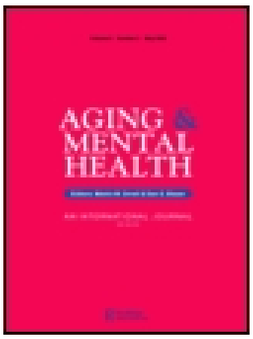

Routledge
Taylor & Francis Group

Aging & Mental Health

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/camh20

Educational mobility and older adults' working memory updating ability: association and role of resilience

Xin Zhao, Qiaoping Zheng & Joseph H. R. Maes

To cite this article: Xin Zhao, Qiaoping Zheng & Joseph H. R. Maes (2022): Educational mobility and older adults' working memory updating ability: association and role of resilience, Aging & Mental Health, DOI: 10.1080/13607863.2022.2141194

To link to this article: https://doi.org/10.1080/13607863.2022.2141194

AGING & MENTAL HEALTH
https://doi.org/10.1080/13607863.2022.2141194

Educational mobility and older adults' working memory updating ability: association and role of resilience

Xin Zhao[a], Qiaoping Zheng[a] and Joseph H. R. Maes[b]

[a]School of Psychology, Northwest Normal University, Lanzhou, China; [b]Donders Institute for Brain, Cognition and Behaviour, Centre for Cognition, Radboud University, Nijmegen, The Netherlands

ABSTRACT

Objective: Previous research revealed that a low childhood socioeconomic status, including low parental education, correlates with impaired executive functioning. However, there is a lack of research on the association of working memory updating (WMU) ability, which is one of the major components of executive functioning, and of resilience with educational mobility. The purpose of the present two studies was to further examine these associations.

Method: In Study 1, 180, 60–88-year old adults with different levels of educational mobility performed a WMU task. In Study 2, 130, 60–89-year old adults that had experienced different levels of upward educational mobility completed a WMU task and a resilience questionnaire.

Results: Study 1 revealed that extent of educational mobility was significantly positively associated with WMU ability. Study 2 revealed significant positive associations among extent of educational mobility, resilience, and WMU task performance.

Conclusion: The results were discussed in terms of possible causal relations between the variables and implications for interventions that aim to enhance upward educational mobility and cognitive functioning in late adulthood.

ARTICLE HISTORY
Received 20 March 2022
Accepted 23 October 2022

KEYWORDS
Educational mobility; working memory updating; resilience; older adult

Introduction

It is well established that growing up in a family with a low socioeconomic status (SES) is associated with compromised physical and mental health throughout the individual's life (e.g. Angelini et al., 2019; Balaj et al., 2021; Milaniak & Jaffee, 2019; Murray et al., 2011). Such association has also been found for cognitive functioning in general, and executive functioning, such as working memory updating (WMU), in particular (e.g. Aartsen et al., 2019). WMU refers to a limited-capacity system that enables the individual to hold information in mind for a short period of time and to replace it with novel task-relevant information (e.g. Ecker et al., 2014). WMU ability has a unique contribution to performing many daily-life tasks (e.g. Ecker et al., 2010), and has been target of many cognitive training programs. Such training has been shown to have moderate positive effects on cognitive performance, especially on the trained task and tasks closely related to the trained task, and underlying brain substrates (e.g. see Pappa et al., 2020, for a recent review).

Negative cognitive effects of low childhood SES have been found to persist into adolescence (e.g. Hackman et al., 2014) and (late) adulthood (Last et al., 2018; Zhang et al., 2018). Such persistence may be due to enduring, direct neurocognitive effects of exposure to disadvantageous environmental circumstances (e.g. pollution, toxic substances; e.g. Dórea, 2021), harsh parenting (e.g. Suor et al., 2017), poor nutrition and medical care (e.g. Pizzol et al., 2021), and deprivation of cognitive stimulation (e.g. Rosen et al., 2020). According to the latency or critical period hypothesis, the negative effects of these low childhood SES-associated conditions operate independently of the SES level achieved during adulthood (e.g. Kaplan et al., 2001; Zhang et al., 2008; Zhang et al., 2018). Alternatively, these negative conditions might in turn lead to low SES in adulthood, which then is conducive to poor cognitive functioning. This hypothesis, fitting a pathways or chain of risks model (Kuh et al., 2003), is supported by research finding evidence that adulthood SES mediates the relation between childhood SES and cognitive functioning (e.g. Greenfield et al., 2021; Lyu & Burr, 2016).

However, fortunately, there is also evidence that the association between low childhood SES and poor health and cognitive outcomes is not irrevocable. For example, research suggests that it may be moderated by changes in childhood SES, such as when the income of the child's parents increases (e.g. Levesque et al., 2021). Moreover, the association may be moderated by the SES level attained in adulthood (e.g. Liu & Lachman, 2019), even to the extent that the current SES level is a determining factor independent of the SES in childhood (e.g. Zhang et al., 2015). That a low childhood SES does not necessarily continue into adulthood becomes evident in case a low childhood SES individual is able to realize higher levels of income, education, etc., as compared to the individual's parents or caregivers, or in other words, experiences upward socioeconomic mobility. Although such mobility may have negative physical health consequences under certain conditions (Chen et al., 2022; Destin, 2019), positive health and cognitive effects have generally been found in previous research when compared to individuals experiencing no or a downward SES mobility (e.g. Faul et al., 2021; Luo & Waite, 2005; Turrell et al., 2002; Weissberger et al., 2021). The latter effects are in accordance with the accumulation hypothesis, which assumes that

CONTACT Joseph H. R. Maes roald.maes@donders.ru.nl
Supplemental data for this article can be accessed online at https://doi.org/10.1080/13607863.2022.2141194

childhood and adulthood SES have an additive effect on health outcomes (Kuh et al., 2003).

