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Formal Education Level Versus Self-Rated Literacy as Predictors of Cognitive Aging

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Objectives. To compare the prediction of cognitive functioning by formal education and self-rated literacy and the differences in prediction across younger and older cohorts.

Method. Data on 28,535 respondents were drawn from a cross-sectional representative sample of community-dwelling older individuals (≥50), participating in the Survey of Health, Ageing, and Retirement in Europe. Education level was classified according to the International Standard Classification of Education 1997 (ISCED-1997) self-rated literacy was determined by having respondents rate their reading and writing on 1–5 scales. Cognitive functioning was measured by verbal recall, word fluency, and arithmetic ability.

Results. Structural equation modeling demonstrated that self-rated literacy was more strongly associated with cognitive functioning than was education level, with or without additional exogenous variables (age, sex, household income, medical conditions, activities of daily living, reading eyesight, and country). The association between education level and cognitive functioning was weaker in older than in younger age groups, whereas the association between self-rated literacy and cognitive functioning showed the opposite trend.

Discussion. Self-rated literacy was found to be a better predictor of late-life cognitive functioning than was the level of formal education. The results have implications for studies of age-related differences in which education level is taken into account.

Key Words: Aging—Cognitive functioning—Education—Literacy—Reading and writing.

MOST studies that predict behavior of older individuals take their formal education level into account. As formal schooling is usually completed in young age, it might not reflect cognitive changes that occur over the adult years. The current research compares the contribution of objective education level on the one hand and subjective self-rated literacy on the other hand to the prediction of cognitive functioning in the second half of life. In addition, we compare this prediction in three age groups to see whether it varies with age/cohort.

Education level, as measured by years of formal schooling or through various classifications of school type, serves as a control variable or as a predictor in most studies of aging. A recent search of MEDLINE records with the words "education" and "aging" led to more than 8,000 results. Education is taken into account in diverse domains of research, such as mortality, disease, depression, life satisfaction, as well as physical or cognitive functioning. Studies of age-related differences control for one's level of schooling because it is associated with native ability (Johnson, Gow, Corley, Starr, & Deary, 2010), with socioeconomic class in early and/or in late life (Breen & Jonsson, 2007; Hillmert & Jacob, 2010; Muller & Karle, 1993), and with lifelong choices that may lead to different outcomes in old age.

Measures of formal education are used extensively to predict cognitive performance in healthy aging (e.g., Albert et al., 1995; Ardila, Ostrosky-Solis, Rosselli, & Gomez, 2000; Barnes, Tager, Satariano, & Yaffe, 2004; Christensen, Korten, Jorm, Henderson, Jacomb, & Rodgers, 1997) and in dementia (e.g., McDowell, Xi, Lindsay, & Tierney, 2007; Mehta et al., 2007; Ngandu et al., 2007; Scarmeas, Albert, Manly, & Stern, 2006). However, this measure might be more cohort sensitive than is commonly assumed. Specifically, in a series of studies in the United States, Manly and her colleagues (Manly et al., 1999; Manly, Schupf, Tang, & Stern, 2005) showed that a quantitative index of formal schooling was not necessarily the most accurate measure of one's native ability and/or the best indicator of one's educational experience. Being a quantitative index in nature, argued Dotson, Kitner-Triolo, Evans, and Zonderman (2009), the number of years in school does not attest to the quality of education, which depends on factors such as the availability of teaching materials, pupil–teacher ratio, peer characteristics, or per pupil expenditures. Accordingly, the seemingly objective measure of formal schooling might not apply equally to individuals from diverse social backgrounds.

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Dotson and colleagues (2009) and Manly and colleagues (1999, 2005) showed that an objective test of literacy level, in which irregular or rare words have to be read out loud, is better in predicting cognitive decline among elderly African Americans, as well as among Caucasians from a low social background, than is the number of years of formal education. Thus, previous research has indicated the shortcomings of using formal schooling level in the prediction of cognitive performance, indicating the need to assess actual literacy levels. We suggest that literacy might be examined not only through a reading test but also through self-report, a measure that might be more practical in large-scale population studies. In the context of aging research, it is especially important to note that reading and writing abilities continue to develop after graduation because they are indispensable in occupational, social, and cultural life. We believe that self-reported literacy is most suitable for capturing these dynamic life-span changes. Furthermore, previous studies have demonstrated the validity of self-reports in assessing psychological constructs such as well-being (Oswald & Wu, 2010), as well as in assessing more objective conditions such as health (Benyamini, Blumstein, Lusky, & Modan, 2003; Idler & Benyamini, 1997).

