

Supplementary Online Content

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This supplementary material has been provided by the authors to give readers additional information about their work.

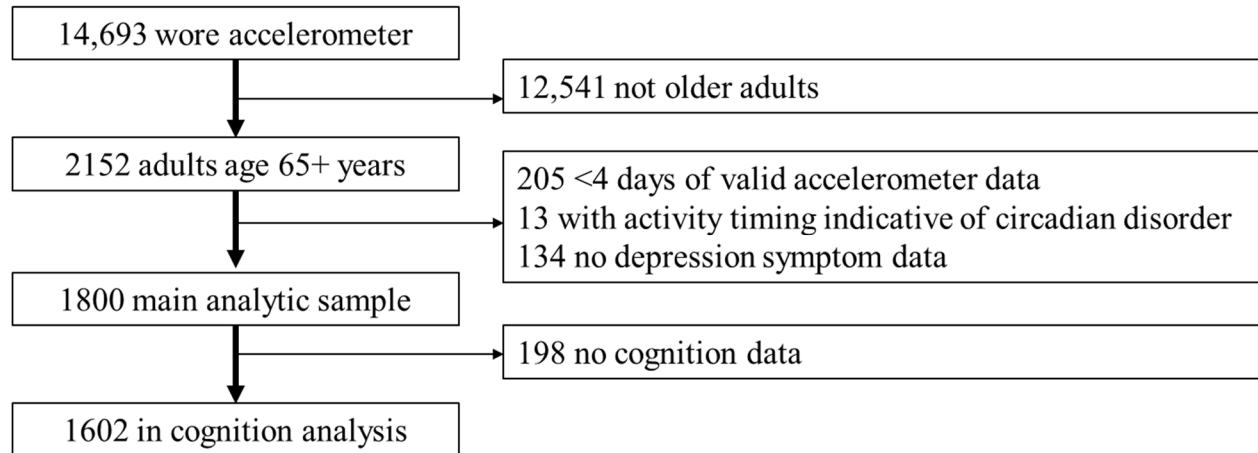
eAppendix. Analytic Sample Size, Accelerometer Measures, and Cognition Measures

1. Analytic sample size: Participants were recruited through stratified four-stage probability sampling¹. The 2011-2012 and 2013-2014 waves of NHANES, combined for this analysis, included 24-hour activity monitoring (accelerometer) assessments. Of the 14,693 individuals who wore the activity monitor, because our research question focuses on older adults, we initially restricted to 2152 of the activity monitor wearing participants who were 65 years of age or older. Of the 2152 older adult participants with activity monitor data, we excluded: 205 participants because they did not have at least 4 valid days of accelerometer data quality (valid days defined as >80% wear time), 13 individuals who had extreme activity timing indicative of a possible circadian rhythm disorder (activity onset occurring between 3 PM and 3 AM); and additional 134 who did not have at least the depression symptom outcome data. An additional 198 individuals did not complete the cognitive tests and were excluded from these analyses only. See Supplemental Table 1 for a comparison of activity patterns subgroups between participants with and without cognitive test data.

2. Accelerometer measures: Standard counts were computed in 60-second epochs from 80 hertz tri-axial accelerometer recordings. We extracted both extended (antilogistic transformed) cosine modeling² and non-parametric approaches³ measures from this time series. For the clustering analysis we used three measures computed from the “extended cosine” approach and three from the “non-parametric” approach: (1) the estimated activity onset time defined as the time the fitted curve reached the middle level on the left side of the curve (also known as up-mesor); (2) the estimated activity offset time defined as the time the fitted curve again reached the middle on the right side of the curve (also known as down-mesor); and (3) the pseudo-F statistic, a measure of how well the model fits the observed data, indicating how robust or “modellable” the activity pattern is given this approach. From the non-parametric approach, we assessed: (1) interdaily stability; (2) relative amplitude; and (3) intradaily variability. For descriptive purposes, we also calculated the estimated active period length, but this variable was not used in the clustering as it was mathematically redundant with the activity onset and offset times. In addition, to determine if the detected activity patterns were associated with the outcomes independent of overall activity level, we measured overall habitual activity level as the log-transformed amplitude of the extended cosine model.

3. Cognition measures: The tests were: (1) the Consortium to Establish a Registry for Alzheimer’s Disease Word Learning (CERAD-WL) subtest⁴ used to measure delayed memory; (2) the Animal Fluency (AF) test⁵ used to measure verbal fluency; and (3) the Digit Symbol Substitution Test (DSST)⁶ used to measure sustained attention/processing speed. Prior to analysis, all variables were standardized based on age, sex, and education sample norms. We did this by calculating age/sex/education strata specific means/standard deviations for each test, then computing participant z-scores within these strata. The Consortium to Establish a Registry for Alzheimer’s Disease Word Learning (CERAD-WL) included three learning trials where participants first read 10 unrelated words aloud, then are asked to recall as many as possible. After the three learning trials and the other two tests (described below; approximately 8-10 minutes later), participants were again asked to recall as many of the words as possible from the CERAD word list, and this score was used as a measure of delayed memory recall. resulting in an assessment of “Delayed Memory” (scores ranging 0-10). In the AF test, participants were asked to name as many animals as possible in one minute. Participants were asked to name three items of clothing as a practice test. The total number of animals named in the test was used as a measure of “Verbal Fluency.” In the DSST, participants are presented with a key linking nine numbers with symbols. Below the key are 133 boxes with numbers, and participants have two minutes to write the corresponding symbols in as many of boxes as possible. The total DSST score is the number of correctly written symbols. This test requires sustained attention, and also depending on psychomotor processing speed and working memory. For simplicity the total DSST score is referred to here as a measure of “Sustained Attention/Processing Speed.”