One of the factors that may play a role in the association between SES and cognitive and health outcomes is resilience. The concept of psychological resilience is a complex one, with a multitude of definitions (e.g. Fletcher & Sarkar, 2013; Southwick et al., 2014). Some definitions refer to resilience as a *process,* for example the process of adapting well in the face of adversity, trauma, tragedy, threats, or significant sources of stress (APA, 2020). Other definitions conceive of the concept as a *trait,* referring to a stable individual personality characteristic that promotes adaptation to adverse circumstances (e.g. Luthans et al., 2007), or as an *outcome*, that is the maintenance of mental and physical health under such circumstances (e.g. Chmitorz et al., 2018). However, resilience can perhaps best be considered as the interaction between, or synergy of, trait, process, and outcome (e.g. Fullerton et al., 2021; Kuldas & Foody, 2022). In the present study, we will use a common self-report resilience measurement instrument, which may be considered to primarily tap into resilience as a trait. However, given the foregoing considerations, the score on such instruments is likely also relevant for the individual's process of dealing with adverse situations, and for the outcome of this process. One implication of this would be that resilience, as measured with such instruments, should not be considered as a fixed ability, but to be amendable by, for example, interventions. Resilience could explain why, and affect whether, an individual with a low childhood SES achieves upward socioeconomic mobility. Specifically, self-reported resilience has been found to at least partially mediate the positive association between objective and subjective childhood SES indicators and engagement in learning, which in turn predicts SES-relevant academic achievement (Chen et al., 2021). Huang et al. (2019) found that the negative association between childhood SES and risk of emotional maladaptation in adolescence, including emotion (dis)regulation, was moderated by self-reported resilience. As emotional maladaptation may be a factor relevant for achieved SES level during adulthood, this result again suggests that, at least for some outcome variables, the link between low childhood SES and low adulthood SES may not be inevitable. Specifically, it may be weakened or eliminated by resilience as a modifiable mechanism. However, to our knowledge, the role of resilience in (upward) socioeconomic mobility when focusing on executive functioning in general, and working memory updating in particular, has not been investigated before. Such knowledge might inform measures to promote upward SES mobility.

Present studies

As outlined above, previous research yielded mixed results regarding the role of adulthood SES in the association between childhood SES and cognitive outcome variables. The purpose of Study 1 was to further our knowledge on this issue, specifically focusing on WMU. As also indicated above, WMU has strong links to daily-life functioning, including academic achievement (e.g. Gathercole et al., 2004). We used data from a larger study that had provided data from older adults (OAs) that reported on their own and parents' educational attainments, and that had performed a WMU task. Educational attainment is one of the most frequently used SES indicators (e.g. Broer et al., 2019; Willms & Tramonte, 2019), and one of the major factors affecting the SES (e.g. Li, 2020). The sample included OAs that had experienced downward educational mobility (having achieved a lower educational level than their parents), no educational mobility (same level as their parents' education level), or upward mobility (higher educational attainment compared to their parents). The question of primary interest was whether WMU ability would primarily be a function of the parents' educational attainment, the OAs own educational attainment, or both. According to the latency hypothesis, the parents' education level would be the sole determining factor for WMU ability as measured during late adulthood. The accumulation hypothesis instead assumes that the combination of both parental and own educational level predicts WMU ability, perhaps even to the extent that only the individual's own education level determines WMU performance, irrespective of the parents' education level. A second question was whether individual differences in extent of educational mobility, defined as the difference in educational level attained by the parents and the individual, would be significantly associated with differences in WMU ability.

In Study 2, we zoomed in on the role of resilience in the association between educational mobility and WMU ability. Using OAs that all had undergone upward educational mobility, we examined the associations among magnitude of upward mobility, performance on a WMU task, and self-reported resilience. We hypothesized these associations would all be positive. The results of the current studies were evaluated in terms of possible causal models that may inform measures to enhance upward educational mobility.

Method

Participants

In Study 1, OAs were approached via notices in two large local activity centers for the elderly, in housing communities, and in public parks. Consent to issue the notices was obtained from community representatives or responsible persons. One-hundred and eighty-eight participants volunteered to participate. Eight participants did not complete all parts of the study and their data were not included in the analyses. The remaining sample consisted of 110 men and 70 women, with a mean age of 68.9 years ($SD = 5.9$; range: 60 – 88). One-hundred and twenty-nine participants (71.7%) were urban residents; the remaining participants lived in rural areas. In Study 2, a total of 165 OAs, aged ≥ 60 years, were approached in the same manner as in Study 1. Twenty-six individuals were excluded because they did not fulfil the criterion for upward educational mobility. One OA terminated participation halfway the study and eight participants did not complete the RM tasks according to the instructions (e.g. writing down the to-be-remembered items on paper). The remaining 130 participants, 74 men and 56 women with a mean age of 70.0 ($SD = 7.2$; range: 60 – 89), all had a lower parental than own educational level. In fact, for each participant the parental educational level was 1. All participants in Study 1 and 2 were of the Han population and had verbally given their informed consent and participated on a voluntary basis. Each participant was given a small gift at the end of the study. The study was approved by the ethics committee of Northwest Normal University (approval number: nwnupsy202108).

Power analyses

The main analysis in Study 1 concerned a multiple regression analyses with 5 predictors (see below). An a priori power analysis using Gpower (Faul et al., 2007) had revealed a required

sample size of 166 in order to detect a weak-to-moderate effect size (f^2 = .08), with a power of 1-β = 0.80 and α = 0.05. For both studies and based on previous studies, we expected at least moderate positive correlations (ρ = .30) among the key variables. An a priori power analysis revealed a required sample size of 67 in order to find such moderate correlation in a one-tailed test, with a power of 1-β = 0.80 and α = 0.05.

Materials

Parental educational level

We asked the participants to report the highest level of parental education, either of the father or mother (e.g. see Liu & Lachman, 2019). The possible scores (1 – 9) were as follows: (1) without any education; (2) primary school, not finished; (3) graduated from private school/primary school; (4) graduated from junior high school; (5) graduated from senior high school; (6) graduated from technical secondary school; (7) graduated from junior college; (8) undergraduate; (9) master or doctoral degree.