Thus, the current research examines whether self-rated literacy predicts cognitive status in old age and compares measures of self-report to the well-studied objective measure of education level. We hypothesize that the level of formal education will be less strongly associated with cognitive functioning in older individuals, whereas self-rated literacy will be more strongly associated with cognitive functioning in this population.

Method

Participants and Procedure

Data were drawn from the Survey of Health, Ageing, and Retirement in Europe (SHARE; Börsch-Supan et al., 2008). The SHARE data include persons aged 50 years and older from a dozen countries (Austria, Belgium, Denmark, France, Germany, Greece, Israel, Italy, The Netherlands, Spain, Sweden, and Switzerland) and their spouses of any age. Based on probability samples of households in each participating country, SHARE represents the community-dwelling older population. In total, 31,115 persons were queried in the first wave of the SHARE project (2004–2006) by means of computer-assisted face-to-face interviews. Wave 1 obtained an overall household response rate of 62%, ranging from approximately 40% in Belgium and Switzerland to 81% in France. The average within-household response rate (i.e., the ratio between the number of responding individuals and the number of eligible persons in these households) was 85% and ranged from more than 70% in Spain to more than 90% in Denmark, Belgium, France, and Greece.

The current analyses focused on respondents aged 50 years and older (excluding any younger spouses, n = 1,098). Respondents with missing values in at least one variable were also excluded (n = 1,482). After excluding these respondents, the sample included 28,535 individuals (92% of the original interviewees). Detailed demographic characteristics appear in Table 1.

Measures

Education level was classified into one of seven categories according to the International Standard Classification of Educational Degrees (ISCED-97, United Nations Educational, Scientific and Cultural Organization, 1997): (0) preprimary education, (1) primary education, (2) lower secondary education, (3) upper secondary education, (4) post secondary education, (5) first tertiary education, and (6) second stage tertiary education. Each country team adapted local educational and vocational information to the respective ISCED-97 code, based on the Organization of Economic Cooperation and Development (Organization for Economic Co-Operation and Development, 1999) manual (overall skewness of education level = 0.35, kurtosis = –0.90).

Self-rated literacy included two items: "how would you rate your everyday reading ability?" and "how would you rate your everyday writing ability?" Respondents rated these skills as (1) poor, (2) fair, (3) good, (4) very good, or (5) excellent (rating of reading: skewness = –0.44, kurtosis = –0.55; rating of writing: skewness = –0.33, kurtosis = –0.73). Respondents were asked to assess their literacy level prior to any cognitive testing.

Cognitive functioning consisted of three domains. (I) Verbal recall was assessed by the number of words out of a 10-word list recalled 5 min after presentation (the adapted Ten-Word Delay Recall Test; Prince, Acosta, Chiu, Scazufca, & Varghese, 2003; skewness = 0.17, kurtosis = –0.30). (II) Word fluency was assessed by the number of correct animal names produced within 1 min. As the distribution of word fluency scores was highly skewed (skewness = 0.73, kurtosis = 2.35), respondents whose score fell more than three standard deviations above the mean group score (e.g., greater than 40) were given a score of 40. The new verbal fluency distribution was considerably less skewed (skewness = 0.39, kurtosis = 0.16). (III) Arithmetic ability was assessed by the number of correct answers to four arithmetic questions (e.g., "if the chance of catching a disease is 10%, how many people out of 1,000 are expected to catch the disease?" possible range 0–4; skewness = 0.32, kurtosis = –0.70).

