**Supplemental Material**

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**Supplemental Material 1. Measures of the covariates used in the main analysis**

The following covariates were used in the main analysis: gender, measurement occasions (1, 2, 4, 5, 6), birth cohort [war (between 1914 and 1918 and between 1939 and 1945) / the Great Depression (between 1929 and 1928) / no war and no economic crisis (before 1913, between 1919 and 1938, and after 1945)], participant attrition [no dropout / dropout (participants who did not respond to both measurements 5 and 6) / death (participants who died during the survey)], participants’ chronic health conditions ($\geq $2 / $<$2), country of residence (Austria, Belgium, Croatia, Czech Republic, Denmark, Estonia, France, Germany, Greece, Hungary, Ireland, Israel, Italy, Luxembourg, Netherlands, Poland, Portugal, Slovenia, Spain, Sweden, Switzerland), and dementia (dementia / no dementia). Chronic conditions and dementia were assessed using the following question: “Has a doctor ever told you that you had / Do you currently have any of the conditions on this card?” (de Souto Barreto, Cesari, Andrieu, Vellas, & Rolland, 2017; van der Linden et al., 2018). It was specified that a doctor had told the participants that they currently have this condition or that they were treated or affected by the condition. Participants who had selected the option “Alzheimer’s disease, dementia, organic brain syndrome, senility or any serious memory impairment” were categorized as having dementia. Participants who selected at least two options in the following list were classified as having more than two chronic conditions: cardiac disease, hypertension, cholesterol, stroke, diabetes, lung disease, asthma, osteoporosis, arthritis, cancer, ulcer, Parkinson disease, cataract, hip or femoral fracture, tumor.

**Supplemental Material 2. Measures of the additional covariates used in the sensitivity analyses**

**Health behaviors**

*Pack-year smoking.* Pack-year smoking was determinedby multiplying the number of packs smoked (i.e., twenty cigarettes) per day by the number of years smoking.

*Alcohol consumption*. Alcohol consumption was assessed with the item “In the last 3 months, on the days you drank, about how many drinks did you have?” Participants who answered more than 2 were classified as drinking “too much”.

*Dietary behaviours.* Dietary behaviours were assessed with the item “In a regular week, how often do you consume a serving of fruits or vegetables?” Participants answered on a 5-point scale: 1, every day; 2, 3 to 6 times a week; 3, twice a week; 4, once a week; 5, less than once a week. Participants who did not answer “1” were classified as having “not eating enough fruits or vegetables”.

**Sociodemographic variables**

*Partner status*. Partner status was assessed with an item assessing whether people were living with a partner (married or in a registered partnership) or not.

*Satisfaction with household income.* Satisfaction with current household income based on the question “Is the household able to make ends meet?” as an indicator for old-age SECs. Answers ranged from 1 “with great difficulty” to 4 “easily”.

**Health-related covariates**

*Depressive symptoms*. Depressive symptoms were assessed with the Euro-Depression scale, a geriatric depression scale including 12 items (Copeland et al., 2004; Prince et al., 1999).

*Body mass index.* Body mass index was assessed using self-reported questions on height and weight.

*Self-reported health.* Self-reported health was assessed using a 5-point Likert scale ranging from 1, “poor”, to 5, “excellent”.(Ware Jr & Gandek, 1998) We grouped the answer categories “poor” and “fair” to indicate poor Self-reported health as compared with “good”, “very good” and “excellent”, indicating good self-reported health.

All the covariates were repeatedly assessed across waves and we used the mode to obtain a global measure for the period the participants were followed. All these measures and the strategies used to compute the scores have been previously described in detail (Cheval, Boisgontier, et al., 2018; Cheval, Chabert, et al., 2018; Cheval, Sieber, et al., 2018).

**Supplemental Material 3. Measures of the additional variables used in the robustness analyses**

**Time orientation**

Time orientation was assessed using four questions asking to the day of month, the month, the year, and the day of the week. Errors were coded 1 and correct answer 0. For the robustness, we excluded people with suspicion of dementia as indicated with scores greater than 2 on the time orientation question.

**Hearing**

Hearing ability was assessed based on the question “Is your hearing…”. Answers ranged from 1 “Excellent” to 5 “Poor”. For the robustness, we excluded people with poor hearing ability.

**Vision**

Vision was assessed based on the following questions. “How good is your eyesight for seeing things at a distance, like recognizing a friend across the street? Would you say it is…” Answer ranged from 1 “Excellent” to 5 “Poor”. For the robustness, we excluded people with either “Poor” or “Fair” eyesight.

**Frailty**

The phenotype of frailty included shrinking, weakness, exhaustion, slowness, and low activity (Fried et al., 2001). Our measure was constructed by selecting the most suitable metric and has been tested and validated in the SHARE population (Macklai, Spagnoli, Junod, & Santos-Eggimann, 2013; Romero-Ortuno, 2013; van der Linden et al., 2019). For shrinking, the question, “What has your appetite been like” was used and the criterion was fulfilled when participants reported a “diminution in desire for food” or, in the case of an unclear response to this question, the answer “less” to the follow-up item “So have you been eating more or less than usual?”. Weakness was operationalized using grip strength measures and the highest out of four dynamometer measures was analyzed. Cut-offs were calculated for each wave separately, stratified by gender and body mass index quartiles (Fried et al., 2001) and the criterion was fulfilled by the weakest 20% in each category. The question, “In the last month, have you had too little energy to do things you wanted to do?” was used to define exhaustion. The slowness attribute was operationalized using mobility questions, as SHARE measured walking speed only for individuals aged 75 or older. The question “How often do you engage in activities that require a low or moderate level of energy such as gardening, cleaning the car, or going for a walk?” was used for the low activity attribute which was fulfilled for individuals answering either “one to three times a month” or “hardly ever or never”. A score ranging from zero to five was created, based on fulfilment of the attributes. Individuals with three or more points were classified (Fried et al., 2001), and were excluded for the robustness analysis.