Participant's educational level

The participant's education level was assessed using the same scale as described for assessing parental educational attainment.

Running memory (RM) tasks

These computer tasks were used to assess WMU ability. Participants were presented with multiple trials, each consisting of a sequence of digits (1 – 9). Upon the presentation of each digit, they had to memorize the last three items presented thus far. The participants were asked to enter the last three digits of the sequence at the end of the current sequence. Unknown to the participants, trials differed in the length of the sequence, which could be 5, 7, 9, or 11 digits. The first RM task (the RM-1750 task) commenced with a block of practice trials, after which the actual test began. The test comprised 24 trials. During each block of four trials, each sequence length was presented once, in a random order. Each digit was presented for 1750 ms after a 500-ms fixation cross, and a blank screen that was presented for a variable duration between 800 and 1200 ms. The second RM task, the RM-750 task, was presented immediately after the RM-1750 task. This task was identical to the RM-1750 task, except that there were no practice trials and the digit presentation time was reduced to 750 ms. The dependent measure used for each task was the proportion of digits that were correctly reproduced in the correct serial order. Overall, the participants performed somewhat better on the supposedly easier RM-1750 task (Study 1 and 2: mean accuracy: 0.73 and 0.78, respectively) than the more difficult RM-750 task (Study 1 and 2: mean accuracy: 0.69 and 0.74, respectively), and analysis of variance (ANOVA) revealed that the difference was significant, Study 1: $F(1, 179) = 14.46$, $p < .001$, $\eta_p^2 = .08$; Study 2: $F(1, 129) = 16.22$, $p < .001$, $\eta_p^2 = .11$. However, the general pattern of results of the main analyses (see below) was the same using either the accuracy score from the RM-1750 or the RM-750 task. Therefore, we used the mean of the performance accuracy of the two tasks as dependent variable in both studies.

Connor-Davidson resilience scale (CD-RISC; only study 2)

The Resilience Scale developed by Connor and Davidson (2003) was translated and revised into Chinese (Yu & Zhang, 2007). The scale consists of 25 statements and includes three dimensions: tenacity, strength, and optimism. An example item is: 'When things look hopeless, I don't give up'. For each item, the participant had to indicate to what extent the statement is applicable, looking at the past month and using a 5-point Likert scale (1 = not true at all; 5= true all the time). A higher total score indicates greater resilience. The inter-rater reliability was high, Cronbach's α = 0.91.

Procedure

The data for Study 1 were collected in the period March–May 2021; those for Study 2 in May–July 2021. In both studies, participants who had given their informed consent were brought to a quiet place near the place of recruitment, such as the reading room of the activity or community center, by a trained professional. They first filled in the educational attainment items using paper and pencil. The OAs in Study 2 then filled in the CD-RISC. All participants completed the two RM tasks after filling in the questionnaires.

Statistical analysis

The scores on the various instruments in Study 1 and 2 did not contain any outliers, defined as scores that are three times the value of the interquartile range (IR) beyond the quartiles scores, and we used parametric statistical analyses. For each study, we computed partial correlation coefficients for each pair of outcome variables, while controlling for the participant's age and sex. One of the outcome variable was the educational mobility score, which was computed by subtracting the parents' educational level from the participant's level (possible range: –8–8 for Study 1, and 1–8 for Study 2). To examine the magnitude of the effect of the parental and/or participant's educational level in Study 1, we subjected the mean RM task performance score to a multiple regression analysis, entering age and sex as predictors in Model 1, and adding parental educational level, the participant's educational level, and their interaction as predictors in Model 2. We used SPSS 27 software to perform the analyses, using an α level of 0.05 as criterion for statistical significance.

Results

Table 1 displays details of the parents' and participants' educational attainment, the RM task performance scores, and, for Study 2, the resilience measurement. The table also shows the partial correlation coefficients among the outcome measures. For Study 1, the participants' educational level and the educational mobility score were each significantly positively associated with performance on the running memory task. The parents' educational level was not significantly correlated with the task performance. Table 2 shows the details of the multiple regression analysis. Model 1, including the participant's age and sex as predictors, did not explain a significant portion of running memory task performance, although the negative regression coefficient for age was significant, reflecting decreasing task performance with increasing age. Importantly, adding the parental and the participants' education level and their interaction as predictors resulted in a significant increase in explained variance. The full model was now significant, with the participants' educational level being the only significant predictor.

Table 1. Descriptive statistics and partial correlations between the variables for Study 1 and 2.

Measure	Mean [CI]	SD	Min –Max	1	2	3	4
Study 1							
1. Edu-parents	1.97 [1.77, 2.16]	1.33	1–8	–			
2. Edu-participant	4.02 [3.78, 4.27]	1.66	1–8	.08 [–.05, .21]	–		
3. Edu-mobility	2.06 [1.76, 2.35]	2.03	–4–7	**–.59** [–.69, –.46]	**.76** [.66, .84]	–	
4. RM-ACC	0.71 [0.69, 0.73]	0.15	0.25–0.94	.11 [–.05, .24]	**.48** [.34, .60]	**.32** [.15, .47]	
Study 2							
2. Edu-participant	5.35 [5.06, 5.65]	1.69	2–8	–			
3. Edu-mobility	4.35 [4.06, 4.65]	1.69	1–7	–	**1.00 [1.00, 1.00]**	–	
4. RM-ACC	0.76 [0.74, 0.79]	0.14	0.20–1.00	–	**.38 [.19,.54]**	**.38 [.18, .53]**	–
5. Resilience	95.01 [92.46, 97.56]	14.69	58–125	–	**.35 [.17, .52]**	**.35 [.18, .51]**	**.34 [.18, .48]**

Note. Edu = educational level RM-ACC = accuracy on the running memory task. SD = standard deviation. Values within square brackets represent 95% bias-corrected and accelerated confidence interval [CI] based on 5000 bootstrap samples. Correlation coefficients represent correlations with control for the participant's age and sex. Correlation coefficients in bold are significant at $p < .001$. $N = 180$ for Study1; $N = 130$ for Study 2.

