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Cognitive Reserve and Digital Confidence among Older Adults as New Paradigm for Resilient Aging

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Abstract

Objective: The purpose of this study was to examine the digital confidence of elder adults and identify behavioral patterns for technology that are related to cognitive abilities among elders. **Method:** An observational study was conducted using a sample of 94 elders, aged 53 to 86 years. Neuropsychological and emotional measures were used, and technology use was assessed. **Results:** Finding showed elders by resilient neuropsychological aspects can have a good affinity for technology. We examined the role of not only cognitive reserve levels but also demographic characteristics (i.e., age, educational level) and found that elderly were more adherent to digital resources. Technology can be a beneficial resource to those with medium levels of cognitive reserve and make them feel "like they are leading an active lifestyle." **Conclusions:** The focal point of our findings is the relevance of cognitive reserve during older adulthood as a key factor that should be examined in investigations on successful aging; it would be more interesting to examine these factors within the context of analyses on the impact of technology on aging and digital living.

Keywords

aging, cognitive reserve, digital confidence, digital living

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Introduction

Digitization has increased considerably over the past decade, and technology use has become increasingly widespread among elders. These developments have emerged within the context of a rapidly aging society. According to Eurostat (2013), elders (i.e., age ≥ 65 years) constituted 26.8% of the working-age population in Europe. Further, because of consistently low birth rates and increasing life expectancy, these changes in the European demographic distribution are expected to be more pronounced in the coming decades. It has been estimated that, in 2050, elders will constitute approximately 22% of the total global population and that the annual growth rate among those older than 65 years will be 2.4% worldwide.

Elders are not as digitally savvy as their younger counterparts (Di Giacomo et al., 2019; Dyck et al., 1994), and they are described as "digital natives." However, the number of elders who use digital technologies is increasing significantly. In contradistinction to common prejudices, whereby elders are perceived as being unable or unwilling to use technology, they are increasingly incorporating digital learning into their daily lives. In many countries, most elders use several technological solutions. In 2015, 65%, 42%, and 32% of elders used personal computers, smartphones, and tablets, respectively. Further, between 2005 and 2010, the percentage of Europeans aged 65 to 74 years who were daily and weekly internet users increased from 5% to 17% and from 10% to 25%, respectively. These percentages are expected to increase further in the coming years, mainly because of the wave of computer technology adoption, which is evidenced by the increase in the number of older individuals who use computers intensively (García-Betances et al., 2016; Wagner et al., 2010).

Several studies have delineated the positive effects of technology on the wellness and quality of life of the population, and several other studies have found that technology use confers practical, physical, social, and emotional benefits on elders empowering the successful

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aging (Forsman & Nordmyr, 2017). First, technological devices help elders stay in touch with their families and friends, thereby increasing social connectedness and interaction, promoting the maintenance of active relationships, and alleviating loneliness. Furthermore, by helping them cope with geographic and transportation constraints, technological devices benefit elders who are isolated. Thus, access to smartphones and online communities fosters greater independence and social involvement by helping elders emerge from their social isolation and connect and interact with others (Cotton et al., 2013; Iancu & Iancu, 2017). Social interaction and engagement are vital to healthy aging because they are related to healthy behaviors, physical activity, cognitive functioning and psychological well-being, which in turn are related to better longevity, and enhancing the cognitive efficiency in late life (Cherry et al., 2013).

Among healthy elders, technology use can delay or prevent the onset of disabilities by fostering self-management strategies such as the use of various digital health technologies (e.g., smartphone applications, personal digital assistants, remote monitoring devices, and other wireless devices). Wearable trackers and telehealth platforms help elders monitor and manage their behaviors and improve their health outcomes by leading a healthy lifestyle (Kim et al., 2016), adhering to medication regimens (Burnier, 2018), and monitoring biomarkers and health indicators (Kulshreshtha, 2010). All these data can be shared with their healthcare providers to better manage diseases, improve health conditions, and slow down functional decline (Czaja et al., 2018). Furthermore, online health communities serve as a platform on which elders can seek health information and enhance self-preservation. It has been estimated that 30% of elders regularly seek health information online (Bhattarai & Phillips, 2017). Moreover, technology use improves their psychological well-being and self-esteem and motivates them to experiment with new activities and interests. The internet provides many services, which enhance the autonomy of elders by facilitating their execution of many routine tasks through e-services (e.g., home banking, shopping). Elders with better cognitive skills are better positioned to benefit from web-based services.

