Mild cognitive impairment in older adults: the role of cognitive reserve and resilience

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Research article

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Abstract

Background

Positive ageing amid of age-related neurodegeneration is a global challenge. The present study examined whether psychological resilience can be a protective factor among older adults.

Methods

The participants were 233 community-dwelling older individuals with or without mild cognitive impairment (MCI). They completed testing on resilience and the cognitive reserve proxies. Hierarchical logistic regression was conducted to test the hypotheses of the present study.

Results

After controlling for age and the cognitive reserve proxies, resilience ($b = -0.38$) and resilience × visuospatial function significantly predicted MCI group membership ($ps < 0.05$). There are two new findings. First, higher level of resilience in addition to the conventional cognitive reserve proxies predicted lower MCI risks. Second, MCI participants with higher level of resilience had significantly higher visuospatial ability than their lower level counterparts.

Conclusions

These findings raise the question of whether resilience should be considered as a cognitive reserve proxy. It also calls for future research to enhance the level of resilience in older adults for healthy ageing.

Background

According to World Health Organization, 16% of the world population will reach the age of 65 years or older by 2050 [1]. Age-related neurodegenerative diseases (e.g., dementia) has imposed an enormous burden on the health care system [2]. Promotion of healthy ageing is a key agenda embraced in the society. Better understanding of the protecting factors which slow down degeneration might help designing interventions for promoting heathy ageing in older adults. Cognitive reserve is a common construct theorizing neurodegeneration in older adults [3-6]. It is the ability to actively make flexible and efficient use of brain reserve that is available in the performance of tasks [5].

Proxies of cognitive reserve include education, intelligence, memory, visuospatial function and literacy [3, 7-11]. Among these variables, visuospatial ability has been recently revealed to be more sensitive to age-related decline when compared to other cognitive abilities such as verbal component of working memory [12, 13]. For instance, Suri et al. reported that visuospatial memory was significantly related to the resting state hippocampal-parietal and motor-parietal interactions in older adults [14]. As the atrophy in the hippocampal region is hallmark of Alzheimer's Disease [15-17], investigating the decline in visuospatial function and its relationships with other variables would help build a more robust model of cognitive reserve for neuroprotection in older adults [3, 18, 19].

Besides visuospatial function, another construct which is the focus of this study is psychological resilience. Classic diagnostic criteria of mild cognitive impairment (MCI) appear to bias towards cognition such as the adoption of self-report cognitive decline and objective cognitive measure [20-22]. This prompts the question, would psychosocial construct such as resilience presently not included as a criterion for MCI as well as cognitive reserve is protective of MCI? Recent studies reported that higher level of resilience related to reduced mortality risk in older adults [23-28], better self-perceptions of ageing [24, 27, 29], and improved quality of life in older adults [23-25, 28, 29]. Resilience has been rephrased as “the process of adapting well in the face of adversity, trauma, tragedy, threats, or significant sources of stress, or ‘bouncing back’ from difficult experiences” [30]. This definition has been supported by the evidence that those with high resilience were found to more readily adapt to chronic illness and traumatic disabilities than those with low resilience [31]. The Connor-Davidson Resilience scale (CD-RISC) is a measure of resilience relevant for use in a variety of individuals including older adults [29, 32]. Resilience has an age-related characteristic as previous studies revealed that older adults had significantly higher level of resilience than younger adults especially with respect to emotional regulation and problem solving [26, 33, 34]. As suggested by Gooding et al. [26], the higher level of resilience in older adults might be due to the development of more effective coping strategies when compared to the younger adults. Nevertheless, these results indicated the differential psychological processes underlying resilience across the lifespan. Given that individuals diagnosed as MCI could have experienced feeling of incompetence, adversity, and trauma, resilience may play a protective role by deploying the compensatory strategies to boost cognitive abilities and prevent them from developing pathological symptoms.

