Psychiatric Quarterly (2019) 90:629–635
https://doi.org/10.1007/s11126-019-09655-y

ORIGINAL PAPER

Numeracy Skills and Self-Reported Mental Health in People Aging Well

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Published online: 20 June 2019

Abstract

This study investigated the relationship between numerical accuracy (i.e, number comprehension and mental calculation) and self-reported depression in late adulthood. Whether social context (i.e., marital status) and very early cognitive decline symptoms impacted numerical performance was also examined. Ninety-four community-dwelling elderly participants were recruited in Sardinia, an Italian island characterized by increased longevity. All participants were presented a battery of tests and questionnaires assessing general cognitive efficiency, lifestyle, perceived physical health, numeracy, metacognitive and depressive responses. Number comprehension skills, time spent for gardening, metacognitive performance, and physical health predicted 26% of variance in CES-D index. Furthermore, married participants outperformed single/widowed ones in both number comprehension and mental calculation tasks. The same pattern of results was replicated when cognitively healthy controls were contrasted with participants with some signs of cognitive decline. The assessment of numeracy skills can be very informative in order to promote mental health and life quality in late adult span.

Keywords Numeracy · Mental health · Aging, mental calculation · Number comprehension

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Introduction

The understanding and processing of numerical information (i.e., numeracy) is crucial in many daily activities throughout the life course [1]. However, numeracy processes (e.g., simple calculation) have mainly been studied in infants and students with little attention on number use in late adulthood. Consequently, how typical age-related changes in, for example cognitive (e.g., attention, episodic memory) processes, impact numeracy in agers, is unclear. Nonetheless, quantitative understanding and numerical processing play a significant role in health-related choices (e.g., understanding dosage instructions or the risks and benefits associated with certain medications) and financial operations (e.g., transfer payment, investment decisions) made by the elderly [2, 3]. The impact of poor numeracy in these areas could increase the risk of adverse health outcomes (e.g., morbidity and mortality) and lower life quality due to vulnerability to financial exploitation ("the illegal or improper use of older adults' financial resources", p. 978, [4]), [5–7].

There is evidence that health and financial literacy are associated with demographic (e.g., age, gender, education) and cognitive (e.g., text comprehension, verbal memory, executive functions) factors in late adulthood [1, 4, 5, 8]. However, little is known about the interplay among such influences [9, 10], especially in relation to more global outcomes. Indeed, research relating mathematical skills to self-reported mental health is very limited and inconsistent. For example, Bennett et al. [11] found a significant relationship between literacy and depressive symptoms in older participants, whereas Agarwal et al. [12] did not. Even if such a relationship exists, whether it is independent from age-related cognitive decline has not been considered i.e., does cognitive decline underlie a relationship between numerical literacy and mental well-being. Indeed, although previous studies have examined numeracy skills in participants with and without overt cognitive decline [8, 13], no studies have investigated if mathematical performance is sensitive to the very early/minimal cognitive impairment. The latter would include those with lower scores on cognitive screening tools such as the Mini Mental State Examination test [14], but without any neuropsychological diagnosis. Such information could be highly valuable given advantages of early intervention in atypically developing elders [9].

The main aim of this study was to investigate the relationship between negative affect and numeracy skills in a sample of elders recruited in Sardinia. Previous evidence indicates that longevity and positive psychological characteristics, including high psychological well-being, low depression, preserved memory and metacognitive functioning, are present in this population [15, 16]. To confirm if an independent relationship exists between numeracy and negative affect, several potential covariates were also assessed. In light of the limited and fragmentary background literature, a selection of spanning demographic factors, metacognition and perceived physical health was made. This selection also allowed for subsidiary analyses exploring correlates of numeracy in agers. This was undertaken because most research on numeracy and decision-making concerns younger adults and the generalizability of these findings to older adults is uncertain.

Based on previous evidence, it was hypothesized that self-reported depressive symptoms would be predicted by demographic (age, sex and marital status), metacognition and perceived physical health [16–19]. No specific hypotheses about the role of numeracy skills in predicting depressive signs was stated because of the lack of relevant prior research. With respect to the subsidiary aims, similarly, marital status could be expected to impact [20] or not [12] numerical performance. Finally, the occurrence of early signs of cognitive impairment was expected to disrupt number comprehension but not mental calculation skills [8].

Method

Participants

Ninety-four community-dwelling adults (65–94 years-old, mean age = 76.3 years, SD = 7.02) were recruited from Arborea, a rural village located in the western central region of Sardinia (Italy). This sample consisted of 59 females and 35 males of whom 40 were single/widowed and 54 who were married. General cognitive efficiency, assessed by the Mini Mental State Examination (MMSE) test, indicated that 83/94 were cognitively healthy (≥ 24), the remainder (11/94) had a score of 20–23 and were classified as suspected cognitively impaired.

Following previous studies [16, 21], education attainment was dichotomized as low (i.e., ≤ 8 years, $n = 53$) and high (i.e., > 8 years, $n = 29$).

Gender ($\chi^2 = 6.13$, df = 1, $p = .013$) and education ($\chi^2 = 13.79$, df = 1, $p < .0001$) were not counterbalanced across the participants, whereas marital status was counterbalanced ($\chi^2 = 2.08$, df = 1, $p = .15$).