Some studies have found that the use of digital solutions fosters the development of new skills (e.g., higher-order thinking skills, instrumental activities of daily living) and influences human cognition and brain plasticity (Gindrat et al., 2015; Kaye et al., 2014) as well the cognitive reserve. Cognitive reserve refers to the extent to which cognitive functions are preserved despite neural damage due to age, injury, or disease (Stern, 2002). It has been suggested that engagement in cognitive, social, and physical activities throughout one's lifespan contributes to high levels of cognitive reserve, which protects individuals against the sequelae of neural damage, reduces their risk of developing dementia, and slows the rate of memory decline due to normal aging (Clare et al., 2017; Stern, 2009). Cognitive reserve refers to intellectual capacity which may be influenced by genetic factors. However, education, occupational experience, and participation in ongoing intellectually stimulating activities have also been found to influence cognitive reserve (Potter et al., 2008; Scarmeas et al., 2003). In this scenario, cognitive reserve could be reflect the influence of technology application in daily life toward to the efficient psychological processes.

Past studies have primarily focused on the technological skills that are related to cognitive abilities of elders rather on the digital confidence of elders.

The aim of this study was to examine the technological attitudes in successful aging, analyse the characteristics and impact of digital skills of elders, and delineate the role of cognitive reserve in adherence to digital solutions among elders.

Materials and Methods

Ethics Statement

Informed consent was obtained from each participant, and the study adhered to the guidelines outlined in the Declaration of Helsinki (World Medical Association [WMA], 2013).

Sample

A total of 94 elders ($n = 65$ female, $n = 29$ male), aged 53 to 86 years (M = 67.9, SD = 6.01) participated in this study. Six out of 100 eligible participants refused to take part in the study: reasons for refusing was (a) lack of glasses, (b) no time. The participants were enrolled at the AUSER Social Club (L'Aquila, IT), the largest social club in middle Italy. They were divided into two groups based on their median age (68 years old): the old (n.46, age = 53–68 years) and older (n.48, range = 68–86 years) group. The inclusion criteria were as follows: (a) age = 50–90 years, (b) no sign of psychiatric or neurological diseases, (c) no alcohol or substance abuse, and (d) provision of informed consent.

Table 1 presents the demographic characteristics of the participants.

Measures

We used neuropsychological and emotional measures and assessed technology use to examine the cognitive and emotional abilities and related technological skills of elders.

Neuropsychological measures. The neuropsychological battery consisted of a screening test for cognitive decline and nine other tests of verbal and visuo-perceptual abilities.

Table 1. Demographic Characteristics of the Participants.

	Sample (n.94)		
	Old (n.46) *M* = 63.3, *SD* = 3.9 (%)	Older (n.48) *M* = 72.3, *SD* = 4.3 (%)	Total (n.94) *M* = 67.9, *SD* = 6.1 (%)
Gender			
Female	n.35 (53.8)	n.30 (46.2)	n.65 (69.1)
Male	n.11 (37.9)	n.18 (62.1)	n.29 (30.9)
Education			
High school non-graduates	10.9	27.1	19.1
High school graduates	47.8	31.3	39.4
Bachelor degree	41.3	41.7	41.5
Relationship status			
Married/living with	58.7	64.6	61.7
partner	4.3	—	2.1
Single	30.4	8.3	19.1
Divorced/Widow	6.5	27.1	17
Occupation			
Unemployed	4.3	2.1	3.2
Employed	45.7	39.6	42.6
Self-employed	50	58.3	54.3