Compensation due to functional decline is a common phenomenon in older adults, and the posterior-anterior shift (or called PASA) occurs in combating age-related cognitive decline. According to PASA, physiologically, compensatory mechanism has been supported by the ability in older adults on recruiting new brain networks for maintaining the originally declined performances [35, 36]. Yet, visuospatial function, resilience, and their relationships with cognitive reserve in MCI have not been studied. The present study was aimed to investigate how resilience and visuospatial function, in the context of cognitive reserve, can modulate age-related neurodegeneration. It was hypothesized that higher resilience would predict lower risks of MCI in community-dwelling older adults. Resilience would have comparable contributions to the lower risks as the three cognitive reserve proxies - years of education, intelligence and visuospatial function. In addition, it was hypothesized that there would be interaction effect of visuospatial function and resilience in predicting MCI. Findings of this study will enrich the construct of cognitive reserve in defining neurodegeneration as well as the potential of resilience to be a factor for enhancing positive ageing.

Materials And Method

Participants

Invitation leaflets were delivered to older adult members of different community organizations with more than 2000 members having a variety of demographic background (e.g., living in different districts in the city) for subject recruitment. Two hundred and thirty-three community-dwelling older adults were recruited from these community organizations on a voluntary basis. Their mean age was 64.9 years (S.D.= 3.8 years; range= 60 to 79 years; 32.6% males). The average years of education were 13.0 (S.D.= 4.1). The age and years of education were significantly different between the healthy and MCI participants ($ps< 0.05$) (Table 1). All participants were with normal or corrected-to-normal visual and auditory function. The participants with a history of cognitive impairments (e.g., dementia, head injury, and cerebrovascular disease) and depression were excluded from the study.

“Insert Table 1 here”

Data Collection Procedures

Age, sex, years of education, and independence in daily activities - personal hygiene and car, locomotion in the home, meal preparation, running errands, housework and finances of the participants were obtained by means of intake interview. Hong Kong version of the Montreal Cognitive Assessment (MoCA-HK) was administered to each participant for assessing their visuospatial and executive functions, naming, attention, language, abstraction, delayed recall, and orientation functions [37]. The diagnostic criteria for participants classified as the MCI group (specifically for Chinese individuals with seven or more years of education) included: 1) MoCA score of 24 or below [38]; 2) self-reported independence in daily living activities; and 3) self-reported cognitive decline [20-22]. Those who scored 25 or higher on MoCA-HK were classified into the healthy control group. These diagnostic criteria were adopted from a recent study by the author [20] and other previous studies by other researchers [21, 39, 40].

All participants completed measures for assessing their cognitive reserve –intelligence and executive function, short-term memory and visuospatial ability, and the CD-RISC for resilience function. All participants were able to understand the assessments administered in the present study.

Intelligence and executive function were assessed by Test of Nonverbal Intelligence (TONI-3) which taps on participant's aptitude, intelligence, abstract reasoning, and problem solving in a language free format [41]. Short-term memory was measured by the immediate story recall subscale of Rivermead Behavioural Memory Test—Third Edition (RBMT–3)- Chinese version [42]. This RBMT subscale taps on participants' short term memory and the Chinese version has been validated. Visuospatial ability was measured by Judgment of Line Orientation (JLO) [43]. In this test, participant was asked to discriminate the direction of lines in 30 items. In each item, participants saw a pair of lines on a page and was to estimate the inclination of the pair of lines by using another page with 11 lines (numbered from 1 to 11) as a reference. Each line is separated by an angle of 18 degrees. The CD-RISC is a 10-item self-report scale tapping on participant's ability to thrive in the face of adversity, adaptability when coping with change, social problem solving skills, humor in the face of stress [44]. It showed good reliability in the present study (internal consistency= 0.90). Previous studies also reported CD-RISC had one of the best psychometric ratings in adults [45]. Based on the CD-RISC median score of 28, participants in this study were further classified into the lower resilience (<= 28) and higher resilience groups (> 28) for examining possible moderation effect of resilience on the diagnosis of MCI (see Figure 1).

