

SENSOR-BASED PHYSICAL ACTIVITY AND COGNITIVE AGING
AZ BURZYNSKA et al.

Supplementary Material I

Studies Linking Sensor-Based Sedentary Behavior (SB), Light PA (LPA) and Moderate to Vigorous PA (MVPA) with Cognition in Cognitively Healthy Older Adults.

Author, year	Sample	Sensor, placement, time of wear*	PA measure	Cognitive measures	Main findings
(Brown et al., 2012)	N=217 Age=69.5±6.6 (60–89) 54% females	Actigraph Hip 7 days	Peak counts (highest PA intensity recorded daily) Total daily counts	MMSE (global cognition), attention (digit span, Stroop), processing speed (digit symbol), verbal memory (Logical memory I and II, CVLT-II, visuospatial ability (Rey Complex Figure Test), and vocabulary fluency (Controlled Oral Word Association Task)	Peak counts: better performance on speed, visuospatial ability and verbal fluency, adjusted for age, sex, years of education, APOE e4 allele, BMI and self-reported cardiovascular disease
(Hayes et al., 2015b)	N=31 Age 55–82 58% female Study also included N=29 Age=18-31	ActiGraph, non-dominant hip >4 days	Total daily steps Post-hoc analyses included SB and step rate within LPA and MVPA epochs	Visual memory (Brief Visuospatial Memory Test-Revised, Faces subtest from the Wechsler Memory Scale-Third Edition), verbal memory (CVLT-II and Logical Memory subtest from the WMS-III), experimental face memory task, executive function (TMT, Verbal Fluency, Mental Arithmetic and Digit Span, Wisconsin Card Sorting Test)	Older adults: Greater step count related to better visual and face-name memory, adjusted for age, sex, education, depression, hypertension, accelerometer wear time (in minutes), and SB Post-hoc analyses: SB was negatively related to memory, adjusting for the above covariates

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(Wilbur et al., 2012)	N=174 Age=50–84 74% female All Latino	ActiGraph waist 3–7 days	LPA MVPA Total counts	Episodic memory (East Boston Memory Test), perceptual speed (Stroop Task, Numbers Comparison Test), and semantic memory (Category Fluency Test)	LPA, MVPA and total counts were positively associated with semantic memory, controlled for demographics and chronic health problems
(Halloway et al., 2017)	N=59 Age=50–84 All Latino	Actigraph waist 3–7 days	5-year change in: LPA MVPA Total PA LPA bouts MVPA bouts	5-year change in Episodic memory (East Boston Memory Test), perceptual speed (Stroop Task, Numbers Comparison Test), and semantic memory (Category Fluency Test)	Only decline in MVPA bouts was associated with decline in semantic memory, adjusted for baseline age, number of chronic health problems, depressive symptoms, acculturation scores and other demographic and health status variables (e.g., marital status, self-reported personal income level, education level, number of hardships, and self-rated health)
(Zhu et al., 2017)	N=6452, Age=69.7±8.5 55.3% female 30.5% black	Actical™ right hip 4-7 days	SB LPA %MVPA	Incident cognitive impairment defined as a shift from 4> to <4 on Six-Item Screener score over 3 years. Executive function and memory: Letter fluency, animal fluency, word list learning, Montreal Cognitive Assessment (orientation and recall)	Higher MVPA% quartiles: lower risk of cognitive impairment, better maintenance in executive function and memory, adjusted for age, sex, race, region of residence, education, BMI, hypertension, smoking, and diabetes. No significance was found for LPA or sedentary time
(Stubbs et al., 2017)	N=274 (n=65 with possible MCI) Age=74.52 54.4% female	ActiGraph waist >5 days	Total PA Light PA MVPA	22-month decline in cognitive ability measured with Ascertain Dementia 8-item Questionnaire (self-rated changes in memory, orientation, problem-solving abilities, and daily activities)	Higher LPA and MVPA: reduced cognitive decline, adjusted for baseline cognitive score, sex, age, educational attainment, marital status, income source, smoking, number of chronic diseases, depressive symptoms, activities of daily living, and wear time, and LPA or MVPA