Materials

Participants were presented the following battery of tasks:

1) The interview by Fastame and Penna [22] was used to record socio-demographic (e.g., gender, age) and lifestyle information. Specifically, years of education, number of hours spent every week for gardening or for outdoor structured leisure activities were used as proxy for cognitive reserve [13]. Moreover, marital status (i.e., single versus widowed) was recorded as an index of social context (see "Results" section).
2) The MMSE [14] was used to assess general cognitive efficiency. Scores were adjusted for age and years of education [23].
3) The Perceived Physical Health measure (PHY) [18] is composed of 1 item assessing how the person rates his/her physical health on a Likert scale from 0 (lack of health) to 10 (excellent health).
4) Number Comprehension battery [24] encompasses three tests assessing the capacity to compare numerosity showed simultaneously in two panels, to mark a certain number on a line defined by its extremes, and to point to the appropriate number on a stimulus, respectively. Performance was assessed in terms of correct responses (maximum total score = 19).
5) Mental Calculation battery [24] assesses the capacity to perform simple mental calculations involving addition, subtraction and multiplication. Performance was assessed in terms of correct responses (maximum total score = 18).
6) The Cognitive Failure Questionnaire (CFQ) [25], Italian version [26] self-assesses the occurrence of perceptual, motor and memory errors in the daily life. A score ≤ 22.5 denotes a general liability to cognitive failures.
7) The Centre for Epidemiological Studies of Depression Scale (CES-D) [27], Italian version, [28] was used as a measure of self-perceived depressive symptoms during the past week. A score ≥ 16 denotes the risk of depressive illness, whereas a score ≥ 23 indicates the likely occurrence of clinical depression.

Procedure

Participants were individually tested in their own home. Testing began with the MMSE and was followed by the socio-demographic interview. The presentation order of the remaining measures was counterbalanced according to a Latin Square procedure. To minimize fatigue, the examiner read aloud each item of the questionnaire/test and recorded the responses given by the participant. Each experimental session lasted about 70 min.

Results

First, a stepwise regression analysis was performed to assess whether cognitive reserve (i.e., education, hours spent for outdoor leisure, hours spent for gardening, general cognitive efficiency), numeracy skills (i.e., number comprehension and mental calculation), CFQ and PHY predicted CES-D score. It was found that CFQ (b = .30, t = 3.21, $p = .002$), hours spent for gardening (b = −.23, t = − 2.52, $p = .013$), number comprehension skills (b = −.24, t = − 2.56, $p = .012$), and PHY (b = −.24, t = − 2.56, p = .013) predicted 26% of the variance in the CES-D condition (corrected $R^2 = .26$, $F(4,90) = 8.84$, $p < .0001$).

Then, two separate Analyses of Covariance (ANCOVAs) were conducted to investigate the impact of marital status (i.e., single/widowed versus married) on number comprehension and mental calculation skills, respectively, controlling for the effect of general cognitive efficiency. The main effect of marital status was significant in number comprehension [$F(1,91) = 7.34$, $p = .008$, $\eta p^2 = .08$] and mental calculation [$F(1,91) = 9.39$, $p = .003$, $\eta p^2 = .09$] conditions. The effect of the covariate MMSE was significant in number comprehension [$F(1,91) = 12$, $p = .001$, $\eta p^2 = .12$] and mental calculation [$F(1,91) = 21.45$, $p < .0001$, $\eta p^2 = .19$ for] conditions. Specifically, married participants performed number comprehension (M = 17.26, SD = 1.18) and mental calculation (M = 17.06, SD = 1.28) tasks better than single/widowed participants (M = 16.48, SD = 1.22 and M = 15.31, SD = 3.3).

Finally, to test the third hypothesis, the subgroup of participants with suspected cognitively impairment (8 females and 3 males) was age, education and gender-matched with a subgroup of cognitively healthy participants ($n = 11$) and then two Mann-Whitney U tests were performed. Significant differences were found in number comprehension and mental calculation skills of cognitively healthy (Md = 17 and Md = 17) and participants with signs of cognitive decline (Md = 16 and Md = 14), [U = 24, z = −2.05, $p = .04$, r = .44 for number comprehension, and U = 21, z = −2.43, $p = .015$, r = .52 for mental calculation conditions).

Discussion and Conclusions

This study was mainly aimed at clarifying the contribution of numeracy skills for mental health in late adulthood. It extends previous findings on Sardinian successful agers [15, 16, 19], in that a link between numerical processing and perceived mental health was identified. Overall, factors associated with cognitive reserve (8%), number comprehension (5%), metacognition (9%), and physical health (4%) accounted for 26% of the CES-D variance of Sardinian agers. These results are broadly consistent with limited previous research identifying numeracy problems as a risk factor for depression [11], loneliness [20], and cognitive decline [8]. Thus, although only a handful of studies have been conducted, numeracy skills emerge as a

consistent indicator of risk for mental health problems in older adults. This suggests that screening and, where appropriate, intervention to empower numeracy skills, may help limit the risk for financial exploitation and promote health and wealth in agers [4, 9]. Future research to replicate and extend these findings would be desirable especially with respects to the limitations of this preliminary investigation (e.g., sample size, low educational attainment, use of a limited battery of tasks, task ecological validity).

Acknowledgements The authors would like to thank Professor Carlo Semenza for providing the tool for assessing numerical abilities.

Compliance with Ethical Standards

Conflict of Interest The authors have declared that no conflict of interest exists.

Ethical Approval The study was conducted in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration and its later amendments. Written informed consent was given by all participants prior to participation.

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