"Insert Figure 1 here"

Statistical Analysis

Pearson's correlation was used to examine the relationships among the major variables at the total and subgroup levels. Independent t-test was conducted to compare the differences in the major variables between the higher and lower resilience among the participants. Hierarchical logistic regression was conducted for predicting participants' group members (MCI versus healthy) by the cognitive reserve proxies and resilience variables. The four blocks in the model were: age in block 1; years of education in block 2 with scores of TONI-3, RBMT-story recall and JLO as the covariates; score of CD-RISC as the covariate in block 3; the interaction effects in the preliminary model as the covariate in block 4. Significant moderating factor(s) was tested between the higher versus lower resilient subgroups (based on median split CD-RISC scores). All analyses were conducted using SPSS 25.0 and statistical significance were set at p = .05 (2- tailed) [46].

Results

Among the total sample, 35 participants (15.0%) fulfilled the diagnostic criteria for being classified in the MCI group. The other 198 participants (85.0%) were classified in the healthy group. Mean ages for the healthy and MCI groups were 64.6 (S.D.= 3.7 years) and 66.7 years (S.D.= 3.9 years), respectively. The average years of education for the two groups were 13.4 (S.D.= 4.0 years) and 10.4 (S.D.= 4.2 years), respectively (Table 1). With the entire sample (N= 233), age of participants was significantly and negatively correlated with all variables of interest except scores of CD-RISC and RBMT-story recall (rs= -0.17 to -0.29, ps<= 0.01). Significant and positive associations were found among the four cognitive reserve proxies (years of education, TONI-3 score, RBMT- story recall score and JLO score) and participants' MoCA score (rs= 0.26 to 0.41, ps<= 0.001). Moreover, scores of CD-RISC were positively and significantly related to those of TONI-3, JLO, and MoCA (rs= 0.16 to 0.18, ps<= 0.050) (Table 2).

"Insert Table 2 here"

Among the MCI participants, score of resilience was significantly correlated with JLO score (r=0.56), TONI-3 score (r=0.43), and MoCA score (r=0.35) (Table 2). These contrast with the healthy participants of which all correlations between resilience and other three cognitive function variables were not significant (ps< 0.05). To further explore the resilience × JLO interaction effect, median score 28 of CD-RISC was used to divided the MCI and healthy groups into higher and lower resilient subgroups (Figure 1). Among the MCI participants, those with higher resilience scores performed significantly better on the JLO than those with lower resilience score ($t(33) = -2.99$, $p = .005$). No significant differences in terms of MoCA, TONI-3, RBMT-story recall scores were revealed between the MCI higher and lower resilience subgroups. In contrast, there were no significant JLO score difference between the two healthy subgroups ($t(196) = -1.36$, $p = .174$). MoCA, TONI-3, RBMT-story recall scores also did not significantly differ between these two subgroups ($ps > 0.05$). By comparing the four subgroups (healthy participants with high or low resilience scores, and MCI participants with high or low resilience scores), the two subgroups of healthy participants had higher MoCA scores than both MCI subgroups respectively ($ps < 0.001$). As for the JLO performance, two healthy subgroups and the MCI participants with high resilience scores had higher scores than the MCI participants with low resilience scores ($ps < 0.01$). Moreover, significant positive correlation was found for JLO and MoCA score in the higher resilient participants but not the lower resilient ones in both pairs of subgroups (MCI: higher: $r = 0.56$, $p = .026$; lower: $r = 0.08$, $p = .742$) (Healthy: higher: $r = 0.27$, $p = .005$; lower: $r = 0.14$, $p = .193$).