- *Mini-Mental State Examination* (MMSE; Folstein et al., 1975). The MMSE is a screening test that is used to detect cognitive decline in elders. It consists of 30 items and includes tests of orientation, attention, memory, language, and visual-spatial skills. Scoring can be used to assess the risk for dementia.
- *Babcock Story Recall Test* (BSRT; Babcock & Levy, 1940). The BSRT measures verbal memory. The participants are read a brief story, following which their immediate recall is assessed. Subsequently, the story is read a second time and, after 20 minutes, delayed recall is assessed. Thus, in addition to a memory component, the test also contains a learning component.
- *Digit Span Test* (Wechsler & Stone, 1974). The Digit Span Test measures the span of verbal recall. It consists of seven pairs of random number sequences.
- *Verbal Phonemic Fluency Test* (Spreen & Strauss, 1998). This test assesses verbal functioning and requires the participant to produce as many words as possible in response to a phonemic request.
- *Semantic Fluency Test* (Novelli et al., 1986). This test assesses executive function and access to semantic memory. The participant is required to produce as many words that belong to a given semantic category (fruits, animals, objects) as possible.
- *Boston Naming Test* (Kaplan et al., 1983). This test consists of 60 black and white line drawings of objects, and it measures confrontation naming.
- *Rey Auditory Verbal Learning Test* (RAVLT; Rey, 1958). The RAVLT measures verbal learning and memory. A standard list of 15 unrelated words is read out by the examiner, and the participant is required to recall as many words as possible in any order.
- *Cognitive Reserve Index Questionnaire* (CRIq; Nucci et al., 2012). The CRIq measures cognitive reserve by assessing information that pertains to adulthood. The questionnaire consists of 20 items and 3 sections: CRI-Education (years of education, training courses), CRI-Working Activity (occupation), and CRI-Leisure Time (hobbies and other activities). The CRIq scores are classified into the following five categories: low (<70), medium-low (70–84), medium (85–114), medium-high (115–130), and high (>130).
- *Corsi Block Tapping Test* (Spinnler & Tognoni, 1987). This test measures orientation and spatial attention using cubes, which are fastened to a board in a random order.
- *Attentive Matrices Test* (Spinnler & Tognoni, 1987). This test assesses selective and sustained attention. It consists of a series of patterns of numbers.

Emotional measures

- *Beck Depression Inventory* (BDI; Beck et al., 1961). The BDI measures the severity of depression. It consists of 21 multiple-choice questions. Scoring are indicative of five levels of severity: no, minimal, mild, moderate, and severe depression.

Measures of technology use

- *Affinity for Technology Interaction Scale* (ATI Scale; Franke et al., 2019). This 9-item scale

assesses a person's tendency to actively engage in or avoid intensive technology interaction. ATI can be regarded as a core personal resource that helps individuals use technology effectively.

- *Digital Mastery Questionnaire* (DMQ; experimental test). The DMQ is an experimental self-report measure the ability to manage digital solutions in aging. The DMQ measures the use of technology in daily life (i.e., type of tools used, the extent of use, and the type of activities that one engages in). It consists of 20 items, which assess the following six dimensions: (a) daily usage time (i.e., the amount of time spent on technological devices daily); (b) perceived self-efficacy (i.e., confidence in using technological devices); (b) benefit for life (i.e., positive perceptions of the use of technological devices for online operations); (c) digital confidence (i.e., emotional reactions to the use of technological systems); (d) internet surfing (i.e., the number of applications used on devices); and (e) digital tools (i.e., preferences for using certain technological devices such as a personal computer or smartphone). The DMQ was tested in a pilot study, which used a sample of individuals who were not included in this study. The internal reliability of this scale was good ($\alpha = 0.8$).

Procedure

Participation in this study was voluntary, and the submission of a signed informed consent form was mandatory. Recruitment was conducted in AUSER Social Club. The participants took approximately 90 minutes to complete the psychology battery. The psychological evaluation was conducted in a quiet dedicated room. The tests were administered by trained psychologists who were blinded to the objectives of the study. Independent clinical psychologists scored the tests. The data were collected anonymously.

Study Design

In this observational study, the participants were divided into two groups based on their age (i.e., old vs. elder groups). Descriptive statistics were computed to examine their characteristics. One-way analysis of variance (ANOVA) and multivariate analysis of variance (MANOVA) were conducted using the data collected from elder adults, who were subsequently stratified based on their cognitive reserve levels.

All statistical analyses were conducted using SPSS. All the tests were two-tailed, and the level of statistical significance was defined as $p < .05$. Post-hoc tests (with Bonferroni correction) were conducted to further examine significant group differences.

Results

The collected data were subjected to statistical analyses. Table 2 presents the descriptive statistics (i.e., means and standard deviations) for the test scores and even MANOVA analysis.