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(Kerr et al., 2013)	N=217 Age=83 70% female	ActiGraph, hip >4days	Low intensity LPA (LLPA) high intensity LPA (HLP A) MVPA	TMT-A and B	HLP A was associated with faster time to complete TMT-A adjusted for sex, age-, and education. MVPA was associated with faster time to complete TMT-B and TMT B–A, adjusted for age-, sex-, education, LLPA and HLP A.
(Johnson et al., 2016)	N=188 Age= 64±7 53.7% female	ActiGraph >5 days	SB LPA MVPA	TMT-A and B	Only LPA (but not SB or MVPA) were related to better TMT-B performance, adjusted for age, sex, level of education attained, waist-to-hip ratio, history of cigarette smoking, alcohol intake, and cognitive status, total wear time minutes, leg muscle strength
(Iso-Markku et al., 2018)	N=726 Age=72.9 52% female Twin study	Traixal Hookie AM20 accelerometer Waist >4 days	SB LPA MVPA Daily step count Mean daily MET	Total cognitive score: combined TICS and telephone assessment for dementia	SB was negatively and LPA positively associated with cognition only in a fully adjusted (age, sex, wear time, education, BMI, living conditions) in-between family model (twins treated as individuals). The association attributed to genetic and environmental selection.
(Ku, Liu, Lo, Chen, & Stubbs, 2017)	N=274 (n=65 with possible MCI) Age=74.52 54.4% female	ActiGraph waist >5 days	SB (h/day) and SB level: high (11+ h/day), medium (7–10.99 h/day), and low (< 7 h/day)	Decline in cognitive ability measured with Ascertain Dementia 8-item Questionnaire over 22 months	Higher levels of SB were associated with an increased risk of lower cognitive ability at follow up adjusted for age, sex, education, baseline cognitive status, marital status, income source, smoking, number of comorbidities, depressive symptoms, wear time of accelerometer, MVPA, ADLs

*Instructed wear time or minimum days required for analyses (if specified in the original work). TMT: Trial Making Test. ADL: activities of daily living. MCI: mild cognitive impairment.

Supplementary Material II

Bivariate 2-Tailed Correlations Between Accelerometer Wear Time, PA and Cognition

	Number of days of Actigraph measurement	
Number of days of Actigraph measurement	Pearson Correlation	1
	Sig. (2-tailed)	
	N	228
Vocabulary (mean of winsorized z-scores)	Pearson Correlation	-.048
	Sig. (2-tailed)	.475
	N	228
Reasoning (mean of winsorized z-scores)	Pearson Correlation	-.040
	Sig. (2-tailed)	.546
	N	228
Perceptual speed (mean of winsorized z-scores)	Pearson Correlation	-.084
	Sig. (2-tailed)	.205
	N	228
Memory (mean of z-scores)	Pearson Correlation	-.005
	Sig. (2-tailed)	.938
	N	228
Min/day in sedentary behavior (winsorized)	Pearson Correlation	.031
	Sig. (2-tailed)	.643
	N	228
Min/day in light PA (winsorized)	Pearson Correlation	.095
	Sig. (2-tailed)	.153
	N	228
Min/day in moderate-to-vigorous PA (winsorized)	Pearson Correlation	.110
	Sig. (2-tailed)	.097
	N	228

Supplementary Material III

FFT Individual Tasks: Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Stair walk down test	228	3.55	20.27	7.49	2.59
Stair walk up test	228	4.19	15.48	7.87	1.94
Chair stand test	227	.00	21.00	11.20	2.73
Arm curl test	228	6.00	29.00	14.66	3.65
Chair sit and reach test	228	-12.50	11.00	.44	3.43
Back scratch test	228	-18.00	6.00	-2.82	4.66
8-ft up and go test	228	3.74	9.80	5.91	1.10
Left leg stand test	228	.18	30.00	16.35	11.72
Right leg stand test	228	.59	30.00	16.36	11.65