Logistic regression analyses

Significant associations were found among age, years of education, RBMT- story recall score, TONI-3 score, JLO (Judgment of Line Orientation) score, resilience score, and resilience × JLO ($\chi2(7) = 41.46$, $p = <.001$). The overall logistic regression equation in predicting participants' MCI membership was (p= 1/ (1+ exp [-(b1*age + b2* years of education + b3*TONI-3 + b4*JLO + b5*RBMT-story recall + b6*resilience + b7*resilience x JLO + b0)]. Significant predictors of participants' MCI memberships in the overall regression model after the control of age (b1 = 0.05, s.e. = 0.06, p = .356, OR = 1.05) were: years of education (p = .035, OR = 0.87), TONI-3 score (p = .004, OR = 0.91), JLO score (p = .051, OR = 0.64), RBMT- story recall score (p = .045, OR = 0.86), resilience score (p = .028, OR = 0.68) and resilience × JLO (p = .030, OR = 1.02) (Table 3). In block 1, age significantly predicted MCI membership (p = .004) accounting for 6.2% of the total variance. The years of education (p = 0.006) and TONI-3 (p = 0.015) in block 2 were significant predictors explaining an additional 19.7% of the total variance. No significant gains in the prediction was observed in the block 3. The significant variables in blocks 2 and 3 together with the score of resilience (p= .028), resilience × JLO (p= .030), and RBMT- story recall (p = 0.045) entered into block 4 accounted for a total of variance of 29.5% for classifying MCI membership. The total model yielded an accuracy of 86.2% predicting MCI versus non-MCI memberships.

"Insert Table 3 here"

Discussion

The present study examined psychological resilience together with the conventional cognitive reserve measured as protective factors of neurodegeneration in a sample of community-dwelling older individuals. Major findings are that higher level of resilience and cognitive reserve significantly predicted lower risks of MCI. More importantly, resilience appears to be a stronger predictor of MCI after controlling for the age and cognitive reserve variables. These findings suggest that in addition to conventional cognitive reserve, resilience may play an equally important role in lowering the risk of MCI in older adults. Resilience was found to correlate moderately with all the cognitive functions except short term memory function specifically in MCI older adults. Among them, the strongest relationship was with visuospatial function which was measured by JLO ($r= 0.56$, $p< 0.001$) in the present study. The results support the notion that resilience could be a facilitating factor enhancing higher cognitive functions in the participants with MCI. It is plausible that such enhancement would have been the effect of increase in motivation and deployment of compensatory strategies amid the neurodegeneration experienced by these individuals.

Resilience as the neuroprotective factor of MCI

Resilience has been revealed to play a role in positive ageing [47]. Behaviorally, older adults with higher resilience were more likely to be independent in activities of daily living [48], and have better adaptive coping styles [49], better health outcomes and mental well-being [50, 51], as well as reduced cognitive failures [52]. Different from previous studies focusing on conventional cognitive reserve proxies [3, 7-11], findings of this study indicate that resilience apart from the conventional cognitive reserve proxies were associated with lower risks for MCI. An increase in one unit of the cognitive reserve proxies would decrease the odds of MCI by 0.64 to 0.91 suggesting that increased levels of cognitive reserve proxies reduce the risk of MCI. More importantly, there would be a decrease of the odds of MCI by 0.68 for a point increase of resilience indicating that the more resilient the less chance of MCI. Moreover, the combined variances of the MCI diagnosis explained by the cognitive reserve proxies and resilience were 19.9%. The findings support the notion that resilience could be a protective factor enhancing higher cognitive functions in the individuals with MCI. As resilience is related to general flexible, compensational and adaptive coping ability in the face of adversity, the "declining" brain reserve would have been regarded as the adversity in older adults and hence they incline to efficiently and flexibly adapt to the task demands [35, 36]. Besides, resilience has been reported to exert a significant top-down effect for influencing one's flexibility in behaviors. Such effect therefore would have been general rather than specific for benefiting older adults particularly those experiencing an overall decline in cognitive functions. Our proposition is supported by previous studies on resilience in healthy ageing. For instance, Genet and Siemer stipulated that cognitive flexibility and flexible affective processing were associated only with trait resilience but not other trait measures including extraversion and neuroticism [53]. Moreover, it was found that resilience significantly contributed to the critical proximal factors such as work and social engagement which are important for healthy ageing in older person with multiple sclerosis [54]. Taken these altogether, the enhancement in cognitive functions induced by resilience may potentially be due to the effect of increase in motivation and deployment of compensatory strategies amid the neurodegeneration in these individuals.