Additional variables included age, sex, household income, medical conditions, activities of daily living (ADL), reading eyesight, and country of origin. Gross household income was defined as the annual household income (in Euro) adjusted for relative purchasing power parity within the participating SHARE countries and standardized by the household size square root to get the equivalent disposable income per standard person. Similar to previous studies (Ben-Ezra & Shmotkin, 2006), medical conditions were

Table 1. Descriptive Statistics of Study Variables

	Middle-aged adults (age 50–64)	Young–old (age 65–79)	Old–old (age 80+)	Difference test F/χ^{2a}
N	15,462	10,542	2,531	
Age	56.92 (4.13)	71.10 (4.23)	84.11 (3.88)	67,308.82*
Women % (*N*)	54.5 (8,433)	52.5 (5,538)	60.0 (1,519)	46.94*
Household income (in Euro)	46,261 (55,677)	36,604 (41,501)	31,596 (38,539)	173.83*
Medical conditions	1.17 (1.23)	1.88 (1.50)	2.28 (1.65)	1,245.26*
ADL	0.08 (0.47)	0.19 (0.72)	.63 (1.26)	710.88*
Reading eyesight	3.36 (1.17)	3.18 (1.08)	2.82 (1.08)	271.76*
Participants from countries with mean education level above the entire sample's median (%)	45.6	46.4	44.8	2.76
Education level (%)				1,908.27*
Preprimary	2.6	7.3	9.0	
Primary	19.3	34.9	44.0	
Lower secondary	19.0	16.8	17.3	
Upper secondary	32.5	24.4	18.1	
Post secondary	3.2	2.1	1.7	
First tertiary	22.9	14.2	9.9	
Second tertiary	0.6	0.3	0.1	
Subjective reading	3.85 (1.05)	3.46 (1.15)	3.14 (1.22)	686.41*
Subjective writing	3.73 (1.11)	3.29 (1.19)	2.89 (1.25)	808.74*
Verbal recall	3.88 (1.88)	2.90 (1.87)	1.74 (1.69)	1,851.09*
Word fluency	20.38 (6.94)	17.44 (6.67)	13.89 (6.37)	1,289.59*
Arithmetic ability	1.72 (0.83)	1.45 (0.80)	1.16 (0.77)	695.59*

Notes. If not otherwise specified, the first number refers to the mean and the second, parenthesized number refers to the standard deviation. ADL = activities of daily living.

[a] Difference tests used to compare the three age groups.

* $p < .0001$.

assessed by the sum of listed illnesses self-reported to have been diagnosed by a physician (e.g., heart disease, high cholesterol, cancer, etc.; possible range 0–14). ADL was assessed by summing up the number of self-reported difficulties in everyday activities (Katz, Downs, Cash, & Grotz, 1970; e.g., limitation in dressing up, showering, etc.; possible range 0–6). Reading eyesight was assessed by asking participants to rate their ability to see things up close, such as reading ordinary newspaper print (using glasses or contact lenses) on a scale ranging from (1) poor to (5) excellent. This variable was used to control for any vision problems that may affect self-rated literacy skills. Country of origin was dichotomized according to the median level of education within the entire sample: (a) countries with a mean education level at or above the median (Austria, Belgium, Denmark, Germany, Israel, and Switzerland; $N = 13{,}065$) and (b) countries with a mean education level below the sample's median (France, Greece, Italy, the Netherlands, Spain, and Sweden; $N = 15{,}470$).

Data Analysis

Two main analyses were performed using structural equation modeling with the AMOS 18.0 program. The first analysis examined whether education level and self-rated literacy contributed equally to cognitive functioning. The model consisted of two exogenous variables, education level, and self-rated literacy (literacy was a latent variable that was based on two observed variables: subjective reading and subjective writing). The endogenous variable was a latent variable of cognitive functioning that included three observed variables: verbal recall, verbal fluency, and arithmetic. After running the basic model, we ran it again with age as a continuous variable, sex, household income, number of diseases, ADL, reading eyesight, and country of origin as additional exogenous variables.

The second analysis examined whether the association between education level and self-rated literacy on the one hand and cognitive functioning on the other hand was moderated by age. This analysis divided the sample into three age groups: middle-aged participants (50–64), young–old participants (65–79), and old–old participants (80+). An unconstrained model was compared with a model in which the relationships between the exogenous variables and the endogenous variables were constrained across groups. A significant difference between the unconstrained and the constrained model will suggest that age is a significant moderator in the relationship between the exogenous and endogenous variables. This model was run once without the additional variables and once with them (excluding age, which served as a moderator).