First, we analysed the neuropsychological data comparing old and elder group performance. MANOVA (10×2) analysis was conducted comparing neuropsychological tests (10) and groups (2) in order to evaluate the cognitive aspects of groups. With regard to the MMSE, which was used to screen for cognitive decline, groups appeared in normal aging no evidencing significant difference between themselves and more reporting scoring in no pathological range. There was a significant difference in performance on the verbal tasks and tests of attentional function. The old group performed significantly better than the elder group on language production tasks and tests that assessed the following: naming (Boston Naming Test), lexical (Verbal Phonemic Fluency Test), semantic (Semantic Fluency Test), and oral (RAVLT) memory. Even on the Attentive Matrices Test, the old group demonstrated better attentive performance than the elder group. There was no significant difference in performance on visuo-perceptual tasks.

There were some significant differences within the elder group (e.g., language vs. visuo-perceptual). However, when the participants were stratified based on their cognitive reserve levels, there were no significant differences in the two group

With regard to the emotional measure, none of the participants reported any signs of depression. All the participants obtained a positive score that was lower than the cut-off score (i.e., 14). No significant difference emerged between the two age groups.

Although the participants could be classified into two contrasting age groups, they were similar in their cognitive and emotional characteristics. Further, the results showed that the participants were undergoing successful aging.

Next, we conducted one-way ANOVA to compare the ATI Scale scores of the two groups. Contrary to our expectations, the elder group reported greater ATI than the old group. Further, those belonging to the elder group and were more confident about their ability to use digital devices. The old group reported lower levels of technology engagement were less likely to be effective users.

Analyses of their DMQ scores revealed that the old group reported longer durations of daily use than the elder group. There was no significant difference in perceived self-efficacy, benefit for life, and digital confidence in the use of innovative technological solutions in daily life.

Finally, the participants reported a high rate of internet surfing (old group: 58.7%, elder group: 45.8%) and preference for personal computers over smartphones.

Table 2. Raw Score of Measurement Test and MANOVA Analysis.

	Sample		MANOVA		
Measures	Old (n.46)	Elder (n.48)	*F*	*p* Value	π Value
Neuropsychological data					
MMSE	28.7 ± 1.3	28.4 ± 1.5	1.3	0.2	–
Babcock story recall test	9.6 ± 3.2	9.4 ± 3.6	0.0	0.8	–
Digit span test					
Forwards	5.7 ± 1.1	5.5 ± 1.1	0.7	0.3	–
Backwards	4.5 ± 1	4.4 ± 1.1	0.3	0.5	–
Verbal phonemic fluency test	42.2 ± 13.8	35.8 ± 10.9	6.9	0.01*	0.7
Semantic fluency test	44.3 ± 10.3	39.1 ± 8.8	6.3	0.01*	0.7
Boston naming test	49.5 ± 5.1	45.2 ± 7.7	9.8	0.00*	0.8
Rey auditory verbal learning test					
Immediate recall	50.5 ± 7.5	42.5 ± 7.9	24.7	0.00*	0.9
Delayed recall	11.9 ± 6.4	9.6 ± 5	3.5	0.06	–
Recognition	44.1 ± 1.5	43.2 ± 2.5	4.1	0.04*	0.5
False recognition	0.9 ± 1.5	1.7 ± 2.5	4.0	0.04*	0.5
Cognitive reserve index-q					
Education	112.7 ± 11.5	114.7 ± 16.3	0.4	0.4	–
Leisure time	125.3 ± 16.1	129.6 ± 17.5	1.5	0.2	–
Working activity	115.2 ± 19.6	118.5 ± 23	0.5	0.4	–
Tot	123.5 ± 15.2	127.6 ± 17.3	1.3	0.2	–
Corsi block tapping test	5.1 ± 0.9	5 ± 1.1	0.0	0.7	–
Attentive matrices test	55.7 ± 3.8	52.6 ± 5.1	8.9	0.00*	0.8
Emotional data					
Beck depression inventory	8.5 ± 5.5	8.5 ± 7.1	0.0	0.9	–
Technology usage data					
Affinity for tech interaction	28.8 ± 9.3	32.5 ± 9.1	4.4	0.03*	0.5
Digital Mastery-q					
Daily usage time (mins)	146.7 ± 78	100.6 ± 69.9	9.1	0.00*	0.8
Perceived self-efficacy	8.7 ± 2.2	9.3 ± 2.1	1.8	0.1	–
Benefit for life	7.3 ± 2.2	7.5 ± 2.4	0.1	0.7	–
Digital confidence	9 ± 2.6	8.8 ± 2.4	0.3	0.5	–
Internet surfing					
Low	15.2%	20.8%			
Medium	26.1%	33.3%			
High	58.7%	45.8%			
Digital tools					
PC	89.1%	75%			
Smartphone	10.9%	25%			