Resilience and cognitive functions in MCI

Resilience moderating the visuospatial ability among the MCI participants is a new finding. The results suggest that the MCI participants who had higher level of resilience had significantly better visuospatial ability than those with lower level of resilience. Such differences were not observed among the healthy older participants. Besides visuospatial function, in both the MCI and healthy groups, participants with higher level of resilience also had significantly higher intelligence, executive function and other cognitive functions. The results on healthy controls are consistent with those reported in previous studies. For instance, Lamond et al. [52] reported that resilience had a positive impact on the cognitive functions which included more self-rated successful ageing and fewer cognitive complaints in a group of healthy older adults. No study however has been reported in individuals with MCI. However, why visuospatial ability was the only cognitive function that was impaired in the MCI participants with the present data. In this study, visuospatial function was measured with JLO (judgement of line orientation). The test items of JLO are characterized with the fine-grain spatial discrimination required in the participants. A participant was required to match the orientation of a pair of lines to a set of 11 lines with 18 degrees separated from each other. The extent of differences and similarities between the source and target were manipulated. The smallest differences in the angle can be as little as less than 18 degrees [43]. Making a correct response would need the participant to encode the orientation of the lines, holding the spatial information in visual working memory, and appraise the orientation of the pairs of lines for matching. The task demands as described herein would have been novel and more challenging to the MCI participants when compared with other cognitive measures which is in line with prior finding that visuospatial impairment might be an independent sign of MCI and other neurodegeneraitve diseases [51]. Lesions in the posterior parietal cortex that are unique to amnestic MCI individuals [55] match with the neural substrate that is associated with the poor performance on JLO [56]. The challenges posed by the JLO to the MCI participants could have been perceived as “adverse” and hence those with higher resilience would have responded in adaptive ways. The underlying mental strategies deployed and hence the underlying mechanisms for explaining the observed phenomena are beyond the scope of this study. Future research is needed to explore these two aspects. Taken all these findings together, the assessment and treatment planning for MCI individuals are suggested to take cognitive reserve and resilience into considerations.

Not only that the present research findings have theoretical implications, they can be translated to clinical strategies for enhancing neuroprotection in older adults with MCI. Specifically, a few existing interventions found effective for improving the level of resilience in younger adults [57] and children [58] can be considered for adapting to address the characteristics and the needs of older adults. For instance, the Coherence Advantage Training is a program for building the capacity to recognize and self-regulate responses to stressors in both work and personal contexts for police officers in the United States [57]. The training program was revealed to effectively enhance the physiological and psychological recovery from stressors in the participants. This program includes learning what resilience is, practicing self-regulation of emotion, and integrating alternative cognitive strategies into daily life. Relevant to visuospatial function and older adults with MCI is to explain the processes underlying the decline in the function and how such decline would become a stressor in individual's daily life, such as recalling where objects are organized in a cupboard. Resilience training, strengthening the adaptation process, involves learning to accept the decline in one's ability to decode the relative positions of objects in the cupboard. Instead of indulging in the frustrating emotion, older adults learn the use of semantic method to register the objects and contextualize the objects for easier memory recall. Future study will employ evidence-based practice approach for adapting other resilience training programs for improving older adults' resilience which in turn decreases their risk of cognitive decline progressing into MCI.