Supplementary Material IV

Bivariate 2-Tailed Correlations Between Key Variables from Table 1

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1. Age	Pearson Correlation	1	.073	-.148 [*]	-.127	.017	.068	-.105	-.138 [*]	-.129	-.153 [*]	-.055	-.014	.083	.012	-.044	.031	-.003	.009	-.075	.036	-.029	-.042
	Sig. (2-tailed)		.274	.026	.081	.803	.307	.114	.037	.051	.021	.407	.829	.213	.852	.512	.647	.965	.898	.257	.588	.663	.528
	N	228	228	228	188	228	228	228	228	228	228	228	228	228	228	228	226	226	226	228	228	227	228
2. Sex	Pearson Correlation	.073	1	-.086	-.245 ^{**}	.103	.160 [*]	.014	.093	.300 ^{**}	.005	.029	-.118	.166 [*]	-.173 ^{**}	-.404 ^{**}	.009	-.019	.034	-.050	-.117	.016	.182 ^{**}
	Sig. (2-tailed)	.274		.198	.001	.119	.015	.830	.160	.000	.937	.666	.076	.012	.009	.000	.892	.775	.613	.456	.078	.810	.006
	N	228	228	228	188	228	228	228	228	228	228	228	228	228	228	226	226	226	228	228	227	228	227
3. Education (years)	Pearson Correlation	-.148 [*]	-.086	1	.198 ^{**}	-.155 [*]	.084	.246 ^{**}	.225 ^{**}	.158 [*]	.261 ^{**}	.391 ^{**}	.064	.001	.152 [*]	.246 ^{**}	.074	-.171 [*]	.036	-.144 [*]	-.178 ^{**}	.034	.021
	Sig. (2-tailed)	.026	.198		.006	.019	.204	.000	.001	.017	.000	.000	.337	.985	.022	.000	.265	.010	.587	.030	.007	.605	.749
	N	228	228	228	188	228	228	228	228	228	228	228	228	228	228	226	226	226	228	228	227	228	227
4. Income (low/high)	Pearson Correlation	-.127	-.245 ^{**}	.198 ^{**}	1	-.188 ^{**}	.014	.246 ^{**}	.156 [*]	.091	.193 ^{**}	.136	.075	-.029	.131	.223 ^{**}	.090	-.161 [*]	-.130	-.084	-.288 ^{**}	.258 ^{**}	.086
	Sig. (2-tailed)	.081	.001	.006		.010	.853	.001	.032	.213	.008	.062	.305	.695	.074	.002	.223	.028	.076	.252	.000	.000	.241
	N	188	188	188	188	188	188	188	188	188	188	188	188	188	188	186	186	186	188	188	187	188	187
5. Employment	Pearson Correlation	.017	.103	-.155 [*]	-.188 ^{**}	1	.111	-.275 ^{**}	-.246 ^{**}	-.096	-.173 ^{**}	-.076	-.013	-.115	-.172 ^{**}	-.242 ^{**}	-.042	.135 [*]	.202 ^{**}	.097	.048	-.205 ^{**}	-.001
	Sig. (2-tailed)	.803	.119	.019	.010		.096	.000	.000	.147	.009	.253	.843	.082	.009	.000	.534	.043	.002	.144	.000	.472	.984
	N	228	228	228	188	228	228	228	228	228	228	228	228	228	228	226	226	226	228	228	227	228	227
6. Adult edu.	Pearson Correlation	.068	.160 [*]	.084	.014	.111	1	.060	-.036	.084	-.041	.196 ^{**}	.036	.001	.009	.025	.024	-.133 [*]	-.095	-.029	-.149 [*]	-.010	-.034
	Sig. (2-tailed)	.307	.015	.204	.853	.096		.370	.589	.204	.538	.003	.593	.991	.894	.713	.724	.045	.154	.663	.025	.882	.610
	N	228	228	228	188	228	228	228	228	228	228	228	228	228	228	226	226	226	228	228	227	228	227
7. Comfort at comp.	Pearson Correlation	-.105	.014	.246 ^{**}	.246 ^{**}	-.275 ^{**}	.060	1	.281 ^{**}	.257 ^{**}	.364 ^{**}	.162 [*]	.039	.000	.075	.200 ^{**}	.169 [*]	-.058	-.044	-.096	-.229 ^{**}	.141 [*]	.019
	Sig. (2-tailed)	.114	.830	.000	.001	.000	.370		.000	.000	.000	.014	.557	.999	.259	.003	.141	.389	.512	.149	.001	.033	.779
	N	228	228	228	188	228	228	228	228	228	228	228	228	228	228	226	226	226	228	228	227	228	227
8. Perceptual speed	Pearson Correlation	-.138 [*]	.093	.225 ^{**}	.156 [*]	-.246 ^{**}	-.036	.281 ^{**}	1	.317 ^{**}	.420 ^{**}	.207 ^{**}	-.129	.166 [*]	.291 ^{**}	.149 [*]	.169 [*]	-.099	-.105	-.068	-.076	.152 [*]	.059
	Sig. (2-tailed)	.037	.160	.001	.032	.000	.589	.000		.000	.000	.002	.052	.012	.000	.025	.011	.138	.115	.305	.256	.021	.374
	N	228	228	228	188	228	228	228	228	228	228	228	228	228	228	226	226	226	228	228	227	228	227
9. Memory	Pearson Correlation	-.129	.300 ^{**}	.158 [*]	.091	-.096	.084	.257 ^{**}	.317 ^{**}	1	.468 ^{**}	.520 ^{**}	.091	-.092	-.030	.006	.003	-.083	-.107	-.055	-.230 ^{**}	.056	.096