Table 2. Study 1: Hierarchical regression with score on the RM task as criterion.

Predictor	β	ΔF (df)	F (df)	ΔR^2	R^2
Model 1			2.49 (2, 177)		.03
Age	–.18*				
Sex	–.10				
Model 2		17.89*** (3, 174)	12.02*** (5, 174)	.23	.26
Age	–.06				
Sex	–.03				
Edu-parental	.08				
Edu-participant	.48***				
Edu-interaction	–.04				

Note. Edu = educational level. β represents standardized regression coefficient. *$p < .05$, ***$p < .001$.

In Study 2, the moderate correlations between educational mobility and the CR-RISC score, between educational mobility and the RM task performance score, and between the CR-RISC and RM task performance scores were all highly significant (see lower part of Table 1).

Discussion

Study 1 revealed that OAs' WMU ability was positively associated with the participants' own educational level but not with the educational level of their parents. Moreover, WMU ability was significantly associated with the direction and magnitude of educational mobility. Specifically, with the parents' educational level as comparison, a larger educational attainment during adolescence/adulthood was associated with a stronger WMU ability. Study 2 revealed positive associations between WMU ability, self-reported resilience, and extent of upward educational mobility in a sample of OAs.

The results of the correlational analysis in Study 1 support the general notion that WMU ability is positively associated with educational mobility. The significant effect of educational level attained in adulthood on RM task performance is in accordance with other studies reporting an independent contribution of adulthood SES level to cognitive performance in older age (e.g. Zhang et al., 2015, measuring processing speed). However, the simultaneous absence of an independent, main effect of parental educational level in Study 1 is not in line with studies finding an independent effect of childhood SES on cognitive abilities, even when controlling for SES level in adulthood (thus supporting the latency model; e.g. see Zhang et al., 2018, measuring episodic memory ability). Possible reasons for the discrepant results may be the difference in operationalization of educational level and in the examined cognitive ability, but this should be further examined in future studies.

The pattern of results in our Study 1 is not in accordance with two of the three models of the association of childhood SES and/or adulthood SES with cognitive functioning. Specifically, the absence of a significant main effect of parental education level is not in line with the latency model, predicting an enduring influence of indicators of childhood SES on the OAs cognitive functioning irrespective of adulthood SES. It is also not in line with a pathway (mediation) model, which hypothesizes a significant association between (indicators of) childhood SES and cognitive performance that is mediated by (indicators of) adulthood SES (implicating no SES mobility at all). However, an accumulation model, which expects independent, summed contributions of childhood and adulthood SES, may be supported by the present results. That is, the participants' educational level on average was much higher and showed more variance compared to the parental educational level (e.g. 73.9% of the participants reported the lowest two parental educational levels, possibly promoting floor effects). Therefore, the relative contribution of the participant's educational level to RM task performance was larger than that of the parent's educational level.

The positive association between educational mobility and RM performance accuracy observed in Study 2 is in accordance with a similarly strong association found in Study 1. The combined results suggest a robust association between educational mobility, expressed as the difference between the parents' and own education level, and WMU ability, regardless of whether the sample consists of individuals with mixed educational mobility (no, upward, or downward; Study 1) or exclusively of individuals with an upward mobility (Study 2). The positive association between educational mobility and self-reported resilience supports the results of recent studies, which were also performed within a Chinese cultural context, examining the role of resilience for other related factors relevant for (upward) educational mobility, such as learning engagement (Chen et al., 2021) and emotional adaptation (Huang et al., 2019). Finally, the positive association between RM task performance and resilience is partly in line with the results of a recent study examining the relation between measures of related concepts in young South African adults from disadvantaged backgrounds (Bemath et al., 2020). Specifically, these authors examined working memory abilities, using a computerized test battery that tapped various types of working memory (but not WMU), and resilience using a self-report measure of resilience-promoting resources. The authors also employed a qualitative instrument (semi-structured interview) to assess aspects related to everyday working memory and resilience. Primarily based on the qualitative analyses, the authors found support for the notion that working memory processes indirectly promote resilience-enabling behaviors. The results of the present Study 2 indicate quantitative support for an association

between one specific aspect of working memory, namely WMU, and self-reported resilience, when examining OAs that had a low parental education background but that had succeeded in achieving a higher educational level than that of their parents.

Speculations on causal relations

The positive association between the OAs' educational (mobility) level and WMU ability found in the present studies expands the results of previous studies examining the association between educational attainment and general cognitive abilities (like measured with tests of processing speed or fluid intelligence, or with composite scores based on test batteries), across adulthood (see Lövdén et al., 2020, for a review). However, studies reporting positive associations (including the present studies) often are cross-sectional and correlational, thereby not allowing strong claims about the causal relation underlying these associations. On one hand, exposure to education, and the implied cognitive stimulation, might be conducive to the development of cognitive abilities, including those measured with the WMU task used in the present studies. For example, the better educated individual might have developed more cognitive resources to tackle cognitively demanding tasks than the less well educated individual. Alternatively, and perhaps more likely (see also Von Bastian et al., 2022), the better educated person might have become more efficient in performing tasks demanding functions like those implied in WMU tasks, for example as a result of learning specific strategies to approach such tasks (see also Lövdén et al., 2020). This view implies a causal relation whereby differences in educational mobility result in differences in WMU ability (educational mobility–>WMU ability). On the other hand, there may be individual differences in a child's (developed or inherited) WMU ability, and a relatively strong WMU ability is one factor involved in the achievement of educational mobility. On this view, differences in WMU ability are cause rather than effect of differences in educational mobility (WMU ability–>educational mobility). At present, we cannot determine which one of the two possible causal pathways underlies the current results, or whether they are equally involved in a reciprocal relation.