Limitations and future directions

The present findings revealed resilience as the significant protective factor of MCI in older adults. However, this study suffered from a number of limitations which should be addressed in future studies. First, the findings were based on cross-sectional data which did not take the temporal factor and it may influence the relationship between cognitive reserve, resilience and cognitive impairment. For instance, Netuveli et al. found that resilience was positively related to age [33]. Second, the present study only assessed four proxies of cognitive reserve. Future studies are suggested to take a broader perspective in understanding the cognitive reserve by investigating more proxies such as long-term memory. Third, since MoCA is to detect possible MCI, future studies should also consider using a comprehensive neuropsychological battery to address the cognitive status of the participants. Last but not least, the present study only focused on cognitive reserve but not brain reserve. Future studies are suggested to investigate the interaction between cognitive reserve and brain reserve in the prediction of MCI.

Conclusions

The present study examined the predictive effect of conventional cognitive reserve and psychological resilience on the risks of MCI in older adults. The present findings suggest that in addition to conventional cognitive reserve, higher level of resilience predicts less risk of MCI in older adults. Higher level of resilience enhances the visuospatial ability in the people with MCI and such effect is not observed in healthy controls. It is worthwhile to consider including resilience as part of the cognitive reserve for describing neurodegeneration in older adults. The present findings offer insight into exploring of the mechanism behind resilience as a modulating factor of early neurodegeneration as well as designing assessment and intervention for the MCI individuals.

Abbreviations

CD-RISC: The Connor-Davidson Resilience scale; JLO: Judgement of Line Orientation; MCI: Mild Cognitive Impairments; MoCA-HK: Hong Kong version of the Montreal Cognitive Assessment; PASA: posterior-anterior shift; TONI-3: Test of Nonverbal Intelligence; RMBT-3: Rivermead Behavioural Memory Test - Third Edition

Declarations

Ethics approval and consent to participate

Ethical approval was provided by the Research Committee at the affiliation of one of the authors. All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed written consent form

Participants’ written informed consent was obtained.

Consent for publication

All authors have contributed to the work, agree with the presented findings, and that the work has not been published before nor is being considered for publication in another journal.

Availability of data and material

The data of the present study is available upon request.

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Nil.

Authors' contributions

CC and DL conceived of the study, participated in its design and coordination and commented on the draft of this manuscript; BL, JL and ZZ helped with the data collection; and BL performed the statistical analysis and helped to draft the manuscript. All authors read and approved the final manuscript.

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Conflict of interest

The authors have no conflict of interest to report.

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Tables

Table 1. Demographic and psycho-cognitive characteristics of the two groups (healthy and MCI).

	Total Sample (N= 233)	Healthy Controls (n=198)	MCI (n= 35) [high resilience; low resilience]	t/ χ2 statistics
	Mean (S.D.)	Mean (S.D.)	Mean (S.D.)	
1. Age	64.90 (3.79)	64.59 (3.70)	66.68 (3.85) [66.67 (3.40); 66.68 (4.27)]	t(223)= -3.02**
2. Sex (% males)	32.6	32.8	31.4 [50.0; 15.8]	χ2(2)= 0.59
3. Years of Education	12.97 (4.13)	13.43 (3.96)	10.38 (4.16) [10.70 (4.11); 10.13 (4.29)]	t(223)= 4.11***
4. TONI-3 Score	23.62 (9.05)	24.77 (8.81)	17.11 (7.63) [19.31 (6.72); 15.26 (8.03)]	t(231)= 4.83***
5. MoCA Score	26.61 (2.50)	27.37 (1.64)	22.31 (2.19) [22.94 (1.00); 21.79 (2.76)]	t(231)= 15.93***
6. JLO	21.75 (4.66)	22.03 (4.48)	20.17 (5.33) [22.81 (3.47); 17.95 *5.68]	t(231)= 2.20*
7. RBMT- story recall	7.44 (3.45)	7.70 (3.45)	5.96 (3.08) [5.44 (3.36); 6.40 (2.84)]	t(230)= 2.79**
8. Resilience[a]	28.06 (5.60)	28.23 (5.49)	27.09 (6.18) [32.75 (2.79); 22.32 (3.61)]	t(231)= 1.12

NOTE. *p<= .05; **p<= .01; ***p<= .001.

