)		
	Frequency cognitive activities [b]	Frequency of social activities [b]	Diversity of activities
Cognitive abilities			
MoCA (n=291)	.0040 (.53)	.0078 (.57)	**.28 (.004)**
Stroop* (n=286)	**-.19 (.050)**	-.11 (.60)	-2.06 (.17)
CVLT-Semantic (n=280)	-.001 (.57)	.007 (.22)	.046 (.25)
CVLT-Retention (n=280)	-.027 (.61)	-.051 (.66)	1.31 (.10)
CVLT-Learning Curve (n=290)	.023 (.30)	.0094 (.85)	**.97 (.006)**
Cognitive efficiency in daily living			
Multifactorial Memory Questionnaire* (n=290)	-.016 (.48)	-.015 (.74)	.26 (.43)
Rivermead Behavioural Memory Test (n=290)	.00083 (.90)	.014 (.33)	.16 (.12)
Perception of memory (n=289)	.068 (.35)	.055 (.36)	.084 (.27)

[a] Model adjusted for age, gender, living alone, years of education, self-reported socio-economic status, perceived health status, depression, hearing impairment.

[b] The first line for a given outcome is a model including frequency of social and cognitive activities and diversity of activities.

Regressions with a p < .10 are in italics and those with a p < .05 are in bold.

* A negative relationship means better performance on the Stroop and MMQ tests.

Table 4: Relationships between specific leisure activities and cognitive vitality (partial correlations)

n = 281	*Cognitive abilities*					*Cognitive performance in daily life*		
	MoCA	Stroop	CVLT - Learning	CVLT - Retention	CVLT - Semantic	MMQ	RBMT	Perception of memory
	r (p)	r (p)	r (p)	r (p)	r (p)	r (p)	r (p)	r (p)
Knowledge or board games	.097	-.003	*.117*	.007	.009	*.110*	-.016	.050
	(.116)	(.968)	*(.058)*	(.912)	(.886)	*(.073)*	(.796)	(.416)
Crossword puzzles, sudokus and other pencil games	.033	**-.172**	*.104*	.026	.026	-.066	.003	**.141**
	(.598)	**(.005)**	*(.091)*	(.668)	(.678)	(.282)	(.961)	**(.022)**
Art projects or DIY	*.110*	-.082	*.113*	.038	-.013	-.076	.097	.108
	(.074)	(.185)	*(.068)*	(.538)	(.831)	(.220)	(.118)	(.081)
Take a class, attend a conference	.047	-.036	.073	.008	*.104*	-.069	.039	-.003
	(.446)	(.565)	(.240)	(.891)	*(.091)*	(.266)	(.527)	(.967)
Software to enhance memory	.065	*-.112*	*.113*	.039	.044	.081	.067	.031
	(.294)	*(.070)*	*(.067)*	(.523)	(.479)	(.189)	(.280)	(.619)
Computer	**.176**	**-.189**	.047	.073	.025	.013	**.126**	.071
	(.004)	**(.002)**	(.451)	(.235)	(.690)	(.838)	**(.041)**	(.253)
Renovation or decoration projects	.078	-.015	.016	-.040	-.074	*.102*	-.041	*-.104*
	(.205)	(.814)	(.799)	(.516)	(.234)	*(.099)*	(.503)	*(.092)*
Help a sibling	.04	-.07	.05	.05	.05	**-.149**	.06	**.15**
	(.49)	(.23)	(.44)	(.46)	(.47)	**(.015)**	(.30)	**(.01)**

Adjusted for age, sex, living alone, years of education, self-reported socio-economic status, perceived health status, depression, hearing impairment.

Leisure activities that showed a borderline correlation (p < .10) or a significant correlation (p < .05) were included in this table.

Correlations with a p < .10 are in italics and those with a p < .05 are in bold.

* A negative relationship means better performance on the Stroop and MMQ tests

Objective 2: Sociodemographic and health characteristics' influence on participation in leisure activities

Results of correlations between sociodemographic or health variables and participation in leisure activities are presented in Table 5. The total frequency of leisure activities was significantly higher among people with more years of education (r = .19, p = .001) and in women (r = .16, p = .008). The diversity of leisure activities was significantly higher among more educated seniors, (r = .189, p = .001) younger persons (r = -.178, p = .003) and seniors with no symptoms of depression (r = -.167, p = .005).

Table 5: Participants' characteristics related to frequency or diversity of leisure (partial correlations)

	n=281	
	Total leisure frequency R (p)	Leisure diversity R (p)
Age	.065 (.276)	**-.178 (.003)**
Education	**.191 (.001)**	**.189 (.001)**
Sex[a]	**.157 (.008)**	.105 (*.078*)
Self-reported socio-economic status	.047 (.427)	-.066 (.268)
Living alone	.104 (*.082*)	.102 (*.088*)
Health perception	-.084 (.160)	-.113 (*.057*)
Symptoms of depression	-.083 (.162)	**-.167 (.005)**
Hearing impairment	.028 (.641)	-.074 (.214)

Each correlation was adjusted for the seven other sociodemographic and health factors
Correlations with a p < .05 are in bold.
[a]Women participated in more leisure activities than men.

