

Association between subjective hearing difficulty and executive function in older adults at risk for Alzheimer’s Disease

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Background

Age-related hearing loss has been linked to cognitive decline and Alzheimer’s disease (AD) and related dementia risk. **Self-reported hearing changes may be an indicator of cognitive decline.** To evaluate self-assessments of hearing as a potential non-invasive, low-burden screening tool, **we examined whether reports indicating hearing difficulty were associated with longitudinal executive function (EF) decline**–independent of AD risk factors and depressive symptoms–in a late middle-aged cohort enriched for AD risk.

Table 1. Sample Characteristics by Subjective Hearing Difficulty										
Characteristic	Overall N = 1,211		Low n = 456		Moderate n = 391		High n = 364		p-value	
Age at baseline (years)	58.48	(6.91)	57.07	(6.76)	58.58	(6.97)	60.12	(6.66)	<0.001	
Years of follow-up	10.80	(5.41)	10.71	(5.19)	10.68	(5.77)	11.05	(5.28)	0.5	
Sex (Female)	841	69%	354	78%	268	69%	219	60%	<0.001	
Race										0.2
Asian	4	0.3%	3	0.7%	0	0%	1	0.3%		
Black or African American	172	14%	64	14%	60	15%	48	13%		
Other	1	<0.1%	1	0.2%	0	0%	0	0%		
Unknown	11	0.9%	8	1.8%	2	0.5%	1	0.3%		
White	1	84%	380	83%	329	84%	313	86%		
Cognitive status at baseline										0.2
Unimpaired - Stable	977	81%	376	82%	319	82%	282	77%		
Unimpaired - Declining	207	17%	72	16%	66	17%	69	19%		
Clinical MCI	27	2.2%	8	1.8%	6	1.5%	13	3.6%		
Education (years)	16.13	(2.80)	16.19	(2.75)	16.07	(2.90)	16.11	(2.76)	0.8	
WRAT Reading score	105.37	(9.59)	105.59	(9.29)	105.03	(10.00)	105.45	(9.54)	0.9	
Depressive symptoms (CES-D)	7.51	(7.41)	5.98	(6.14)	8.13	(7.52)	8.74	(8.36)	<0.001	
APOE ε4 carrier	422	38%	160	39%	142	40%	120	35%	0.4	
p-tau217 Status										0.007
Negative	703	60%	289	66%	224	59%	190	54%		
Intermediate	227	19%	68	15%	84	22%	75	21%		
Positive	239	20%	83	19%	70	19%	86	25%		
MMSE Total Score	29.33	(1.01)	29.43	(0.87)	29.33	(1.02)	29.20	(1.14)	0.020	
Executive Function Composite (z)	-0.15	(1.15)	0.03	(1.10)	-0.18	(1.22)	-0.35	(1.11)	<0.001	
Trails B (seconds)	65.13	(34.21)	61.61	(31.98)	66.06	(38.15)	68.56	(32.04)	<0.001	
WAIS-R Digit Symbol	55.96	(11.26)	58.55	(11.25)	55.03	(11.40)	53.72	(10.48)	<0.001	
Letter Fluency (C-F-L)	43.85	(11.10)	44.11	(11.03)	44.49	(10.88)	42.85	(11.37)	0.077	

[†] Mean, (SD); n, %
[‡] Kruskal-Wallis rank sum test; Pearson’s Chi-squared test; Fisher’s exact test