The sample was stratified into three groups based on their CRIq score categories: "high (HCg, n.39), medium-high (MHCg, n.28), and medium (MCg, n.26)." One-way ANOVA was conducted to compare these groups on their ATI, and the results showed that there was a significant group difference ($F(3, 2)=3,8$; $\pi=0.6$; $p=.02$). Post-hoc analysis (with Bonferroni correction) showed that the HCg performed significantly better than the MCg ($p=.03$). Figure 1 depicts the performance of the three groups graphically.

MANOVA was conducted to compare the three groups (i.e., HCg, MHCg, and MCg) on the DMQ indices (i.e., daily usage time, perceived self-efficacy, benefit for life, and digital confidence). There was a significant group difference in benefit for life ($F(3, 2)=5,5$; $\pi=0.8$;

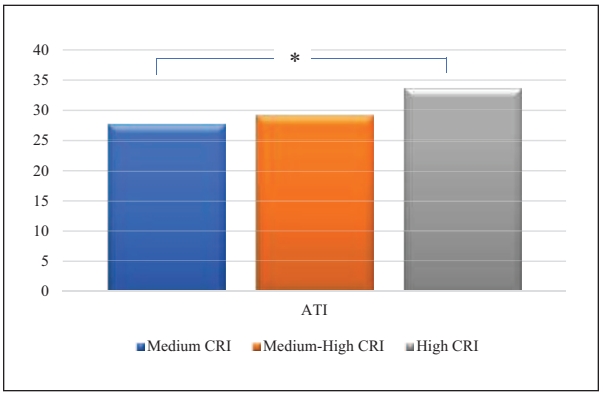

Figure 1. Affinity for technology interaction across the three CRI groups.

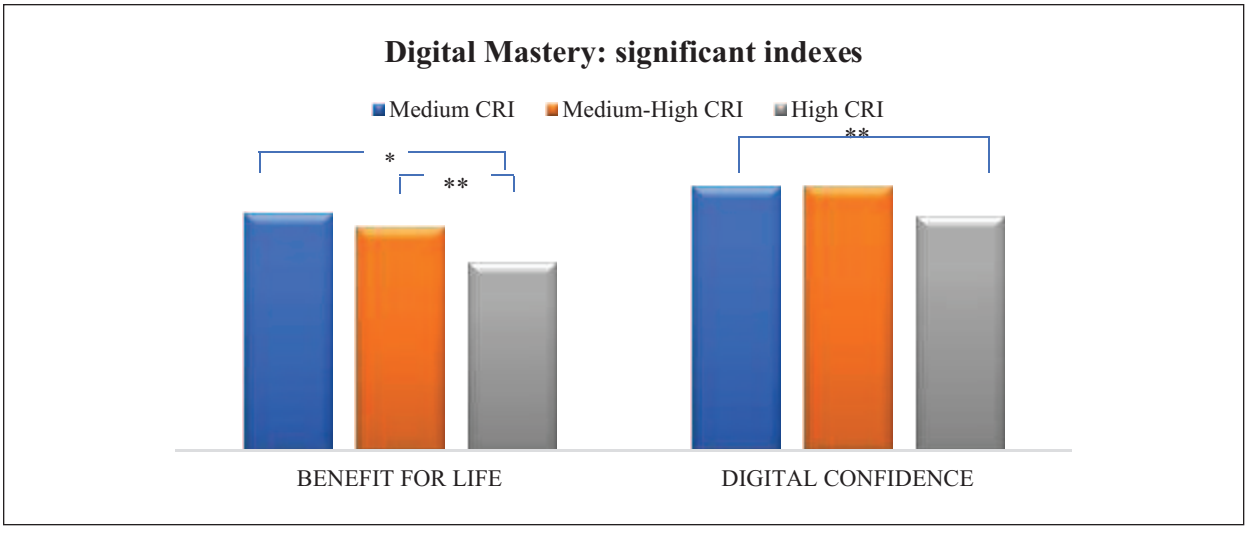

Figure 2. Significant differences in Digital Mastery Questionnaire scores between the three groups differing in their cognitive reserve levels.