**Table S1. Association of cognitive resources with the levels and trajectories of moderate physical activity across aging.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|   | **Models delayed recall****only** | **Models verbal fluency****only** | **Models education****only** | **Full Models**  |
| **Moderate physical activity** | b (95% CI) | *P* | *b* (95% CI) | *P* | *b* (95% CI) | *P* | *b* (95% CI) | *P* |
| **Level** |  |  |  |  |  |  |  |  |
| **Cognitive resources** |  |  |  |  |  |  |  |
| **Between-person effects** |  |  |  |  |  |  |  |
|  Delayed recall  | 0.06 (0.06-0.06) | <.001 |  |  |  |  | 0.02 (0.02-0.03) | <.001 |
|  Verbal fluency |  |  | 0.03 (0.02-0.03) | <.001 |  |  | 0.02 (0.02-0.02) | <.001 |
|  Education (ref. primary) |  |  |  |  |  |  |  |
|  Secondary |  |  |  |  | 0.14 (0.13-0.16) | <.001 | 0.08 (0.06-0.09) | <.001 |
|  Tertiary |  |  |  |  | 0.21 (0.20-0.23) | <.001 | 0.07 (0.05-0.09) | <.001 |
| **Within-person effects** |  |  |  |  |  |  |  |
|  Delayed recall  | 0.01 (0.01-0.02) | <.001 |  |  |  |  | 0.01 (0.01-0.01) | <.001 |
|  Verbal fluency |  |  | 0.01 (0.01-0.01) | <.001 |  |  | 0.01 (0.01-0.01) | <.001 |
| **Covariates** |  |  |  |  |  |  |  |  |
| Men (ref. Women) | 0.09 (0.08-0.10) | <.001 | 0.06 (0.05-0.07) | <.001 | 0.06 (0.05-0.07) | <.001 | 0.07 (0.06-0.08) | <.001 |
| Wave | -0.02 (-0.02--0.01) | <.001 | -0.02 (-0.02--0.01) | <.001 | -0.01 (-0.02--0.01) | <.001 | -0.02 (-0.02--0.02) | <.001 |
| Dementia (ref. No) |  |  |  |  |  |  |  |
|  Yes | -0.34 (-0.37–-0.31) | <.001 | -0.30 (-0.33--0.27) | <.001 | -0.39 (-0.42--0.36) | <.001 | -0.29 (-0.32--0.26) | <.001 |
| Chronic conditions (ref. 2 or more) |  |  |  |  |  |  |
|  Less than 2 | 0.20 (0.19-0.21) | <.001 | 0.19 (0.18-0.20) | <.001 | 0.20 (0.19-0.21) | <.001 | 0.19 (0.18-0.20) | <.001 |
| Countries (ref. Belgium) |  |  |  |  |  |  |  |
|  Austria | 0.03 (0.00-0.05) | 0.04 | -0.01 (-0.03-0.02) | .51 | 0.05 (0.02-0.08) | <.001 | -0.02 (-0.04-0.01) | .22 |
|  Denmark | 0.24 (0.21-0.26) | <.001 | 0.19 (0.17-0.22) | <.001 | 0.25 (0.22-0.27) | <.001 | 0.19 (0.16-0.21) | <.001 |
|  France | -0.01 (-0.04-0.01) | .26 | 0.02 (-0.00-0.04) | .11 | 0.01 (-0.02-0.03) | .51 | 0.03 (0.01-0.05) | .02 |
|  Germany | 0.13 (0.11-0.16) | <.001 | 0.11 (0.09-0.14) | <.001 | 0.12 (0.10-0.15) | <.001 | 0.10 (0.08-0.13) | <.001 |
|  Greece | -0.04 (-0.07--0.02) | .001 | 0.10 (0.07-0.13) | <.001 | -0.03 (-0.06--0.00) | 0.044 | 0.11 (0.08-0.14) | <.001 |
|  Israel | -0.20 (-0.23--0.17) | <.001 | -0.17 (-0.20--0.14) | <.001 | -0.21 (-0.24--0.18) | <.001 | -0.17 (-0.20--0.13) | <.001 |
|  Italy | -0.30 (-0.33--0.28) | <.001 | -0.21 (-0.24--0.19) | <.001 | -0.29 (-0.32--0.27) | <.001 | -0.20 (-0.22--0.17) | <.001 |
|  Netherlands | 0.11 (0.09-0.14) | <.001 | 0.12 (0.10-0.15) | <.001 | 0.12 (0.09-0.15) | <.001 | 0.11 (0.09-0.14) | <.001 |
|  Spain | 0.07 (0.05-0.09) | <.001 | 0.12 (0.10-0.15) | <.001 | 0.07 (0.05-0.10) | <.001 | 0.16 (0.13-0.18) | <.001 |
|  Sweden | 0.29 (0.26-0.31) | <.001 | 0.24 (0.21-0.26) | <.001 | 0.32 (0.29-0.34) | <.001 | 0.24 (0.22-0.27) | <.001 |
|  Switzerland | 0.13 (0.10-0.16) | <.001 | 0.16 (0.13-0.18) | <.001 | 0.17 (0.14-0.20) | <.001 | 0.14 (0.11-0.16) | <.001 |
|  Czech Republic | -0.03 (-0.05--0.00) | .02 | -0.08 (-0.10--0.05) | <.001 | -0.04 (-0.06--0.01) | .004 | -0.07 (-0.10--0.05) | <.001 |
|  Ireland | 0.08 (0.02-0.15) | .01 | 0.21 (0.14-0.27) | <.001 | 0.11 (0.05-0.18) | .001 | 0.18 (0.12-0.25) | <.001 |