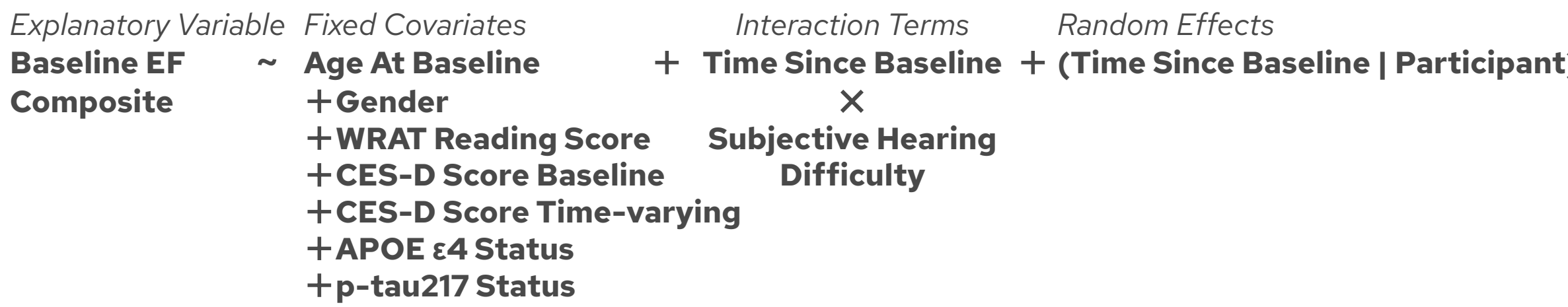
Notes: Participants were categorized into three bins (Low, Moderate, or High Difficulty) based on their subjective hearing assessment scores. Executive Function Composite score is the average of the z-scores of Trails B time (Reitan, 1958), Digit Symbol Substitution Test (Wechsler, 1981), and Controlled Oral Word Association Test Letters C,F,L (Benton, 1983). Plasma p-Tau217-ALZpath cut-offs at 0.40pg/mL and 0.63pg/mL.

Abbreviations: WRAT=Wide Range Achievement Test (Wilkinson, 1993); CES-D=Center for Epidemiology Scale for Depression (Radloff, 1977); MMSE=Mini Mental State Examination (Folstein, 1975).

Measurement: Subjective Hearing Questionnaire is comprised of Likert-scale items reflecting hearing and auditory abilities where the lowest score (1) indicates no hearing difficulty and the highest (10) indicates the greatest amount of hearing difficulty.

Methods

Participants from the Wisconsin Registry for Alzheimer’s Prevention were binned into Low, Moderate, or High Difficulty tertiles based on scores from a five-item self-assessment of hearing (e.g., listening effort, speech-in-noise; scale range 1=no difficulty; 10=high difficulty). EF was indexed by a composite score of Trails B, Digit Symbol Substitution, and Letter Fluency (C,F,L). **We used linear mixed effects models, including person-specific random intercepts and slopes, to examine longitudinal changes in EF relative to participants’ first available subjective hearing scores.** Fixed covariates included age at baseline, sex, literacy, plasma p-tau217 status, APOE-E4 genotype, and depressive symptoms (Center for Epidemiologic Studies Depression Scale; CES-D).



Participants with the highest hearing difficulty experience faster EF decline.