Goodness-of-fit was assessed with four different fit indices: (a) the χ^2 likelihood ratio with degrees of freedom and *p* values, (b) the comparative fit index (CFI), (c) adjusted goodness-of-fit index (AGFI), and (d) the root mean square error of approximation (RMSEA). Scores above 0.90 indicate acceptable fit (Finch & West, 1997), except for the

RMSEA, on which values below 0.10 indicate adequate fit (Browne & Cudeck, 1993).

Results

Assessment of Study Variables

Table 1 presents descriptive statistics for all study variables by age groups. Table 2 presents means and standard deviations of all variables across the entire sample as well as correlations between study variables. In general, age showed moderate negative correlations with the cognitive variables (*r* ranged from −.23 to −.37, all $p < .0001$). Education level showed moderate positive correlations with the cognitive variables (*r* ranged .32–.42, all $p < .0001$). Self-rated literacy showed moderate positive correlations with the cognitive variables (*r* ranged .33–.40, all $p < .0001$).

The Relationship Between Education Level, Self-Rated Literacy, and Cognitive Functioning

The first analysis showed that the unconstrained study model had an acceptable fit to the data—$\chi^2(7) = 509.58$, $p < .0001$; CFI = 0.99, AGFI = 0.98, RMSEA = 0.05. The standardized parameters were 0.39 for education level and 0.44 for self-rated literacy (both $p < .0001$). That is, education level showed a slightly lower association with cognitive functioning than did self-rated literacy. To examine whether the parameters for education level and self-rated literacy differed significantly, we compared the unconstrained model in which the parameters were freely estimated to a model in which the parameters were constrained to be equal. The constrained model showed an acceptable fit—$\chi^2(8) = 797.47$, $p < .0001$; CFI = 0.98, AGFI = 0.97, RMSEA = 0.06. Nevertheless, the unconstrained model showed a significantly better fit to the data than did the constrained model, $\Delta\chi^2(1) = 287.88$, $p < .0001$, indicating that relative to self-rated literacy education level had a significantly weaker relationship with cognitive functioning. After adding age, sex, household income, number of diseases, ADL, reading eyesight, and country of origin as additional exogenous variables, the model still had an acceptable fit to the data—$\chi^2(25) = 2{,}309.26$, $p < .0001$; CFI = 0.97, AGFI = 0.95, RMSEA = 0.05. The standardized parameters were 0.34 for education level and 0.38 for self-rated literacy (both $p < .0001$). The parameters for education and self-rated literacy differed significantly, as the unconstrained model showed a significantly better fit to the data than did the constrained model, $\Delta\chi^2(1) = 182.33$, $p < .0001$. Thus, education level was less strongly related to cognitive functioning than was self-rated literacy, even after controlling for various relevant demographic variables.

Age as a Moderator in the Relationship Between Education Level, Self-Rated Literacy, and Cognitive Functioning

To examine whether age acted as a moderator for the association between education level and self-rated literacy on the one hand and cognitive functioning on the other hand, an unconstrained model was compared with a model in which the relationships between the exogenous variables and the endogenous variables were constrained across the age groups. This analysis showed an acceptable fit for both the unconstrained model—$\chi^2(21) = 531.76$, $p < .0001$; CFI = 0.99, AGFI = 0.98, RMSEA = 0.02—and the constrained model—$\chi^2(25) = 559.91$, $p < .0001$; CFI = 0.99, AGFI = 0.98, RMSEA = 0.02. Yet, the unconstrained model showed a significantly better fit to the data than did the constrained model, $\Delta\chi^2(4) = 28.14$, $p < .0001$, indicating that age moderated the relationships between the exogenous and the endogenous variables. After entering the additional exogenous variables to the model, the unconstrained model still showed a significantly better fit to the data than did the constrained model, $\Delta\chi^2(4) = 13.25$, $p = .01$.