|  Poland | -0.24 (-0.27--0.20) | <.001 | -0.20 (-0.23--0.16) | <.001 | -0.25 (-0.29--0.22) | <.001 | -0.18 (-0.21--0.14) | <.001 |
|  Estonia | 0.08 (0.06-0.11) | <.001 | 0.05 (0.02-0.07) | <.001 | 0.05 (0.03-0.08) | <.001 | 0.04 (0.02-0.07) | <.001 |
|  Hungary | -0.06 (-0.10--0.02) | .004 | -0.01 (-0.05-0.03) | .75 | -0.09 (-0.13--0.05) | <.001 | -0.03 (-0.07-0.01) | .21 |
|  Portugal | -0.38 (-0.42--0.34) | <.001 | -0.29 (-0.33--0.25) | <.001 | -0.36 (-0.40--0.32) | <.001 | -0.25 (-0.30--0.21) | <.001 |
|  Slovenia | 0.20 (0.17-0.23) | <.001 | 0.13 (0.11-0.16) | <.001 | 0.15 (0.13-0.18) | <.001 | 0.15 (0.12-0.18) | <.001 |
|  Luxembourg | 0.08 (0.04-0.12) | <.001 | 0.17 (0.13-0.21) | <.001 | 0.13 (0.09-0.17) | <.001 | 0.17 (0.13-0.21) | <.001 |
|  Croatia | 0.09 (0.05-0.14) | <.001 | 0.11 (0.07-0.16) | <.001 | 0.06 (0.02-0.11) | .003 | 0.12 (0.08-0.16) | <.001 |
| Attrition (ref. No drop out) |  |  |  |  |  |  |  |
|  Drop out | -0.10 (-0.12--0.09) | <.001 | -0.09 (-0.10--0.07) | <.001 | -0.11 (-0.13--0.10) | <.001 | -0.09 (-0.10--0.07) | <.001 |
|  Death | -0.42 (-0.45--0.40) | <.001 | -0.40 (-0.43--0.38) | <.001 | -0.44 (-0.46--0.41) | <.001 | -0.39 (-0.42--0.37) | <.001 |
| Birth cohort (ref. Born after 1945) |  |  |  |  |  |  |  |
|  1939 to 1945 | 0.05 (0.03-0.07) | <.001 | 0.05 (0.03-0.07) | <.001 | 0.05 (0.03-0.07) | <.001 | 0.05 (0.03-0.07) | <.001 |
|  1929 to 1938 | 0.09 (0.06-0.12) | <.001 | 0.09 (0.06-0.12) | <.001 | 0.09 (0.06-0.12) | <.001 | 0.10 (0.07-0.12) | <.001 |
|  1919 to 1928 | 0.12 (0.07-0.17) | <.001 | 0.11 (0.06-0.16) | <.001 | 0.12 (0.07-0.17) | <.001 | 0.11 (0.07-0.16) | <.001 |
| **Rate of change (trajectories)** |  |  |  |  |  |  |  |  |
| Age (10y follow-up) | -0.22 (-0.23--0.20) | <.001 | -0.20 (-0.22--0.19) | <.001 | -0.25 (-0.26--0.23) | <.001 | -0.19 (-0.20--0.17) | <.001 |
| Age (10y follow-up) squared | -0.11 (-0.12--0.11) | <.001 | -0.11 (-0.11--0.10) | <.001 | -0.12 (-0.12--0.11) | <.001 | -0.11 (-0.11--0.10) | <.001 |
| **Cognitive resources** |  |  |  |  |  |  |  |
| **Between-person effects** |  |  |  |  |  |  |  |
| ***Linear effect*** |  |  |  |  |  |  |  |  |
|  Delayed recall  | 0.06 (0.06-0.07) | <.001 |  |  |  |  | 0.02 (0.01-0.02) | <.001 |
|  Verbal fluency |  |  | 0.08 (0.08-0.09) | <.001 |  |  | 0.07 (0.06-0.08) | <.001 |
|  Education (ref. primary) |  |  |  |  |  |  |  |
|  Secondary |  |  |  |  | 0.02 (0.01-0.03) | .001 | -0.01 (-0.02-0.00) | .15 |
|  Tertiary |  |  |  |  | 0.08 (0.07-0.10) | <.001 | 0.02 (0.00-0.04) | .02 |
| ***Non-linear (quadratic) effect*** |  |  |  |  |  |  |  |
|  Delayed recall  | 0.02 (0.01-0.02) | <.001 |  |  |  |  | 0.00 (-0.00-0.01) | .21 |
|  Verbal fluency |  |  | 0.02 (0.02-0.03) | <.001 |  |  | 0.02 (0.01-0.02) | <.001 |
|  Education (ref. primary) |  |  |  |  |  |  |  |
|  Secondary |  |  |  |  | 0.03 (0.02-0.04) | <.001 | 0.02 (0.01-0.03) | <.001 |
|  Tertiary |  |  |  |  | 0.04 (0.03-0.05) | <.001 | 0.03 (0.01-0.04) | .001 |
| **Within-person effects** |  |  |  |  |  |  |  |
| ***Linear effect*** |  |  |  |  |  |  |  |  |
|  Delayed recall  | 0.01 (0.00-0.01) | .004 |  |  |  |  | 0.00 (-0.00-0.01) | .39 |
|  Verbal fluency |  |  | 0.02 (0.01-0.02) | <.001 |  |  | 0.02 (0.01-0.02) | <.001 |
|  Education (ref. primary) |  |  |  |  |  |  |  |
|  Secondary |  |  |  |  |  |  |  |  |
|  Tertiary |  |  |  |  |  |  |  |  |
| ***Non-linear (quadratic) effect*** |  |  |  |  |  |  |  |
|  Delayed recall  | 0.00 (-0.00-0.01) | .16 | 0.00 (-0.00-0.01) | .18 |  |  | 0.00 (-0.00-0.00) | .57 |
|  Verbal fluency |   |   |  |  |  |  | 0.00 (-0.00-0.01) | .31 |