The complex issue of causality is also clearly involved when it comes to interpreting the found positive associations between educational mobility, WMU ability, and self-reported resilience. For example, differences in resilience and persistence may be causal to differences in educational mobility (e.g. Browman et al., 2017), assuming that resilience is a necessary condition for being able to cope with, and counteract, the negative conditions associated with a low SES background. This notion, combined with an assumed causal relation between mobility and WMU would support a mediation model in which resilience promotes educational mobility, which in turn enhances WMU task performance (resilience–>educational mobility–>WMU ability). However, one cannot rule out the possibility that experiencing upward SES mobility, including educational mobility, results in higher levels of such psychological features as confidence and resilience than having been subject to downward SES mobility. Such enhanced resilience may then facilitate performance on demanding cognitive tasks (model: educational mobility–>resilience–>WMU ability). However, other models might be equally feasible. For example, Evans et al. (2016) performed a longitudinal study in 9-15-year-old children in which working memory (WMU was not measured) at T1 predicted different coping styles at T2. As coping is a concept related to resilience (e.g. Leipold & Greve, 2009), this study provides some indirect support for a WMU ability->resilience causal link. Combining this link with the notion of resilience promoting educational mobility yields the mediation model: WMU ability->resilience–>educational mobility. Yet another model might assume that differences in WMU ability are causal to differences in (upward) educational mobility, which in turn facilitates resilience (WMU ability–>educational mobility–>resilience). In fact, exploratory formal mediation analyses based on the data of Study 2 (see Supplementary material, Table 1, for details) found support for each of the six possible mediation models involving the three variables (significant indirect effect of predictor on criterion through mediating variable). On a side note, none of the six theoretically possible *modulation* models involving the three variables WMU ability, resilience score, and RM task performance revealed a significant predictor × modulator interaction (moderation) effect (see Supplementary material, Table 2, for details). Arguably, as also suggested for the link between WMU ability and educational mobility, these causal relations likely operate in a mutual, reciprocal way. If so, then enhancing resilience and/or WMU ability through (cognitive) interventions might contribute to facilitate educational mobility in children from low SES backgrounds, thereby also positively contributing to cognitive functioning at an older age.

Limitations and future directions

As already implied in the above speculations, a clear limitation of the present cross-sectional studies is that they do not allow us to draw strong conclusions about causal relations underlying the observed associations. The various possible pathways discussed require future longitudinal studies for further validation. A second limitation concerns the fact that we only used one task, the running memory task, to assess WMU ability. This means that non-WMU, task-specific aspects might have importantly driven the associations with educational mobility and resilience. A collection of tasks purportedly measuring the (latent) WMU concept should be used in future research to further support the observed associations. However, given the examined target population in our studies, we felt somewhat limited in terms of the (cognitive) strain that we wanted to confront our participants with. There is also some support in the literature for the claim that the running memory task does not measure WMU at all, but simple retrieval from a passive storage (Broadway & Engle, 2010; Elosúa & Ruiz, 2008; Palladino & Jarrold, 2008). However, other research suggests that WMU updating is the dominant process when the participant has sufficient time to use WMU resources, such as is the case with relatively long stimulus presentation times (Botto et al., 2014; Bunting et al., 2006). In this framework, it must be noted that even our shortest presentation time RM task version implied a presentation time that is longer than that used in the studies supporting the 'retrieval from passive store' claim, suggesting that our tasks did assess WMU. However, this issue also calls for the (additional) use of other WMU tasks in future research. Relatedly, although WMU is considered by many to be the most important component of executive functioning, other components, such as inhibition and cognitive flexibility (e.g. Miyake et al., 2000), have also been shown to have associations with SES indices and resilience (e.g. Spielberg et al., 2015; Wu et al., 2021) and future work should assess whether the present results generalize to these other aspects of executive functioning. Finally, as

there are cultural influences on SES mobility-relevant resilience (e.g. Phillips et al., 2016; Wu et al., 2011), it remains to be seen whether the present results, based on participants from a collectivistic culture, generalize to non-western, individualistic cultures. Relatedly, the relations implied in the different discussed paths might differ as a function of race or ethnicity (e.g. Akhlaghipour & Assari, 2020; Assari, 2018; Assari & Caldwell, 2019). The present study exclusively involved individuals from the Han population and it remains to be investigated whether the present results generalize to other ethnic or racial groups.

Conclusions

Study 1 revealed that WMU ability was positively associated with the participants' own educational level but not with the educational level of their parents. Furthermore, extent and direction of educational mobility, indexed by the difference in participant's and parents' education level, was significantly associated with performance on the WMU task. Study 2 focused on OAs that all had experienced upward educational mobility. In this group, moderate but highly significant positive associations were found between extent of educational mobility, self-reported resilience, and RM task performance. The results from the studies, which were discussed in the framework of hypotheses regarding possible causal relations, may inform interventions to enhance upward socioeconomic mobility and cognitive functioning of older adults.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

This work was supported by the National Natural Science Foundation of China under Grant number 32260207; Humanities and social sciences research project of the Ministry of Education under Grant number 21XJA190005; and Cultivation project of major scientific research projects of Northwest Normal University under Grant number NWNU-SKZD2021-06. Recipient: XZ for all three grants.