Discussion

This cross-sectional study aimed to explore the relationship between leisure and cognitive vitality in community-dwelling seniors with no diagnosis of cognitive impairment who were attending community organizations. The following discussion will address the results for each of the objectives of the study, followed by its limitations.

Types of leisure are related to cognitive vitality

Our study found a significant association between cognitive leisure *frequency* and inhibition. A similar association was also demonstrated in a cross-sectional study conducted by Dodge and colleagues (2008) among Japanese seniors with no cognitive impairment. Some prospective studies have shown that practice of cognitive leisure activities may be associated with many cognitive functions, such as global cognition, language and executive functions (Gow et al., 2012; Wang et al., 2013). Frequent participation in cognitive leisure may act as an intensive cognitive stimulant for the brain, which could foster brain plasticity and neuron longevity, thereby promoting cognitive vitality (Karp et al., 2006). Many hypotheses could explain our finding, which would merit examination in future studies. In any case, our results show that more frequent participation in cognitive leisure activities is related to better inhibition capacities. Frequency of leisure activities is therefore related to cognitive vitality in seniors.

Conversely, frequency of participation in social leisure activities was not associated with cognitive vitality for participants involved in our study. This is consistent with the results of a systematic review (Wang et al., 2012) which concluded that only cognitive and physical leisure have a protective effect against the onset of dementia. Social leisure activities could rather have an effect on depression in healthy seniors. In two longitudinal studies (Akbaraly et al., 2009; Iwasa et al., 2012), it was demonstrated that the association between social leisure and cognition lost its

significance after controlling for depression. Therefore, the significant relation between social leisure and seniors' depressive symptoms could result in an indirect relation with seniors' cognitive vitality. In other words, by influencing the negative effects of depression, social leisure could then cause a change in cognitive vitality in seniors who attend community centers.

Specific leisure activities are related to seniors' cognitive vitality

In our study, only three *specific activities* were related to certain dimensions of seniors' cognition: paper-and-pencil games (related to self-perception of memory skills and inhibition), computer use (related to inhibition, everyday memory performance and general cognition) and helping a sibling (related to self-perception of memory skills and function in daily life). These results are in agreement with those of many other studies. In fact, crossword puzzles have been associated to better general cognition (Herrera et al., 2011), to postpone memory decline (Pillai et al., 2011) and to a lower risk of dementia (Verghese et al., 2009). Crossword puzzles have been related to adopting healthy life habits (Fratiglioni, Paillard-Borg, & Winblad, 2004) and could enhance the seniors' cognitive reserve (Stern, 2002), which could promote cognitive vitality (Fratiglioni et al., 2004). Computer use has also been related to better memory in routines of daily life (Xavier et al., 2014). The broad range of pursuits which can be accomplished with a computer could make this leisure activity even more stimulating than repetition of a single one (Karp et al., 2006). Finally, helping a sibling was significantly related to better self-perception of memory and greater confidence in memory abilities. This result is worth noting, since many studies have rather focused on the burden associated with helping a sibling, considering all the responsibilities involved (Nakken et al., 2015). Although our findings regarding this activity are relatively different, our results could be explained by those of a cross-sectional study conducted among 8966 seniors (Fu et al., 2018). In that study, volunteering was associated to cognitive function in women, who composed 87% of our own sample. In fact, the responsibilities associated with helping a

sibling could contribute to the maintenance of a feeling of self-efficacy in helpers, and therefore influence the self-perception of their memory abilities. This hypothesis would require confirmation in future studies, however.

Diversity of leisure is related to cognitive vitality

Diversity of leisure activities was associated with better verbal memory and general cognitive function in our participants. Therefore, diversity is related to more dimensions that we associated to cognitive vitality than frequency of cognitive leisure activities. This could be related to other studies that have found better maintenance of cognitive vitality in seniors who engage in more diverse leisure activities (Karp et al., 2006; Leung et al., 2011). A larger variety of leisure activities could entail greater novelty, and expose seniors to more cognitive stimuli than repeated practice of the same activity (Hultsch, Hertzog, Small, & Dixon, 1999; Wang et al., 2012). Our cross-sectional design can only identify   associations between cognitive vitality and diversity. In any case, the fact that diversity is the dimension of leisure most related to cognitive vitality in our study, and that other longitudinal studies have shown stronger associations between diversity of leisure and cognitive vitality compared to frequency of leisure, lead us to hypothesize that diversity of activities should be emphasized for seniors attending community centers who wish to promote their cognitive vitality through leisure.