Notes. The models estimating the level of physical activity did not include interactions between cognitive resources and age (linear and quadratic). The models estimating the rate of change of physical activity included these interactions. For the level, all the coefficients of the parameters included in the model were reported. For the rate of change, only the coefficients of interest were presented

**Table S2. Summary of the sensitivity and robustness analyses**

|  |  |  |
| --- | --- | --- |
|  | **Description**  | **Rationale and main results** |
|  | **Sensitivity analyses** |  |
| 1 | Adjusting for health behaviors (i.e., smoking, alcohol consumption, and dietary behaviors), additional sociodemographic variables (i.e., partner status, satisfaction with household income) and additional health related covariates (i.e., depression, body mass index, and self-rated health). The final sample includes 37,003 participants.  | **Rationale**These variables are likely to influence the physical activity level at old age. **Main results**Results were consistent with those of the main analysis.*Level.* Delayed recall, verbal fluency, and education (secondary level) were associated with the levels of moderate physical activity. These associations remained significant in the model fully adjusted for the three cognitive resources, with the exception of the effect of education. Depression, smoking, dietary behaviors, satisfaction with household income, body mass index, and self-rated health were all associated with moderate physical activity. *Rate of change.* Education, delayed recall, and verbal fluency were associated with the trajectories of moderate physical activity across aging. These associations were attenuated but the cognitive resources remained associated with the trajectories of moderate physical activity in the model fully adjusted for the three cognitive resources. |
| 2 | Excluding 2,799 participants with dementia | **Rationale**Respondents with dementia may bias the observed associations. **Main results**Results were consistent with those of the main analysis.*Level.* Education, delayed recall, and verbal fluency were associated with the levels of moderate physical activity. These associations remained significant in the model fully adjusted for the three cognitive resources. *Rate of change.* Education, delayed recall, and verbal fluency were associated with the trajectories of moderate physical activity across aging. These associations were attenuated but the cognitive resources remained associated with the trajectories of moderate physical activity in the model fully adjusted for the three cognitive resources. |
| 3 | Excluding 6,020 participants who died during follow-up | **Rationale**Respondents who died during the follow-up were likely to have poorer health status (selective attrition). **Main results**Results were consistent with those of the main analysis.*Level.* Education, delayed recall, and verbal fluency were associated with the levels of moderate physical activity. These associations remained significant in the model fully adjusted for the three cognitive resources. *Rate of change.* Education, delayed recall, and verbal fluency were associated with the trajectories of moderate physical activity across aging. These associations were attenuated but the cognitive resources remained associated with the trajectories of moderate physical activity in the model fully adjusted for the three cognitive resources. |
| 4 | Excluding 18,741 participants who dropped out during follow-up | **Rationale**Respondents who dropped during the follow-up were likely to have specific characteristics that may bias the associations observed (selective attrition). **Main results**Results were consistent with those of the main analysis.*Level.* Education, delayed recall, and verbal fluency were associated with the levels of moderate physical activity. These associations remained significant in the model fully adjusted for the three cognitive resources. *Rate of change.* Education, delayed recall, and verbal fluency were associated with the trajectories of moderate physical activity across aging. These associations were attenuated but the cognitive resources remained associated with the trajectories of moderate physical activity in the model fully adjusted for the three cognitive resources. |
| 5 | Excluding 2435 participants with a suspicion of dementia | **Rationale**Respondents with dementia may bias the observed associations. **Main results**Results were consistent with those of the main analysis.*Level.* Education, delayed recall, and verbal fluency were associated with the levels of moderate physical activity. These associations remained significant in the model that was fully adjusted for the three cognitive resources. *Rate of change.* Education, delayed recall, and verbal fluency were associated with the trajectories of moderate physical activity across aging. These associations were attenuated but the cognitive resources remained associated with the trajectories of moderate physical activity in the model fully adjusted for the three cognitive resources. |
|  | Excluding 8794 participants with eyesight problems | **Rationale**Respondents with eyesight may bias the observed associations as eyesight impairments may limit daily life activities and are related to age-related cognitive loss. **Main results**Results were consistent with those of the main analysis.*Level.* Education, delayed recall, and verbal fluency were associated with the levels of moderate physical activity. These associations remained significant in the model that was fully adjusted for the three cognitive resources. *Rate of change.* Education, delayed recall, and verbal fluency were associated with the trajectories of moderate physical activity across aging. These associations were attenuated but the cognitive resources remained associated with the trajectories of moderate physical activity in the model that was fully adjusted for the three cognitive resources. |
|  | Excluding 1889 participants with hearing problems | **Rationale**Respondents with hearing problems may bias the observed associations. **Main results**Results were consistent with those of the main analysis.*Level.* Education, delayed recall, and verbal fluency were associated with the levels of moderate physical activity. These associations remained significant in the model fully adjusted for the three cognitive resources. *Rate of change.* Education, delayed recall, and verbal fluency were associated with the trajectories of moderate physical activity across aging. These associations were attenuated but the cognitive resources remained associated with the trajectories of moderate physical activity in the model fully adjusted for the three cognitive resources. |
|  | Excluding 12568 participants with frailty | **Rationale**Respondents with frailty may bias the observed associations. **Main results**Results were consistent with those of the main analysis.*Level.* Education, delayed recall, and verbal fluency were associated with the levels of moderate physical activity. These associations were reduced but remained significant (expect for verbal fluency within and tertiary education) in the model fully adjusted for the three cognitive resources. *Rate of change.* Education, delayed recall (between-level), and verbal fluency (between-level) were associated with the trajectories of moderate physical activity across aging. These associations were attenuated but overall cognitive resources (expect delayed recall) remained associated with the trajectories of moderate physical activity in the model that was fully adjusted for the three cognitive resources. |
|  | Excluding 65462 participants with less than 3 measurements | **Rationale**Respondents to less than 3 time points may influence the estimation of the cognitive functioning trajectories. **Main results**Results were consistent with those of the main analysis.*Level.* Education, delayed recall, and verbal fluency were associated with the levels of moderate physical activity. These associations were reduced but remained significant (expect for verbal fluency within and tertiary education) in the model that was fully adjusted for the three cognitive resources. *Rate of change.* Education, delayed recall (between-level), and verbal fluency (between-level) were associated with the trajectories of moderate physical activity across aging. These associations were attenuated but overall cognitive resources (expect delayed recall) remained associated with the trajectories of moderate physical activity in the model that was fully adjusted for the three cognitive resources. |
|  | **Robustness analyses** |  |
|  |  | **Rationale**The original scale was ordinal (four categories), whereas it was treated as continuous in the main analysis. Therefore, to ensure the robustness of the results, we tested various cut-off of the scale and run logistic mixed effect models instead of linear mixed effects models. |
|  | **First cut-off:** Participants who answered ‘‘more than once a week’’ were classified as ‘‘physically active’’, whereas the others participants were classified as “physically inactive”. | The objective of this first cut-off is to reduce a potential misclassification bias in which physical inactive participants would be classified as physically active.**Main results**Results were consistent with those of the main analysis.*Level.* Education, delayed recall, and verbal fluency were associated with increased odds of being “physically active”. These associations remained significant in the model that was fully adjusted for the three cognitive resources. *Rate of change.* Education (tertiary level and linear), delayed recall (linear and between level), and verbal fluency (linear) were associated with the trajectories of moderate physical activity across aging. The negative effect of aging on the odds of being “physically active” were weaker in individuals with higher cognitive resources. These associations were attenuated but the cognitive resources remained associated with the trajectories of moderate physical activity in the model that was fully adjusted for the three cognitive resources. |
|  | **Second cut-off:** Participants who answer “hardly ever or never” were classified as ‘‘physically inactive’’, whereas the other participants were classified as “physically active”. | The objective of this second cut-off was to reduce a potential misclassification bias in which physically active participants would be classified as physically inactive (i.e., the opposite bias to the one avoided in the first robustness analysis).**Main results**Results were consistent with those of the main analysis.*Level.* Education, delayed recall, and verbal fluency were associated with increased odds of being “physically active”. These associations were reduced but remained significant in the model that was fully adjusted for the three cognitive resources.*Rate of change.* Education, delayed recall (linear, within level, and marginal), and verbal fluency (linear) were associated with the trajectories of moderate physical activity across aging. The negative effect of aging on the odds of being “physically active” were weaker in individuals with higher cognitive resources. These associations were attenuated but the cognitive resources remained associated with the trajectories of moderate physical activity in the model that was fully adjusted for the three cognitive resources. |
|  | **Third cut-off:** Participants who answered “hardly ever or never” or “one to three times a month” were classified as ‘‘physically inactive’’, whereas the others participants were classified as “physically active”. | The objective of this third cutoff is to test a potential misclassification bias between the first cut-off and the second cut-off of the two first robustness analyses.**Main results**Results were consistent with those of the main analysis.*Level.* Education, delayed recall, and verbal fluency were associated with increased odds of being “physically active”. These associations were reduced but remained significant in the model that was fully adjusted for the three cognitive resources.*Rate of change.* Education (secondary level only), delayed recall (linear, within level, and marginal), and verbal fluency (linear) were associated with the trajectories of moderate physical activity across aging. The negative effect of aging on the odds of being “physically active” were weaker in individuals with higher cognitive resources. These associations were attenuated but the cognitive resources remained associated with the trajectories of moderate physical activity in the model that was fully adjusted for the three cognitive resources. |

**Supplemental Material 3. Results associated with vigorous physical activity**

*Vigorous physical activity* was measured using the following item: “How often do you engage in activities that require a vigorous level of energy such as sports, heavy housework, or a job that involves physical labor?” Participants answered on a 4-point scale: 1, more than once a week; 2, once a week; 3, one to three times a month; 4, hardly ever, or never. In the models, these variables were reversed so that higher values indicated higher physical activity.

**Cognitive resources and level of physical activity**

Results showed that lower levels of delayed recall, verbal fluency, and education were associated with lower engagement in vigorous physical activity (Table S3). For delayed recall and verbal fluency, this association was observed at the between- and within-person level. At the between-person level, participants with lower levels of delayed recall or verbal fluency showed lower engagement in vigorous physical activity. At the within-person level, lower delayed recall or verbal fluency were associated with lower engagement in vigorous physical activity. These associations remained significant in the fully-adjusted model.