Table 2. Correlations Among Study Variables

Variable	*M*	*SD*	1	2	3	4	5	6	7
1. Age	64.57	9.92	—						
2. Education level	2.53	1.51	−.25	—					
3. Subjective reading	3.65	1.13	−.23	.43	—				
4. Subjective writing	3.49	1.18	−.25	.45	.85	—			
5. Verbal recall	3.33	1.98	−.37	.32	.33	.34	—		
6. Word fluency	18.72	7.09	−.30	.38	.40	.40	.43	—	
7. Arithmetic ability	1.57	.83	−.23	.42	.35	.36	.34	.38	—
8. Sex	54%[a]		.01	−.10	−.02	−.01	.06	−.04	−.19
9. Household income	41,392	49,774	−.11	.20	.14	.14	.12	.16	.13
10. Medical conditions	1.53	1.44	.31	−.16	−.19	−.20	−.18	−.16	−.16
11. ADL	.17	.69	.21	−.10	−.19	−.21	−.16	−.18	−.13
12. Reading eyesight	3.25	1.14	−.14	.17	.35	.33	.16	.19	.16
13. Country	45%[b]		.00	.25	.11	.10	.06	.14	.10

Notes. *N* = 28,535. ADL = activities of daily living. Correlations stronger than |.01| are significant at the .001 level. Point biserial correlations were calculated for dichotomous variables.

[a] Percent women.

[b] Percent countries with mean education level above the entire sample's median.

Figure 1 presents the model for each of the three age groups. The figure shows that the contribution of formal education goes down across the age groups (from 0.42 to 0.27, all $p < .0001$), whereas the contribution of self-rated literacy goes up (from 0.40 to 0.48, all $p < .0001$). We also examined the separate contribution of education level and self-rated literacy to the prediction of cognitive functioning in different age groups. When including education level alone, a model that was unconstrained across the age groups showed a significantly better fit to the data than did a constrained model, $\Delta\chi^2(2) = 13.40$, $p = .001$. When including self-rated literacy alone, a model that was unconstrained across the age groups showed a significantly better fit to the data than did a constrained model, $\Delta\chi^2(2) = 16.22$, $p < .0001$. These analyses indicate that age moderated both the relationship between education level and cognitive functioning and the relationship between self-rated literacy and cognitive functioning.

In the earlier models, education level was measured at a manifest level whereas self-rated literacy was examined at a latent level. When both variables were examined at a manifest level (self-rated literacy computed as the mean of reading and writing ratings), the pattern of results remained the same. Age still moderated the relationship between education level and cognitive functioning as well as the relationship between self-rated literacy and cognitive functioning. An unconstrained model showed a significantly better fit to the data than did a model in which the parameters of education level and self-rated literacy were constrained to be equal, $\Delta\chi^2(4) = 26.45$, $p < .0001$. The contribution of formal education decreased across age groups (from 0.44 in the youngest age group to 0.29 in the oldest age group, all