[a] measured by Connor-Davidson Resilience Scale (CD-RISC) and the cutoff score for high and low resilience was at 28. TONI-3, Test of Nonverbal Intelligence; MoCA, Montreal Cognitive Assessment; JLO, Judgment of Line Orientation; RMBT, Rivermead Behavioural Memory Test

Table 2. Correlations between major variables with the entire sample [healthy controls; MCI].

Major variables	1	2	3	4	5	6	7
1. Age	—						
2. Years of education	-0.17** [-0.08; -0.34*]	—					
3. Non-verbal intelligence[a]	-0.29*** [-0.28***;-0.03]	0.37*** [0.32***; 0.35*]	—				
4. MoCA	-0.25*** [-0.16*; -0.15]	0.36*** [0.24***; 0.30]	0.41*** [0.27***; 0.46**]	—			
5. JLO	-0.20** [-0.16*; -0.25]	0.27*** [0.22**; 0.40*]	0.52*** [0.50***; 0.52**]	0.26*** [0.22**; 0.25]	—		
6. RBMT - story recall	-0.11 [-0.09; -0.01]	0.15* [0.13; -0.04]	0.21*** [0.21**; -0.10]	0.28*** [0.30***; -0.13]	0.10 [0.12; -0.13]	–	
7. Resilience[b]	0.06 [0.10; -0.06]	0.10 [0.08; 0.12]	0.18** [0.12; 0.43**]	0.16* [0.10; 0.35*]	0.18** [0.08; 0.56***]	0.01 [0.04; -0.25]	—

NOTE. *p<= .05; **p<= .01; ***p<= .001.

[a] measured by Test of NonVerbal Intelligence (TONI-3)

[b] measured by Connor-Davidson Resilience Scale (CD-RISC)

MoCA, Montreal Cognitive Assessment; JLO, Judgment of Line Orientation; RMBT, Rivermead Behavioural Memory Test

Table 3. Hierarchical logistic regression analyses in predicting MCI.

Block	Variables	β (S.E.)	p	Odds ratio (95% CI)	R^2
1	Age	0.14 (0.05)	**.004**	1.14 (1.04- 1.26)	0.062
2	Age	0.08 (0.05)	.119	1.08 (0.98- 1.20)	
	Years of education	-0.15 (0.06)	**.015**	0.86 (0.76- 0.97)	
	TONI-3	-0.08 (0.03)	**.006**	0.92 (0.87- 0.98)	
	JLO	0.03 (0.05)	.521	1.03 (0.94- 1.13)	0.259
	RBMT – story recall	-0.13 (0.07)	.062	0.88 (0.77- 1.01)	
3	Age	0.08 (0.05)	.108	1.09 (0.98- 1.21)	
	Years of education	-0.15 (0.06)	**.014**	0.86 (0.76- 0.97)	
	TONI-3	-0.08 (0.03)	**.008**	0.92 (0.87- 0.98)	
	JLO	0.04 (0.05)	.471	1.04 (0.94- 1.14)	
	RBMT – story recall	-0.13 (0.07)	.061	0.88 (0.77- 1.01)	
	Resilience	-0.02 (0.04)	.625	0.98 (0.92- 1.05)	0.261
4	Age	0.05 (0.06)	.356	1.05 (0.94- 1.17)	
	Years of education	-0.14 (0.07)	**.035**	0.87 (0.77- 0.99)	
	TONI-3	-0.09 (0.03)	**.004**	0.91 (0.86- 0.97)	
	JLO	-0.44 (0.23)	**.051**	0.64 (0.41- 1.00)	
	RBMT – story recall	-0.15 (0.07)	**.045**	0.86 (0.75- 1.00)	
	Resilience	-0.38 (0.17)	**.028**	0.68 (0.49- 0.96)	
	resilience x JLO	0.02 (0.01)	**.030**	1.02 (1.00- 1.04)	0.295