$p=.006$) and digital confidence ($F(3, 2)=4.2$; $\pi=0.7$; $p=.01$). Post-hoc analysis (with Bonferroni correction) showed that the HCg obtained higher benefit for life scores than the MCg ($p=.002$) and MHCg ($p=.03$). In contrast, the MCg obtained higher digital confidence scores than the HCg ($p=.005$) (see Figure 2).

Discussion and Conclusion

This study aimed to examine the ATI, digital confidence, cognitive characteristics, and cognitive reserve levels of elder adults. In particular, our study investigated the relationships between neuropsychological/emotional abilities, ATI, and digital confidence to track successful aging in digital living.

Finding showed elder adults with resilient neuropsychological aspects can have a good affinity for technology. We examined the role of not only cognitive reserve levels but also demographic characteristics (i.e., age and educational level) and found that elders were more adherent to digital resources. Technology can be a beneficial resource to those with medium levels of cognitive reserve and make them feel like they lead an active lifestyle. Interestingly, those with high levels of cognitive reserve demonstrated greater awareness about their lack of digital savviness. In contrast, those with medium levels of cognitive reserve experienced more positive feelings toward digital solutions and greater benefits for life. Thus, elders with medium levels of cognitive reserve can improve their quality of life by being more active practitioners of digital living. Elders with high levels of cognitive reserve may have greater access to social and cultural systems, and digital solutions constitute only one aspect of their daily lives.

The focal point of our findings is the relevance of cognitive reserve during older adulthood as a key factor that should be examined in investigations on successful aging; this is more interesting within the context of analyses on the impact of technology on aging and digital living. Cognitive reserve refers to the extent to which cognitive functions are preserved despite neural damage due to age, injury, or disease (Stern, 2002). It has been suggested that engagement in cognitive, social, and physical activities throughout one's lifespan contributes to high levels of cognitive reserve, which protects individuals against the sequelae of neural damage, reduces their risk of developing dementia, and slows the rate of memory decline due to normal aging (Clare et al., 2017; Stern, 2009). Cognitive reserve refers to intellectual capacity which may be influenced by genetic factors. However, education, occupational experience, and participation in ongoing intellectually stimulating activities have also been found to influence cognitive reserve (Potter et al., 2008; Scarmeas et al., 2003). Therefore, ATI and digital confidence should be included as additional focal points in evaluations of cognitive reserve because they are essential for daily digital living capabilities. Both the old and older group members used technological devices. Further, even though they were not digital savvy, they learned to manage digital solutions to fulfill their own needs, and they considered technology to be beneficial to them.

The older group members had higher levels of cognitive reserve (but it was not significantly higher than those of the old group). High levels of cognitive reserve can prevent cognitive decline and engender intellectual curiosity and a stronger desire for knowledge about the use of technological devices, which would not only simplify their daily activities but also help them lead a more active life. Demographic characteristics such as age, gender, educational level, and relationship status were not related to greater technology use; technology use may have a positive impact on cognitive reserve among

elders and, consequently, render them more resilient against cognitive decline. Our findings underscore another additional key factor that influences successful aging, and it can offer a new perspective from which those who are not aging successfully can be identified. As highlighted in one of our earlier studies, technophobia may be an emotional indicator of fragile aging among elders who are unable to adequately utilize technological devices and digital tools. Accordingly, we had suggested that the clinical characteristics of technophobia should be considered as a specific psychological feature of a mental disorder that adversely affects one's ability to cope with societal challenges and daily living (Di Giacomo et al., 2019). Digital tools and technological devices are daily necessities to elders, and the use of innovative solutions can promote active living and enhance their quality of life. Failure to use digital devices may be indicative of a social disadvantage and predictive of marginalization because such individuals are likely to lack access to important and formal communications, social connections, and several healthcare services (Gell et al., 2015). Smart and innovative digital solutions with older adult-friendly features will be more accessible to them, improve their ability to remain autonomous, and enhance their resilience to the changes that occur during older adulthood (Chan et al., 2016; Vaportzis et al., 2017).

Briefly, strength of the study is based on the procedure of psychological evaluation: the test battery was administered by psychologists blinded to the research objectives and scoring was conducted by independent clinical psychologists.

Limit of the study is related to the sampling procedure: the recruitment in the same social club, even though composed of higher olds, could introduce a potential bias affecting the generalisability of results.

Declaration of Conflicting Interests

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