**Cognitive resources and physical activity trajectories**

At the within-person level, results showed that lower levels of delayed recall and verbal fluency, were associated with a steeper decline of physical activity across aging (Figure S1; Table S3). Decreases in delayed recall or verbal fluency were associated with a faster decline of physical activity, but without acceleration across aging. By contrast, at the between-person level, results showed that lower levels of delayed recall, verbal fluency, and education were associated with a decelerated decline of physical activity across aging. As such, unlike the results for moderate physical activity, the influence of cognitive resources on the engagement in vigorous physical activity was less pronounced as adults grew older. In the fully-adjusted model including the three cognitive resources, the associations were attenuated with only verbal fluency and tertiary-level education remaining significantly associated with the quadratic change of vigorous physical activity across aging. In the latter model, cognitive resources explained 2.1% and 2.5% of the inter-individual variance in the level and trajectories of moderate physical activity, respectively. Taken together, all the variables explained 24.6% and 9.2% of the inter-individual variance in the level and trajectories of moderate physical activity, respectively.

**Temporal precedence**

Table S4 presents the results of the Bivariate latent change score models (BLCSMs)

Results showed a fit improvement when the cognitive resources (delayed recall and verbal fluency) $\rightarrow $ change in vigorous physical activity was included in the baseline model (i.e., BLCSM2 vs. BLCSM1). Including the vigorous physical $\rightarrow $ change in delayed recall also improved the model fit (BLCSM3 vs. BLCSM1), and to a higher extent. For delayed recall, the bidirectional couplings model showed better fit than the baseline model (BLCSM4 vs. BLCSM1). This better fit was mainly explained by vigorous physical $\rightarrow $ change in delayed recall coupling. Schwarz weights favored BLCSM3 over all the other models. BLCSM3 accounted for 99.7% of relative predictive accuracy. For verbal fluency, the vigorous physical $\rightarrow $ change in verbal fluency failed to converge. We therefore compare the verbal fluency $\rightarrow $change in vigorous physical activity coupling to the bidirectional couplings model, with evidence than the unidirectional model outperformed the bidirectional couplings model. Schwarz weights favored BLCSM2 over all the other models. BLCSM2 accounted for 99.6% of relative predictive accuracy. To summarize, results suggested that vigorous physical activity predict change in delayed recall, whereas verbal fluency predict change in vigorous physical activity.