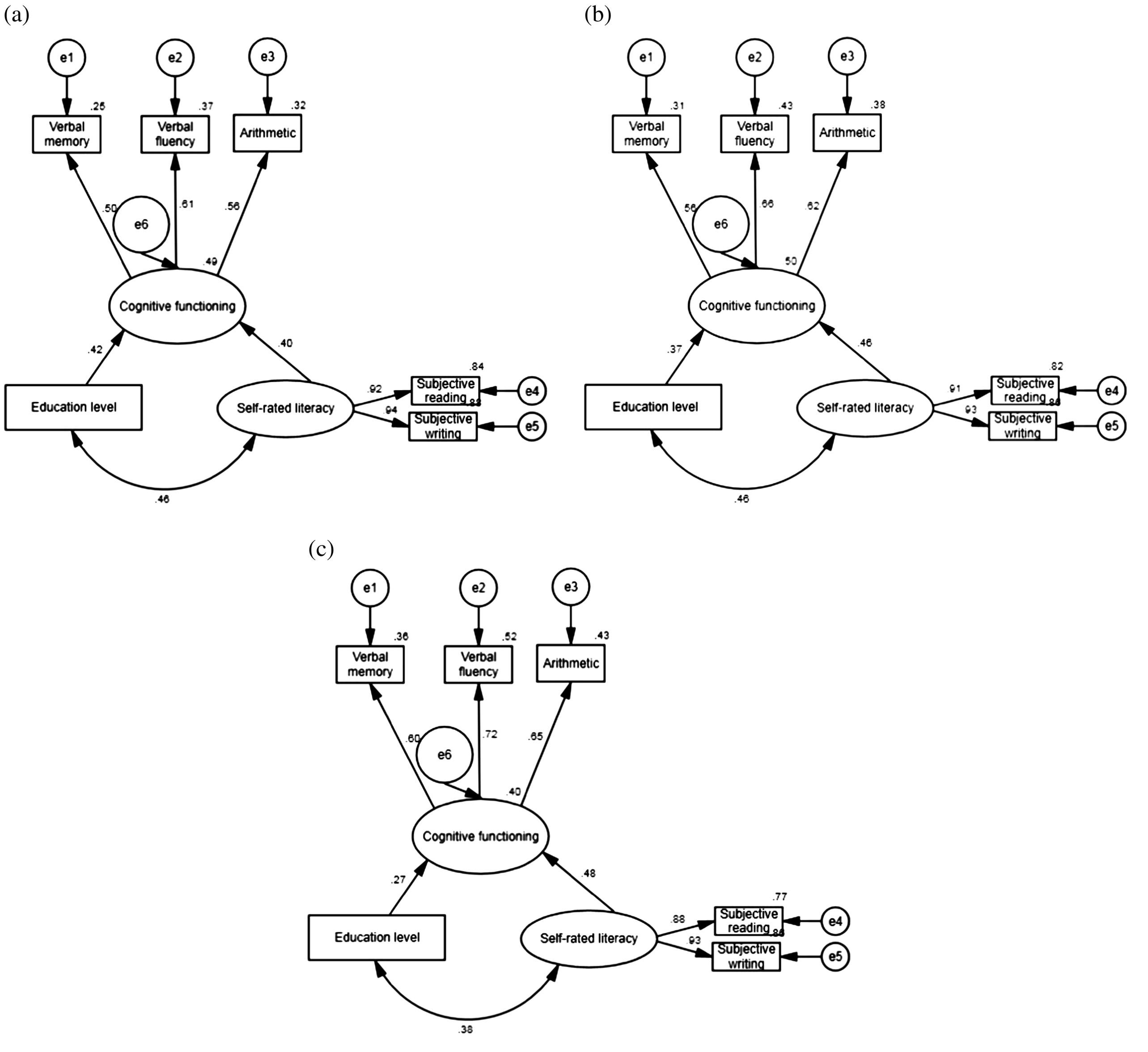

Figure 1. The study model in three different age groups. (a) Middle-aged adults (50–64; $n = 15{,}462$). (b) Young–old (65–79; $n = 10{,}542$). (c) Old–old (80+; $n = 2{,}531$).

$p < .0001$), whereas the contribution of self-rated literacy increased (from 0.38 to 0.45, all $p < .0001$).

Discussion

Our data suggest that self-rated literacy is a better predictor of cognitive functioning in old age than is one's formal educational level. The first analysis demonstrated that the link between self-rated literacy and cognitive ability was stronger than the link between education level and cognitive ability, and this difference remained significant even after adding age, sex, household income, medical conditions, ADL, reading eyesight, and country of origin to the model. Our second analysis showed that age moderated these relationships, so that the older the participants the more strongly self-rated literacy was associated with cognitive ability and the less strongly education level was associated with cognitive ability.

According to previous research, objective measures of literacy attest to the quality of education (Dotson et al., 2009; Manly et al., 1999, 2005), and therefore, they represent actual abilities better than does the formal level of schooling. In the present study, we examined self-assessed measures of reading and writing instead of using an objective test of reading skills, as done before. We acknowledge that there might be a reporting bias in our subjective literacy measure; yet, certain respondents might underestimate their abilities, whereas others might overestimate their abilities. In addition, it is not entirely clear whether people reported their lifetime abilities or their current abilities, as compared with those of their peers, and there might be a tendency toward reporting one's most recent literacy level rather than past abilities. We also cannot rule out the possibility that certain respondents provided inconsistent ratings of their abilities due to cognitive decline. Yet, severely demented individuals could not have completed the in-depth SHARE interview, and individuals with mild cognitive impairment do not necessarily underreport their status, as is often the case in dementia (see Farias, Mungas, & Jagust, 2005). Despite these potential biases, we believe that self-rated literacy may be superior to testing of reading levels because it allows us to predict current cognitive functioning on the basis of an easy-to-administer questionnaire rather than on the basis of a test in which the examiner must record the person's responses. Because we used no objective reading tests but only objective measures of education, future research should directly compare the contribution of literacy ratings and reading tests to the prediction of cognitive functioning in old age.