ORCID

Xin Zhao http://orcid.org/0000-0001-9585-8306
Joseph H. R. Maes http://orcid.org/0000-0002-4536-695X

Data availability statement

Pre-processed data that support the findings of this study are openly available in Mendeley at https://doi.org/10.17632/2b9n96k8vh.1

References

Aartsen, M. J., Cheval, B., Sieber, S., Van der Linden, B., Gabriel, R., Courvoisier, D. S., Guessous, I., Burton-Jeangros, C., Blane, D., Ihle, A., Kliegel, M., & Cullati, S. (2019). Advantaged socioeconomic conditions in childhood are associated with higher cognitive functioning but stronger cognitive decline in older age. *Proceedings of the National Academy of Sciences of the United States of America*, *116*(12), 5478–5486. http://dx.doi.org/10.1073/pnas.1807679116

Akhlaghipour, G., & Assari, S. (2020). Parental education, household income, race, and children's working memory: Complexity of the effects. *Brain Sciences*, *10*(12), 950. https://doi.org/10.3390/brainsci10120950

American Psychological Association. (2020, February 1). *Building your resilience*. http://www.apa.org/topics/resilience

Angelini, V., Howdon, D. D. H., & Mierau, J. O. (2019). Childhood socioeconomic status and late-adulthood mental health: Results from the survey on health, ageing and retirement in Europe. *The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences*, *74*(1), 95–104. http://dx.doi.org/10.1093/geronb/gby028

Assari, S. (2018). Parental education attainment and educational upward mobility; Role of race and gender. *Behavioral Sciences*, *8*(11), 107. https://doi.org/10.3390/bs8110107

Assari, S., & Caldwell, C. H. (2019). Parental educational attainment differentially boosts school performance of American adolescents: Minorities' diminished returns. *Journal of Family & Reproductive Health*, *13*(1), 7–13.

Balaj, M., York, H. W., Sripada, K., Besnier, E., Vonen, H. D., Aravkin, A., Friedman, J., Griswold, M., Jensen, M. R., Mohammad, T., Mullany, E. C., Solhaug, S., Sorensen, R., Stonkute, D., Tallaksen, A., Whisnant, J., Zheng, P., Gakidou, E., & Eikemo, T. A. (2021). Parental education and inequalities in child mortality: A global systematic review and meta-analysis. *Lancet (London, England)*, *398*(10300), 608–620. https://doi.org/10.1016/S0140-6736(21)00534-1

Bemath, N., Cockcroft, K., & Theron, L. (2020). Working memory and psychological resilience in South African emerging adults. *South African Journal ofPsychology*,*50*(4),493–506.https://doi.org/10.1177/0081246320920868

Botto, M., Basso, D., Ferrari, M., & Palladino, P. (2014). When working memory updating requires updating: Analysis of serial position in a running memory task. *Acta Psychologica*, *148*, 123–129. https://doi.org/10.1016/j.actpsy.2014.01.012

Broadway, J. M., & Engle, R. W. (2010). Validating running memory span: Measurement of working memory capacity and links with fluid intelligence. *Behavior Research Methods*, *42*(2), 563–570. https://doi.org/10.3758/BRM.42.2.563

Broer, M., Bai, Y., & Fonseca, F. (2019). A review of the literature on socioeconomic status and educational achievement. In *Socioeconomic inequality and educational outcomes. IEA research for education (A series of in-depth analyses based on data of the International Association for the Evaluation of Educational Achievement (IEA)* (Vol. 5). Springer. https://doi.org/10.1007/978-3-030-11991-1_2

Browman, A. S., Destin, M., Carswell, K. L., & Svoboda, R. C. (2017). Perceptions of socioeconomic mobility influence academic persistence among low socioeconomic status students. *Journal of Experimental Social Psychology*, *72*, 45–52. https://doi.org/10.1016/j.jesp.2017.03.006

Bunting, M., Cowan, N., & Saults, J. S. (2006). How does running memory span work? *Quarterly Journal of Experimental Psychology (2006)*, *59*(10), 1691–1700. https://doi.org/10.1080/17470210600848402

Chen, E., Brody, G. H., & Miller, G. E. (2022). What are the health consequences of upward mobility? *Annual Review of Psychology*, *73*(1), 599–628. https://doi.org/10.1146/annurev-psych-033020-122814

Chen, J.-J., Jiang, T.-N., & Liu, M.-F. (2021). Family socioeconomic status and learning engagement in Chinese adolescents: The multiple mediating roles of resilience and future orientation. *Frontiers in Psychology*, *12*, 714346. https://doi.org/10.3389/fpsyg.2021.714346

Chmitorz, A., Kunzler, A., Helmreich, I., Tüscher, O., Kalisch, R., Kubiak, T., Wessa, M., & Lieb, K. (2018). Intervention studies to foster resilience – A systematic review and proposal for a resilience framework in future intervention studies. *Clinical Psychology Review*, *59*, 78–100. https://doi.org/10.1016/j.cpr.2017.11.002

Connor, K. M., & Davidson, J. R. T. (2003). Development of a new resilience scale: The Connor-Davidson Resilience Scale (CD-RISC). *Depression and Anxiety*, *18*(2), 76–82. https://doi.org/10.1002/da.10113

Destin, M. (2019). Socioeconomic mobility, identity, and health: Experiences that influence immunology and implications for intervention. *The American Psychologist*, *74*(2), 207–217. 10.1037/amp0000297

Dórea, J. G. (2021). Exposure to environmental neurotoxic substances and neurodevelopment in children from Latin America and the Caribbean. *Environmental Research*, *192*, 110199. https://doi.org/10.1016/j.envres.2020.110199

Ecker, U. K. H., Lewandowsky, S., Oberauer, K., & Chee, A. E. H. (2010). The components of working memory updating: An experimental decomposition and individual differences. *Journal of Experimental Psychology. Learning, Memory, and Cognition*, *36*(1), 170–189. https://doi.org/10.1037/a0017891

Ecker, U. K. H., Oberauer, K., & Lewandowsky, S. (2014). Working memory updating involves item-specific removal. *Journal of Memory and Language*, *74*, 1–15. https://doi.org/10.1016/j.jml.2014.03.006

Elosúa, M. R., & Ruiz, R. M. (2008). Absence of hardly pursued updating in a running memory task. *Psychological Research*, *72*(4), 451–460. https://doi.org/10.1007/s00426-007-0124-4

Evans, L. D., Kouros, C. D., Samanez-Larkin, S., & Garber, J. (2016). Concurrent and short-term prospective relations among neurocognitive functioning, coping, and depressive symptoms in youth. *Journal of Clinical Child and Adolescent Psychology*, *45*(1), 6–20. http://dx.doi.org/10.1080/15374416.2014.982282