**Table S4. Association of cognitive resources with the levels and trajectories of vigorous physical activity across aging.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|   | **Models delayed recall** | **Model verbal fluency** | **Model education** | **Full Model**  |
| **Vigorous physical activity** | b (95% CI) | *P* | *b* (95% CI) | *P* | *b* (95% CI) | *P* | *b* (95% CI) | *P* |
| **Level** |  |  |  |  |  |  |  |  |
| **Cognitive resources** |  |  |  |  |  |  |  |
| **Between-person effects** |  |  |  |  |  |  |  |
|  Delayed recall  | 0.07 (0.06-0.07) | <.001 |  |  |  |  | 0.03 (0.03-0.04) | <.001 |
|  Verbal fluency |  | 0.02 (0.02-0.03) | <.001 |  |  | 0.02 (0.02-0.02) | <.001 |
|  Education (ref = primary) |  |  |  |  |  |  |  |
|  Secondary |  |  |  |  | 0.12 (0.10-0.14) | <.001 | 0.05 (0.03-0.07) | <.001 |
|  Tertiary |  |  |  |  | 0.19 (0.17-0.21) | <.001 | 0.05 (0.02-0.07) | <.001 |
| **Within-person effects** |  |  |  |  |  |  |  |
|  Delayed recall  | 0.02 (0.02-0.02) | <.001 |  |  |  |  | 0.02 (0.01-0.02) | <.001 |
|  Verbal fluency |  | 0.01 (0.01-0.01) | <.001 |  |  | 0.01 (0.01-0.01) | <.001 |
| **Covariates** |  |  |  |  |  |  |  |  |
| Men (ref. Women) | 0.25 (0.24-0.26) | <.001 | 0.22 (0.21-0.23) | <.001 | 0.22 (0.21-0.23) | <.001 | 0.23 (0.22-0.24) | <.001 |
| Wave | -0.01 (-0.02--0.01) | <.001 | -0.01 (-0.02--0.01) | <.001 | -0.01 (-0.01--0.00) | <.001 | -0.02 (-0.02--0.01) | <.001 |
| Dementia (ref. No) |  |  |  |  |  |  |  |
|  Yes | -0.20 (-0.24--0.16) | <.001 | -0.17 (-0.21--0.14) | <.001 | -0.26 (-0.30--0.22) | <.001 | -0.15 (-0.19--0.11) | <.001 |
| Chronic conditions (ref. 2 or more) |  |  |  |  |  |  |
|  Less than 2 | 0.35 (0.34-0.37) | <.001 | 0.35 (0.34-0.37) | <.001 | 0.36 (0.35-0.37) | <.001 | 0.35 (0.33-0.36) | <.001 |
| Countries (ref. Belgium) |  |  |  |  |  |  |  |
|  Austria | 0.25 (0.22-0.28) | <.001 | 0.22 (0.19-0.25) | <.001 | 0.28 (0.24-0.31) | <.001 | 0.21 (0.18-0.24) | <.001 |
|  Denmark | 0.37 (0.34-0.41) | <.001 | 0.33 (0.30-0.37) | <.001 | 0.39 (0.35-0.42) | <.001 | 0.33 (0.30-0.36) | <.001 |
|  France | -0.06 (-0.09--0.03) | <.001 | -0.03 (-0.06-0.00) | .05 | -0.04 (-0.08--0.01) | .005 | -0.03 (-0.06-0.01) | .11 |
|  Germany | 0.34 (0.31-0.38) | <.001 | 0.33 (0.29-0.36) | <.001 | 0.34 (0.30-0.37) | <.001 | 0.32 (0.29-0.35) | <.001 |
|  Greece | 0.30 (0.26-0.33) | <.001 | 0.43 (0.40-0.47) | <.001 | 0.31 (0.27-0.34) | <.001 | 0.43 (0.40-0.47) | <.001 |
|  Israel | 0.45 (0.41-0.49) | <.001 | 0.48 (0.44-0.53) | <.001 | 0.44 (0.40-0.48) | <.001 | 0.49 (0.45-0.53) | <.001 |
|  Italy | -0.09 (-0.12--0.05) | <.001 | -0.01 (-0.04-0.03) | .71 | -0.09 (-0.12--0.05) | <.001 | 0.01 (-0.02-0.04) | .64 |
|  Netherlands | 0.49 (0.46-0.53) | <.001 | 0.51 (0.47-0.54) | <.001 | 0.51 (0.47-0.54) | <.001 | 0.50 (0.46-0.53) | <.001 |
|  Spain | -0.08 (-0.11--0.05) | <.001 | -0.04 (-0.07--0.00) | .02 | -0.09 (-0.12--0.06) | <.001 | -0.00 (-0.03-0.03) | .84 |
|  Sweden | 0.40 (0.37-0.44) | <.001 | 0.36 (0.33-0.39) | <.001 | 0.43 (0.40-0.47) | <.001 | 0.36 (0.33-0.40) | <.001 |
|  Switzerland | 0.35 (0.31-0.39) | <.001 | 0.38 (0.34-0.41) | <.001 | 0.39 (0.35-0.43) | <.001 | 0.36 (0.32-0.39) | <.001 |
|  Czech Republic | -0.01 (-0.04-0.02) | .90 | -0.06 (-0.09--0.03) | <.001 | -0.02 (-0.05-0.02) | .33 | -0.05 (-0.08--0.02) | 0.002 |
|  Ireland | 0.14 (0.06-0.22) | .001 | 0.26 (0.18-0.34) | <.001 | 0.17 (0.08-0.25) | <.001 | 0.23 (0.15-0.31) | <.001 |
|  Poland | -0.08 (-0.12--0.03) | <.001 | -0.05 (-0.09--0.01) | .02 | -0.10 (-0.15--0.06) | <.001 | -0.03 (-0.07-0.02) | 0.24 |