The strong correlation between one's subjective literacy and one's objective education level, as well as the fact that subjective ratings were similarly correlated with age as was the objective level of education, suggests that self-rated reading and writing abilities probably reflect one's lifelong self-concept of one's literacy capability. This conclusion is in line with the findings by Richards, Power, and Sacker (2009) that compromised literacy (measured through self-rated difficulties in reading, writing, and math in midlife) is significantly correlated with objective education level. Richards and colleagues (2009) also report that the association between one's education level and one's self-reported literacy is sensitive to changes in social policies (i.e., the change in school-leaving age that occurred in Britain in 1972). Specifically, those who were born at a later time, and consequently received more schooling, believed they had fewer literacy difficulties. It appears, then, that self-reported literacy levels are not completely free of the influence of social factors.

Researchers are undoubtedly inclined to use objective rather than subjective measures, so as to avoid reporting bias or misunderstanding on the part of the respondents. However, studies in various fields of psychology attest to the usefulness of subjective ratings. For instance, a recent attempt to validate the use of self-rated well-being questionnaires shows strong associations between subjective assessment and objective measures of the quality of life (Oswald & Wu, 2010). Moreover, studies of self-rated health show that subjective measures are often superior to objective indicators of health status in predicting mortality (Benyamini et al., 2003; Idler & Benyamini, 1997). Subjective ratings might be more inclusive in that they might contain heuristic self-knowledge, which is not fully detectable in parsimonious tests or survey measures. In addition, ratings might be more dynamic than objective formal measures, adjusting for changes that happened over the years (Benyamini et al., 2003; Idler & Benyamini, 1997). When literacy is concerned, individuals most likely assess their achievements during school as well as the abilities that they have mastered since graduation, taking their lifetime into consideration rather than only the time spent in school. It is not surprising, then, that a contemporary measure (i.e., subjective literacy) is a better predictor of current cognitive status than is a variable that has been static for 30–60 years (i.e., level of education). Hence, our results suggest that self-rating of literacy might be just as useful in aging research as other subjective measures.

Importantly, not only did we find a difference between the contribution of education level and self-rated literacy to the prediction of cognitive performance in the entire data set but we also found that age moderated this differential contribution. It could be the case that age-related changes lead to a decline in one's ability and this decline is reflected in one's self-rating, obviously not affecting past educational attainment. However, the similar correlation between age and self-rated literacy on the one hand and between age and education level on the other hand does not support such an interpretation. Alternatively, literacy might be a better predictor of cognitive ability in old age because the same type of formal education resulted in different outcomes across age cohorts (Alwin & McCammon, 2001). It is also possible that the variance in education level was more restricted among the older respondents than among the younger participants, whereas elderly adults demonstrated a greater variance in self-rated literacy levels than did the younger adults. Our cross-sectional data set does not allow us to distinguish the effects of age from the effects of age cohort, and such distinctions should be examined in a data set that has both cross-sectional and longitudinal observations. Future research should also look at education level as a continuous variable, measuring years rather than type of formal schooling. However, as the SHARE sample includes a dozen countries, each with a very different education system, the schooling categories used here were crucial for equating achievements across cultures.

In summary, although education level is highly connected to cognitive level in healthy older adults (Albert et al., 1995; Ardila et al., 2000; Barnes et al., 2004; Christensen et al., 1997), as well as in our own data, and although it has been shown to contribute to the prediction of dementia (McDowell et al., 2007; Mehta et al., 2007; Ngandu et al., 2007; Scarmeas et al., 2006), our analyses suggest that in late life, self-rated literacy might be a better predictor of the cognitive functions tested here. Although self-rated literacy might be affected by many variables, including native ability, quantity and quality of schooling, an increase or a decrease in ability over life, as well as social and age differences, we believe that it might prove to be a useful tool in future aging research. Our study suggests that the association between self-rated literacy and other variables that normally relate to education level should be further examined.

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