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*(2), 175–191. https://doi.org/10.3758/BF03193146

Faul, J. D., Ware, E. B., Kabeto, M. U., Fisher, J., & Langa, K. M. (2021). The effect of childhood socioeconomic position and social mobility on cognitive function and change among older adults: A comparison between the United States and England. *Journals of Gerontology: Social Sciences*, *76B*(1), 51–63. https://doi.org/10.1093/geronb/gbaa138

Fletcher, D., & Sarkar, M. (2013). Psychological resilience: A review and critique of definitions, concepts, and theory. *European Psychologist*, *18*(1), 12–23. https://doi.org/10.1027/1016-9040/a000124

Fullerton, D. J., Zhang, L. M., & Kleitman, S. (2021). An integrative process model of resilience in an academic context: Resilience resources, coping strategies, and positive adaptation. *PloS One*, *16*(2), e0246000. https://doi.org/10.1371/journal.pone.0246000

Gathercole, S. E., Pickering, S. J., Knight, C., & Stegmann, Z. (2004). Working memory skills and educational attainment: evidence from national curriculum assessments at 7 and 14 years of age. *Applied Cognitive Psychology*, *18*(1), 1–16. https://doi.org/10.1002/acp.934

Greenfield, E. A., Moorman, S., & Rieger, A. (2021). Life course pathways from childhood socioeconomic status to later-life cognition: Evidence from the Wisconsin longitudinal study. *The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences*, *76*(6), 1206–1217. https://doi.org/10.1093/geronb/gbaa062

Hackman, D. A., Betancourt, L. M., Gallop, R., Romer, D., Brodsky, N. L., Hurt, H., & Farah, M. J. (2014). Mapping the trajectory of socioeconomic disparity in working memory: Parental and neighborhood factors. *Child Development*, *85*(4), 1433–1445. https://doi.org/10.1111/cdev.12242.

Huang, S., Han, M., Sun, L., Zhang, H., & Li, H.-J. (2019). Family socioeconomic status and emotional adaptation among rural-to-urban migrant adolescents in China: The moderating roles of adolescent's resilience and parental positive emotion. *International Journal of Psychology : Journal International de Psychologie*, *54*(5), 573–581. https://doi.org/10.1002/ijop.12499

Kaplan, G. A., Turrell, G., Lynch, J. W., Everson, S. A., Helkala, E., & Salonen, J. T. (2001). Childhood socioeconomic position and cognitive function in adulthood. *International Journal of Epidemiology*, *30*(2), 256–263. https://doi.org/10.1093/ije/30.2.256

Kuh, D., Ben-Shlomo, Y., Lynch, J., Hallqvist, J., & Power, C. (2003). Life course epidemiology. *Journal of Epidemiology and Community Health*, *57*(10), 778–783. https://doi.org/10.1136/jech.57.10.778

Kuldas, S., & Foody, M. (2022). Neither resilience-trait nor resilience-state: Transactional resiliency/e. *Youth & Society*, *54*(8), 1352–1376. https://doi.org/10.1177/0044118X211029309

Last, B. S., Lawson, G. M., Breiner, K., Steinberg, L., & Farah, J. (2018). Childhood socioeconomic status and executive function in childhood and beyond. *PloS One*, *13*(8), e0202964. https://doi.org/10.1371/journal.pone.0202964

Leipold, B., & Greve, W. (2009). Resilience. A conceptual bridge between coping and development. *European Psychologist*, *14*(1), 40–50. https://doi.org/10.1027/1016-9040.14.1.40

Levesque, A. R., MacDonald, S., Berg, S. A., & Reka, R. (2021). Assessing the impact of changes in household socioeconomic status on the health of children and adolescents: A systematic review. *Adolescent Research Review*, *6*(2), 91–123. https://doi.org/10.1007/s40894-021-00151-8

Li, Y. (2020). The impact of education on intergenerational mobility: Based on the 2015 CGSS database. *Modern Economy*, *11*(02), 570–580. https://doi.org/10.4236/me.2020.112042

Liu, Y., & Lachman, M. E. (2019). Socioeconomic status and parenting style from childhood: Long-term effects on cognitive function in middle and later adulthood. *The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences*, *74*(6), e13–e24. https://doi.org/10.1093/geronb/gbz034

Lövdén, M., Fratiglioni, L., Glymour, M. M., Lindenberger, U., & Tucker-Drob, E. M. (2020). Education and cognitive functioning across the life span. *Psychological Science in the Public Interest: A Journal of the American Psychological Society*, *21*(1), 6–41. https://doi.org/10.1177/1529100620920576

Luo, Y., & Waite, L. J. (2005). The impact of childhood and adult SES on physical, mental, and cognitive well-being in later life. *The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences*, *60*(2), S93–S101. https://doi.org/10.1093/geronb/60.2.S93

Luthans, F., Avolio, B. J., Avey, J. B., & Norman, S. M. (2007). Positive psychological capital: Measurement and relationship with performance and satisfaction. *Personnel Psychology*, *60*(3), 541–572. https://doi.org/10.1111/j.1744-6570.2007.00083.x

Lyu, J. & J. A. Burr. (2016). Socioeconomic status across the life course and cognitive function among older adults: An examination of the latency, pathways, and accumulation hypotheses. *Journal of Aging and Health*, *28*(1), 40–67. https://doi.org/10.1177/0898264315585504

Milaniak, I., & Jaffee, S. R. (2019). Childhood socioeconomic status and inflammation: A systematic review and meta-analysis. *Brain, Behavior, and Immunity*, *78*, 161–176. https://doi.org/10.1016/j.bbi.2019.01.018

Murray, E. T., Mishra, G. D., Kuh, D., Guralnik, J., Black, S., & Hardy, R. (2011). Life course models of socioeconomic position and cardiovascular risk factors: 1946 birth cohort. *Annals of Epidemiology*, *21*(8), 589–597. https://doi.org/10.1016/j.annepidem.2011.04.005