|  Estonia | 0.33 (0.30-0.36) | <.001 | 0.30 (0.27-0.33) | <.001 | 0.31 (0.27-0.34) | <.001 | 0.30 (0.27-0.33) | <.001 |
|  Hungary | 0.10 (0.05-0.15) | <.001 | 0.15 (0.10-0.20) | <.001 | 0.07 (0.02-0.13) | .006 | 0.14 (0.08-0.19) | <.001 |
|  Portugal | -0.13 (-0.18--0.08) | <.001 | -0.05 (-0.10-0.00) | .07 | -0.12 (-0.17--0.06) | <.001 | -0.02 (-0.07-0.03) | .51 |
|  Slovenia | 0.41 (0.38-0.45) | <.001 | 0.34 (0.31-0.38) | <.001 | 0.36 (0.33-0.40) | <.001 | 0.37 (0.33-0.40) | <.001 |
|  Luxembourg | 0.20 (0.15-0.25) | <.001 | 0.28 (0.23-0.34) | <.001 | 0.24 (0.19-0.30) | <.001 | 0.27 (0.22-0.33) | <.001 |
|  Croatia | 0.27 (0.21-0.32) | <.001 | 0.28 (0.22-0.33) | <.001 | 0.23 (0.18-0.29) | <.001 | 0.29 (0.24-0.35) | <.001 |
| Attrition (ref. No drop out) |  |  |  |  |  |  |  |
|  Drop out | -0.10 (-0.12--0.08) | <.001 | -0.09 (-0.11--0.07) | <.001 | -0.11 (-0.13--0.09) | <.001 | -0.08 (-0.10--0.06) | <.001 |
|  Death | -0.34 (-0.37--0.31) | <.001 | -0.33 (-0.36--0.30) | <.001 | -0.36 (-0.39--0.33) | <.001 | -0.32 (-0.35--0.29) | <.001 |
| Birth cohort (ref. born after 1945) |  |  |  |  |  |  |
|  1939 to 1945 | 0.02 (-0.00-0.05) | .06 | 0.02 (-0.00-0.05) | .07 | 0.02 (-0.00-0.05) | .07 | 0.02 (0.00-0.05) | .04 |
|  1929 to 1938 | 0.04 (-0.00-0.07) | .06 | 0.04 (-0.00-0.07) | .05 | 0.03 (-0.00-0.07) | .08 | 0.04 (0.00-0.08) | .03 |
|  1919 to 1928 | 0.09 (0.03-0.15) | .003 | 0.09 (0.03-0.15) | .003 | 0.10 (0.04-0.16) | .002 | 0.09 (0.03-0.15) | .003 |
| **Rate of change (trajectories)** |  |  |  |  |  |  |  |  |
| Age (10y follow-up) | -0.31 (-0.33--0.29) | <.001 | -0.30 (-0.32--0.28) | <.001 | -0.34 (-0.36--0.32) | <.001 | -0.28 (-0.30--0.26) | <.001 |
| Age (10y follow-up) squared | -0.06 (-0.06--0.05) | <.001 | -0.06 (-0.06--0.05) | <.001 | -0.06 (-0.07--0.06) | <.001 | -0.05 (-0.06--0.05) | <.001 |
| **Cognitive resources** |  |  |  |  |  |  |  |
| **Between-person effects** |  |  |  |  |  |  |  |
| ***Linear effect*** |  |  |  |  |  |  |  |  |
|  Delayed recall  | 0.02 (0.02-0.03) | <.001 |  |  |  |  | 0.02 (0.01-0.03) | <.001 |
|  Verbal fluency |  | 0.01 (0.01-0.02) | <.001 |  |  | 0.01 (-0.00-0.02) | .20 |
|  Education (ref. primary) |  |  |  |  |  |  |  |
|  Secondary |  |  |  |  | -0.05 (-0.06--0.03) | <.001 | -0.05 (-0.06--0.03) | <.001 |
|  Tertiary |  |  |  |  | -0.00 (-0.03-0.02) | .65 | -0.01 (-0.03-0.01) | .38 |
| ***Non-linear (quadratic) effect*** |  |  |  |  |  |  |  |
|  Delayed recall  | -0.02 (-0.02--0.01) | <.001 |  |  |  |  | -0.00 (-0.01-0.00) | .31 |
|  Verbal fluency |  | -0.02 (-0.03--0.02) | <.001 |  |  | -0.02 (-0.02--0.01) | <.001 |
|  Education (ref = primary) |  |  |  |  |  |  |  |
|  Secondary |  |  |  |  | -0.02 (-0.03--0.01) | .004 | -0.00 (-0.02-0.01) | .52 |
|  Tertiary |  |  |  |  | -0.06 (-0.07--0.04) | <.001 | -0.03 (-0.05--0.01) | .001 |
| **Within-person effects** |  |  |  |  |  |  |  |
| ***Linear effect*** |  |  |  |  |  |  |  |  |
|  Delayed recall  | 0.01 (0.00-0.01) | .02 |  |  |  |  | 0.00 (-0.00-0.01) | .09 |
|  Verbal fluency |  | 0.01 (0.00-0.01) | .009 |  |  | 0.01 (0.00-0.01) | .04 |
|  Education (ref. primary) |  |  |  |  |  |  |  |
|  Secondary |  |  |  |  |  |  |  |  |
|  Tertiary |  |  |  |  |  |  |  |  |
| ***Non-linear (quadratic) effect*** |  |  |  |  |  |  |  |
|  Delayed recall  | -0.00 (-0.01-0.00) | .85 |  |  |  |  | -0.00 (-0.01-0.00) | .67 |
|  Verbal Fluency |   | 0.00 (-0.00-0.00) | .99 |  |  | -0.00 (-0.00-0.00) | .93 |