eFigure. Flowchart Illustrating How We Arrived at the Analytic Samples



eTable 1. Activity Pattern Subgroup Rates in Participants With and Without Cognitive Performance Test Data				
	Cluster 1: Earlier rising/robust	Cluster 2: Shorter active period/less modellable	Cluster 3: Shorter active period/very weak	Cluster 4: Later settling/very weak
Missing from cognition analysis (n=198)	35.6	24.9	15.8	23.7
Included in cognition analysis (n=1602)	37.8	33.3	9.3	19.6
Survey weighted Chi-square test p-value = 0.05				

eTable 2. Bayesian Information Criterion for Models of Different Variance Structures and Number of Groups														
<u>Number of groups</u>	<u>Covariance structure</u>													
	EII	VII	EEI	VEI	EVI	VVI	EEE	VEE	EVE	VVE	EEV	VEV	EVV	VVV
1	-32652	-32652	-7833	-7833	-7833	-7833	-5357	-5357	-5357	-5357	-5357	-5357	-5357	-5357
2	-29992	-29973	-6530	-6018	-6193	-5781	-4954	-4186	-4909	-4241	-4785	-4034	-4724	-4038
3	-28228	-27524	-6056	-5456	-5683	-5274	-4670	-4007	-4645	-4175	-4441	-3787	-4351	-3801
4	-27232	-25942	-5800	-5179	-5365	-5075	-4698	-3955	-4312	-4037	-4228	-3721	-4294	-3761
5	-26397	-25054	-5595	-5060	-5232	-4831	-4775	-3905	-4242	-3999	-4205	-3730	-4181	-3772
6	-25780	-24440	-5435	-4903	-5079	-4664	-4409	-3818	-4364	-4052	-4130	-3781	-4211	-3855
7	-25381	-23930	-5397	-4782	-4996	-4619	-4284	-3728	-4251	-3964	-4240	-3867	-4276	-3927
8	-25057	-23659	-5267	-4759	-4979	-4513	-4337	-3731	-4229	-3988	-4303	-3929	-4320	-4050
9	-24495	-23168	-5231	-4637	-4944	-4477	-4341	-3878	-4252	-4050	-4344	-4062	-4493	-4134

Bold indicates selected solution. We considered this range of structures using the R Software package ‘MClust’ as specified in ⁷ to allow for flexibility in identifying the optimal subgroup solution.

eTable 3. Sample Raw Unweighted Cognitive Test Performance Scores		
Test	Mean (standard deviation)	Range
<u>Overall sample (n=1602)</u>		
Digit Symbol Substitution Test	43.4 (16.5)	0 - 100
Animal Fluency Test Total Score	16.1 (5.3)	0 - 39
Consortium to Establish a Registry for Alzheimer's Disease Word Learning Subtest	5.6 (2.3)	0 - 10
<u>Participants with psychometric mild cognitive impairment as defined (n=264)</u>		
Digit Symbol Substitution Test	28.4 (12.6)	0 – 56
Animal Fluency Test Total Score	11.0 (3.6)	3 – 34
Consortium to Establish a Registry for Alzheimer's Disease Word Learning Subtest	3.1 (2.0)	0 – 9

eTable 4. Associations of Individual Activity Pattern Characteristics With the Main Outcomes Expressed Continuously							
Outcome:	Depression symptom severity (n=1800)			Overall cognitive performance composite score (n=1602)			
	β	Standard error	p-value		β	Standard error	p-value
Cluster 1: Earlier rising/robust	Reference				Reference		
Cluster 2: Shorter active period/less modellable	0.60	0.23	0.0096		-0.19	0.07	0.008
Cluster 3: Shorter active period/very weak	1.03	0.36	0.004		-0.46	0.10	<0.0001
Cluster 4: Later settling/very weak	1.11	0.31	0.0003		-0.48	0.08	<0.0001
Model including individual variables:							
Activity onset time	0.45	0.13	0.0005		-0.08	0.03	0.01
Activity offset time	-0.06	0.12	0.59		0.02	0.03	0.63
Pseudo-F Statistic	-0.05	0.09	0.62		0.00	0.04	0.96
Amplitude*	-0.43	0.16	0.01		0.22	0.05	<.0001
Inter-daily stability	0.06	0.17	0.72		-0.19	0.05	0.0001
Relative amplitude	-0.24	0.15	0.11		0.20	0.04	<.0001
Intra-daily variability	0.05	0.15	0.73		0.01	0.04	0.89
Each outcome was examined using separate linear regressions that accounted for the NHANES sampling weights. Models include all factors shown and the following covariates: age, sex, and race. Models of cognitive performance additionally include age and test administration language as covariates. All predictor variables were standardized, to facilitate effect size comparison, to a mean of zero and standard deviation of one.							

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