Palladino, P., & Jarrold, C. (2008). Do updating tasks involve updating? Evidence from comparisons with immediate serial recall. *Quarterly Journal of Experimental Psychology (2006)*, *61*(3), 392–399. https://doi.org/10.1080/17470210701664989

Pappa, K., Biswas, V., Flegal, K. E., Evans, J. J., & Baylan, S. (2020). Working memory updating training promotes plasticity & behavioural gains: A systematic review & meta-analysis. *Neuroscience and Biobehavioral Reviews*, *118*, 209–235. https://doi.org/10.1016/j.neubiorev.2020.07.027

Phillips, S. P., Auais, M., Belanger, E., Alvarado, B., & Zunzunegui, M.-V. (2016). Life-course social and economic circumstances, gender, and resilience in older adults: The longitudinal international mobility in aging study (IMIAS). *SSM – Population Health*, *2*, 708–717. http://dx.doi.org/10.1016/j.ssmph.2016.09.007

Pizzol, D., Tudor, F., Racalbuto, V., Bertoldo, A., Veronese, N., & Smith, L. (2021). Systematic review and meta-analysis found that malnutrition was associated with poor cognitive development. *Acta Paediatrica (Oslo, Norway: 1992)*, *110*(10), 2704–2710. https://doi.org/10.1111/apa.15964

Rosen, M. L., Hagen, M. P., Lurie, L. A., Miles, Z. E., Sheridan, M. A., Meltzoff, A. N., & McLaughlin, K. A. (2020). Cognitive stimulation as mechanism linking socioeconomic status with executive function: A longitudinal investigation. *Child Development*, *91*(4), 762–779. https://doi.org/10.1111/cdev.13315

Southwick, S. M., Bonanno, A. S., Masten, A. S., Panter-Brick, C., & Yehuda, R. (2014). Resilience definitions, theory, and challenges: Interdisciplinary perspectives. *European Journal of Psychotraumatology*, *5*(1), 25338. https://doi.org/10.3402/ejpt.v5.25338

Spielberg, J. M., Galarce, E. M., Ladouceur, C. D., McMakin, D. L., Olino, T. M., Forbes, E. E., Silk, J. S., Ryan, N. D., & Dahl, R. E. (2015). Adolescent development of inhibition as a function of SES and gender: Converging evidence from behavior and fMRI. *Human Brain Mapping*, *36*(8), 3194–3203. https://doi.org/10.1002/hbm.22838

Suor, J. H., Sturge-Apple, M. L., & Skibo, M. A. (2017). Breaking cycles of risk: The mitigating role of maternal working memory in associations among socioeconomic status, early caregiving, and children's working

memory. *Development and Psychopathology*, *29*(4), 1133–1147. https://doi.org/10.1017/S095457941600119X

Turrell, G., Lynch, J. W., Kaplan, G. A., Everson, S. A., Helkala, E.-L., Kauhanen, J., & Salonen, J. T. (2002). Socioeconomic position across the lifecourse and cognitive function in late middle age. *The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences*, *57*(1), S43–S51. https://doi.org/10.1093/geronb/57.1.S43

Von Bastian, C. C., Belleville, S., Udale, R. C., Reinhartz, A., Essounni, M., & Strobach, T. (2022). Mechanisms underlying training-induced cognitive change. *Nature Reviews Psychology*, *1*(1), 30–41. https://doi.org/10.1038/s44159-021-00001-3

Weissberger, G. A., Núñez, R. A., Tureson, K., Gold, A., & Thames, A. D. (2021). Socioeconomic mobility and psychological and cognitive functioning in a diverse sample of adults with and without HIV. *Psychosomatic Medicine*, *83*(3), 218–227. https://doi.org/10.1097/PSY.0000000000000929.

Willms, J. D., & Tramonte, L. (2019). The measurement and use of socioeconomic status in educational research. In L. E. Suter, B. Denman, & E. Smith (Eds.), *The SAGE handbook of comparative studies in education*. Sage.

Wu, L., Zhang, X., Wang, J., Sun, J., Mao, F., Han, J., & Cao, F. (2021). The associations of executive functions with resilience in early adulthood: A prospective longitudinal study. *Journal of Affective Disorders*, *282*, 1048–1054. https://doi.org/10.1016/j.jad.2021.01.031

Wu, M. S., Yan, X. D., Zhou, C., Chen, Y., Li, J., Zhu, Z. H., Shen, X. Q., & Han, B. X. (2011). General belief in a just world and resilience: Evidence from a collectivistic culture. *European Journal of Personality*, *25*(6), 431–442. https://doi.org/10.1002/per.807

Yu, X., & Zhang, J. (2007). Factor analysis and psychometric evaluation of the Connor-Davidson Resilience Scale (CD-RISC) with Chinese people. *Social Behavior and Personality: an International Journal*, *35*(1), 19–30. https://doi.org/10.2224/sbp.2007.35.1.19

Zhang, M., Gale, S. D., Erickson, L. D., Brown, B. L., Woody, P., & Hedges, D. W. (2015). Cognitive function in older adults according to current socioeconomic status. *Neuropsychology, Development, and Cognition. Section B, Aging, Neuropsychology and Cognition*, *22*(5), 534–543. http://dx.doi.org/10.1080/13825585.2014.997663

Zhang, Z., Gu, D., & Hayward, M. D. (2008). Early life influences on cognitive impairment among oldest old Chinese. *The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences*, *63B*(1), S25–S33. https://doi.org/10.1093/geronb/63.1.S25

Zhang, Z., Liu, J., Li, L., & Xu, H. (2018). The long arm of childhood in China: Early-life conditions and cognitive function among middle-aged and older adults. *Journal of Aging and Health*, *30*(8), 1319–1344. https://doi.org/10.1177/0898264317715975