Notes. The models estimating the level of physical activity did not include interactions between cognitive resources and age (linear and quadratic). The models estimating the rate of change of physical activity included these interactions. For the level, all the coefficients of the parameters included in the model were reported. For the rate of change, only the coefficients of interest were presented.

**Figure S1. Associations of cognitive resources with the trajectories of vigorous physical activity across aging.** For delayed recall and verbal fluency, the variables were standardized. The coefficients are interpreted as the effect of an increase of one standard deviation.

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**Table S5. Changes in fit of the bivariate latent change score models**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Vigorous physical activity** |   |   |   |   |   |   |   |   |   |   |
| Models | Parameters | chi2 | df | CFI | BIC | w(BIC)  | RMSEA | delta chi2 | delta df | p |
| ***Delayed recall*** |  |  |  |  |  |  |  |  |  |  |
| No coupling | 19 | 1605.47 | 46 | 0.985 | 1883918.69 | 0.0 | 0.017 |  |  |  |
| Delayed recall $\rightarrow $ changes in vigorous physical activity | 20 | 1598.12 | 45 | 0.985 | 1883923.03 | 0.0 | 0.017 | -7.35 | 1 | <.001 |
| Vigorous physical activity $\rightarrow $ changes in delayed recall | 20 | 1558.73 | 45 | 0.985 | 1883883.64 | 99.7 | 0.017 | -46.74 | 1 | <.001 |
| Full coupling | 21 | 1558.70 | 44 | 0.985 | 1883895.30 | 0.03 | 0.017 | -46.78 | 2 | <.001 |
| ***Verbal fluency*** |  |  |  |  |  |  |  |  |  |  |
| No coupling | 19 | 1152.99 | 46 | 0.991 | 2501573.30 | 0.0 | 0.014 |  |  |  |
| Verbal fluency $\rightarrow $ changes in vigorous physical activity | 20 | 1124.32 | 45 | 0.991 | 2501556.33 | 99.6 | 0.014 | -28.66 | 1 | <.001 |
| Full coupling | 21 | 1124.02 | 44 | 0.991 | 2501567.71 | 0.04 | 0.014 | -28.97 | 2 | <.001 |

Note. CFI = comparative fit index; chi2 = deviance (-2 x log-likelihood); df = change in deviance per degrees freedom; CFI = comparative fit index; BIC = Bayesian information criterion; w(BIC) = Schwarz weight (i.e., relative probability of model preference); RMSEA = root mean square error of approximation. Delta chi2 is estimated in comparison with the no coupling model, with lower values indicating better fi; p = p-value for the log likelihood-ratio test of change in model fit. Models with a uni-directional coupling from vigorous physical activity to changes in verbal fluency did not converge.

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