NOTE. CI= Confidence Intervals; R^2= Nagelkerke R Square for each block; Significance values <=.05 were in bold. TONI-3, Test of NonVerbal Intelligence; JLO, Judgment of Line Orientation; RBMT, Rivermead Memory Test

Figures

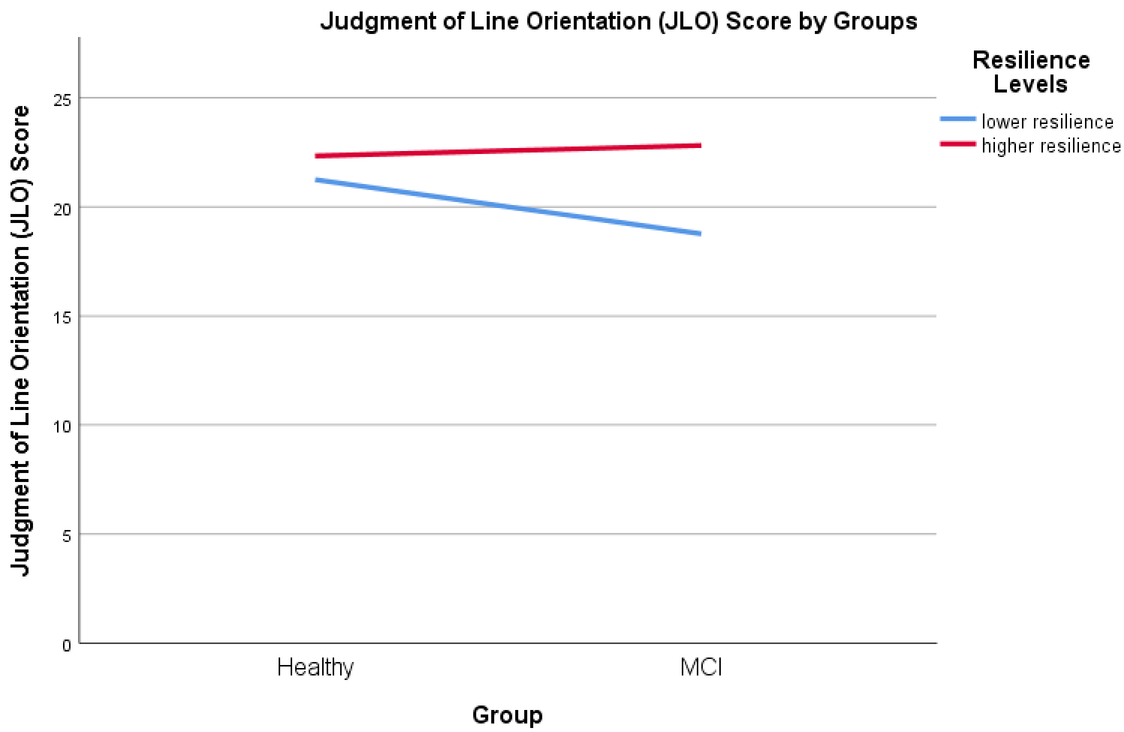

Figure 1

The interaction effect of JLO scores and resilience levels on 2 Groups. To test the moderation effect of visuospatial ability in predicting MCI at different levels of resili-ence, all participants were split into two resilience groups based on the median score at 28 on CD-RISC: lower resilience (CD-RISC score <= 28) (n=114) and higher resilience group (CD-RISC score > 28) (n=119). Within the healthy controls, there were 103 and 95 participants in higher resilience and lower resilience respectively while there were 16 higher resilience and 19 lower resilience individuals among those with MCI.