	Sig. (2-tailed)	.051	.000	.017	.213	.147	.204	.000	.000		.000	.000	.173	.165	.656	.932	.962	.213	.106	.412	.000	.397	.147
	N	228	228	228	188	228	228	228	228	228	228	228	228	228	228	226	226	226	228	228	227	228	227
10. Reasoning	Pearson Correlation	-.153 [*]	.005	.261 ^{**}	.193 ^{**}	-.173 ^{**}	-.041	.364 ^{**}	.420 ^{**}	.468 ^{**}	1	.556 ^{**}	.090	.007	.181 ^{**}	.257 ^{**}	.102	-.090	-.076	-.034	-.155 [*]	.065	.062
	Sig. (2-tailed)	.021	.937	.000	.008	.009	.538	.000	.000	.000		.000	.177	.921	.006	.000	.128	.177	.254	.608	.019	.332	.355
	N	228	228	228	188	228	228	228	228	228	228	228	228	228	228	226	226	226	228	228	227	228	227
11. Vocabulary	Pearson Correlation	-.055	.029	.391 ^{**}	.136	-.076	.196 ^{**}	.162 [*]	.207 ^{**}	.520 ^{**}	.556 ^{**}	1	.230 ^{**}	-.180 ^{**}	-.024	.141 [*]	.025	-.097	.008	-.076	-.193 ^{**}	.008	.035
	Sig. (2-tailed)	.407	.666	.000	.062	.253	.003	.014	.002	.000	.000		.000	.006	.723	.034	.707	.148	.901	.254	.004	.904	.602
	N	228	228	228	188	228	228	228	228	228	228	228	228	228	228	226	226	226	228	228	227	228	227
12. SB	Pearson Correlation	-.014	-.118	.064	.075	-.013	.036	.039	-.129	.091	.090	.230 ^{**}	1	-.554 ^{**}	-.440 ^{**}	-.136 [*]	.081	.078	.061	.166 [*]	.003	-.099	.061
	Sig. (2-tailed)	.829	.076	.337	.305	.843	.593	.557	.052	.173	.177	.000		.000	.000	.041	.227	.244	.360	.012	.963	.137	.360
	N	228	228	228	188	228	228	228	228	228	228	228	228	228	228	226	226	226	228	228	227	228	227
13. Light PA	Pearson Correlation	.083	.166 [*]	.001	-.029	-.115	.001	.000	.166 [*]	-.092	.007	-.180 ^{**}	-.554 ^{**}	1	.461 ^{**}	.175 ^{**}	.039	-.184 ^{**}	-.112	-.173 ^{**}	-.037	.091	.062
	Sig. (2-tailed)	.213	.012	.985	.695	.082	.991	.999	.012	.165	.921	.006	.000		.000	.008	.559	.006	.091	.009	.576	.169	.351
	N	228	228	228	188	228	228	228	228	228	228	228	228	228	228	226	226	226	228	228	227	228	227
14. MVPA	Pearson Correlation	.012	-.173 ^{**}	.152 [*]	.131	-.172 ^{**}	.009	.075	.291 ^{**}	-.030	.181 ^{**}	-.024	-.440 ^{**}	.461 ^{**}	1	.497 ^{**}	-.014	-.241 ^{**}	-.145 [*]	-.167 [*]	-.101	.142 [*]	-.072
	Sig. (2-tailed)	.852	.009	.022	.074	.009	.894	.259	.000	.656	.006	.723	.000	.000		.000	.829	.000	.029	.011	.130	.032	.277
	N	228	228	228	188	228	228	228	228	228	228	228	228	228	228	226	226	226	228	228	227	228	227
15. CRF	Pearson Correlation	-.044	-.404 ^{**}	.246 ^{**}	.223 ^{**}	-.242 ^{**}	.025	.200 ^{**}	.149 [*]	.006	.257 ^{**}	.141 [*]	-.136 [*]	.175 ^{**}	.497 ^{**}	1	.028	-.431 ^{**}	-.148 [*]	-.129	-.165 [*]	.203 ^{**}	.063
	Sig. (2-tailed)	.512	.000	.000	.002	.000	.713	.003	.025	.932	.000	.034	.041	.008	.000		.678	.000	.026	.053	.013	.002	.346
	N	226	226	226	186	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	225	226	225
16. MAP	Pearson Correlation	.031	.009	.074	.090	-.042	.024	.098	.169 [*]	.003	.102	.025	.081	.039	-.014	.028	1	.093	-.048	-.016	-.015	.043	.132 [*]
	Sig. (2-tailed)	.647	.892	.265	.223	.534	.724	.141	.011	.962	.128	.707	.227	.559	.829	.678		.163	-.471	.816	.824	.520	.048
	N	226	226	226	186	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	225	226	225
17. BMI	Pearson Correlation	-.003	-.019	-.171 [*]	-.161 [*]	.135 [*]	-.133 [*]	-.058	-.099	-.083	-.090	-.097	.078	-.184 ^{**}	-.241 ^{**}	-.431 ^{**}	.093	1	.257 ^{**}	.193 ^{**}	.334 ^{**}	-.340 ^{**}	-.044
	Sig. (2-tailed)	.965	.775	.010	.028	.043	.045	.389	.138	.213	.177	.148	.244	.006	.000	.000	.163		.000	.004	.000	.000	.509
	N	226	226	226	186	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	225	226	225
18. Diabetes	Pearson Correlation	.009	.034	.036	-.130	.202 ^{**}	-.																