Personal factors influence participation in leisure

In our study, higher education and female gender were related to a higher total frequency of leisure activities (cognitive and social types). Regarding diversity of leisure, a positive relation with education and negative associations with age and symptoms of depression were found.

Regarding the impact of the level of education, Lifshitz-Vahal et al. (2017) and Akbaraly et al. (2009) have reported a higher frequency of cognitive leisure in more educated seniors. As education level positively influences salary (Institut de la statistique du Québec, 2012), more

educated seniors usually have a higher income. This higher income could allow more educated seniors to participate in certain leisure activities that may be too expensive for lower-income seniors, thereby fostering frequency and diversity of leisure participation. Higher education could also be related to lower stress levels, which would also facilitate involvement in recreational activities (Ross & Zhang, 2008).

The discrepancies between the experiences of men and women in leisure activities have also been addressed by Agahi and Parker (2008). In their study, men who demonstrated greater cognitive health engaged frequently in solitary leisure activities (i.e. gardening), while among women, frequent social activities seemed more strongly related to better health status. However, as our study involved a large majority of women, our results are likely to be biased toward them, and should therefore be interpreted with caution.

Older age was related with a significant decrease in frequency of engaging in leisure activities in at least one study (Dodge et al., 2008). Age-related decline of physical capacities (e.g. decreased walking speed and mobility) could gradually impede participation in leisure activities, especially when they involve walking outside (Latham et al., 2003). This may explain why older participants in our study showed a lower diversity of leisure activities compared to younger ones.

Depression has been related to a lower participation in leisure, especially the social type (Dodge et al., 2008; Okura et al., 2017). As features of depression include a loss of interest in most activities (American Psychiatric Association, 2013), it could lead seniors to disengage from familiar leisure activities or not attempt new ones. Moreover, considering that social leisure activities often involves leaving one's home and interacting with others, depressive people may be discouraged from taking part in these activities and favor pursuits that are mostly individual, such as the cognitive type. Symptoms of depression are thus likely to reduce the diversity of leisure in seniors attending community organizations.

In summary, our results show which seniors attending community organizations are less likely to participate in leisure activities. More precisely, seniors of male gender, who are less educated, older or show symptoms of depression are less likely to participate in leisure. Considering past research, these seniors are therefore less likely to promote their cognitive vitality by engaging in leisure activities. In order to foster participation in leisure for a wider range of seniors, new initiatives should address their needs.

Strengths and limitations

This study was conducted among 294 seniors who were recruited by 23 community organizations, including 255 women (86,7%)., The community groups managers used their usual recruitement strategies, which contributed to the representativeness of our sample in regard to the population of seniors who attend community organizations. Indeed, according to our community group partners, women are often overrepresented in their activities. Nevertheless, this sample migth misrepresentant some segments of the senior population, namely men, people with low litteracy, and seniors from different cultural background. This was discussed in another paper (Lorthios-Guilledroit et al., 2018). However, participants who were recruited had an interest in participating in a group to promote cognitive vitality. This may have fostered greater participation among seniors with worries or problems related to their cognitive vitality, and therefore lowered performance outcome on cognitive tests. This could explain the significant proportion of participants (40 per cent) whose performance in the MoCA was below the cut-off score. On the other hand, many variables were measured and controlled for in each participant, and the inclusion and exclusion criteria were clearly stated, in order to minimize the selection bias. Therefore, our results may be generalized with caution to the specific population of seniors attending community organizations.

Finally, the use of a cross-sectional design for this study only allowed us to establish associations between leisure activities and participants' cognitive performance. We considered this

in interpreting our analyses, and no direct causality was assumed. Moreover, each of our hypotheses was clearly identified and supported by relevant studies.

Considering the exploratory nature of our study and the limits of the methodology, the fact that our results show significant associations between diversity of leisure and cognitive vitality shows the relevance of the subject and the potential to obtain significant and more important results in the study of the relations between leisure and seniors' cognitive vitality.

The present study showed that diversified practice of leisure activities and frequent participation in cognitive leisure activities are related to specific components of cognitive health in community-dwelling seniors who attend community organizations, even when sociodemographic and health characteristics are controlled. The subject of diversity of leisure in relation to cognitive vitality should therefore be the object of future studies. In order to promote cognitive vitality in seniors, diversity of leisure should be emphasized first, followed by the frequency of cognitive leisure. In seniors who only engage in one activity, some specific leisure such as paper and pencil games (e.g. crossword puzzles) and computer use seem to be related to particular components of cognitive vitality and should therefore be favored. Lastly, this study highlighted that education and gender can influence the participation of seniors in leisure. However, further studies using diversified samples and prospective methodologies are necessary in order to thoroughly analyze the impact of leisure on cognitive vitality. These studies could increase the specificity of recommendations for promoting cognitive vitality through the practice of leisure, to the benefit of seniors all around the world.

Declaration of interest statement

No conflict of interest was reported by the authors.

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Tables