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19. Cardiovasc. history	Pearson Correlation	-.075	-.050	-.144*	-.084	.097	-.029	-.096	-.068	-.055	-.034	-.076	.166*	-.173**	-.167*	-.129	-.016	.193**	.217**	1	.275**	-.194**	.012
	Sig. (2-tailed)	.257	.456	.030	.252	.144	.663	.149	.305	.412	.608	.254	.012	.009	.011	.053	.816	.004	.001		.000	.003	.859
	N	228	228	228	188	228	228	228	228	228	228	228	228	228	228	226	226	226	228	228	227	228	227
20. Health rating (1-5)	Pearson Correlation	.036	-.117	-.178**	-.288**	.048	-.149*	-.229**	-.076	-.230**	-.155*	-.193**	.003	-.037	-.101	-.165*	-.015	.334**	.282**	.275**	1	-.386**	-.021
	Sig. (2-tailed)	.588	.078	.007	.000	.472	.025	.001	.256	.000	.019	.004	.963	.576	.130	.013	.824	.000	.000	.000		.000	.756
	N	227	227	227	187	227	227	227	227	227	227	227	227	227	227	225	225	225	227	227	227	227	226
21. Physical health SF-12	Pearson Correlation	-.029	.016	.034	.258**	-.205**	-.010	.141*	.152*	.056	.065	.008	-.099	.091	.142*	.203**	.043	-.340**	-.222**	-.194**	-.386**	1	.006
	Sig. (2-tailed)	.663	.810	.605	.000	.002	.882	.033	.021	.397	.332	.904	.137	.169	.032	.002	.520	.000	.001	.003	.000		.923
	N	228	228	228	188	228	228	228	228	228	228	228	228	228	228	226	226	226	228	228	227	228	227
22. Diabetes	Pearson Correlation	-.042	.182**	.021	.086	-.001	-.034	.019	.059	.096	.062	.035	.061	.062	-.072	.063	.132*	-.044	-.013	.012	-.021	.006	1
	Sig. (2-tailed)	.528	.006	.749	.241	.984	.610	.779	.374	.147	.355	.602	.360	.351	.277	.346	.048	.509	.851	.859	.756	.923	
	N	227	227	227	187	227	227	227	227	227	227	227	227	227	227	225	225	225	227	227	226	227	227

Variable coding: Sex: 1: Male, 2: Female; Income: 1: \$40,000; 2: >\$40,000, Employment status: 1: Working 2: Not working, Diabetes: 0: Non-diabetic, 1: Diabetic; *p<.05, **p<.01, ***p<.001