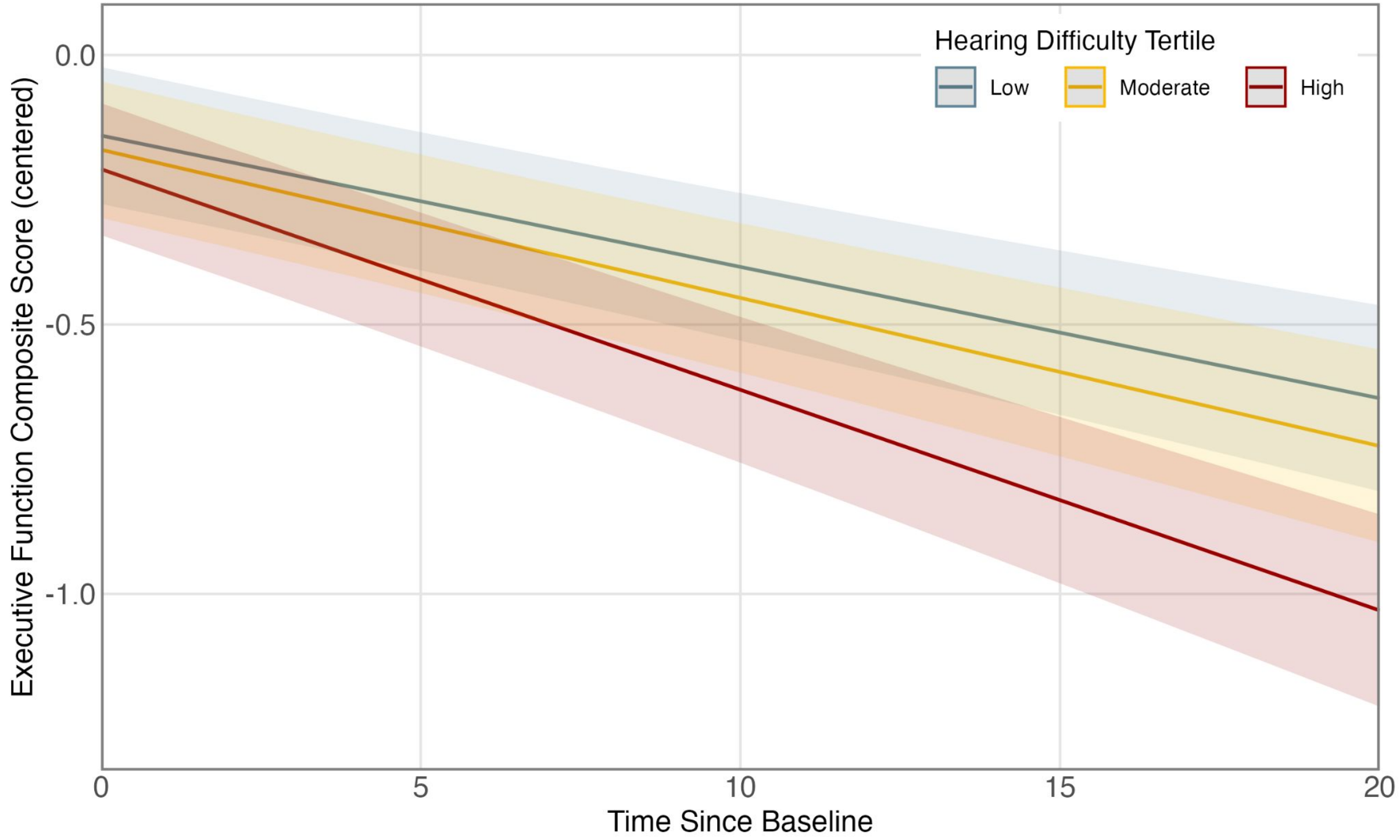


Figure 1. Interaction between subjective hearing difficulty and time on Executive Function (EF) showing faster declines in EF over time for individuals with the highest hearing difficulty. Linear mixed-effect models included person-specific random intercepts and slopes. Covariates included baseline age, sex, literacy, plasma p-tau 217 status, APOE-E4 genotype, and depressive symptoms (Center for Epidemiologic Studies Depression Scale; CES-D). Baseline was defined as the first study visit with EF composite score. Participants were binned into tertiles based on summative scores of five Likert-type items measuring hearing and auditory difficulty, where the lowest score (1) indicates no hearing difficulty and the highest (10) indicates the greatest amount of hearing difficulty.

Results

A significant interaction between subjective hearing difficulty and time since baseline on EF ($\beta = -0.017$, $p < .001$) indicated that **individuals reporting high hearing difficulty exhibited a faster decline in EF over time compared to those reporting moderate or low hearing difficulty.** This finding persisted when controlling for baseline ($\beta = -0.016$, $p < .001$) and time-varying ($\beta = -0.005$, $p = .002$) CES-D scores, suggesting **subjective hearing difficulty may predict EF changes independently of depressive symptoms**, a known correlate of EF. APOE-E4 carrier status ($\beta = -0.066$, $p = .222$), p-tau217 intermediate status ($\beta = -0.005$, $p = .937$), and p-tau217 positive status ($\beta = -0.040$, $p = .551$) status did not show significant main effects on EF in our model.

Table 2. Linear Mixed Model of the Association Between Subjective Hearing Difficulty and Executive Function Over Time				
Predictor	Estimate (β)	Std. Error	t-value	p-value
Age at baseline (centered)	−0.058	0.004	−14.642	<.001***
Gender (Female)	0.397	0.055	7.180	<.001***
WRAT Reading Score (centered)	0.077	0.006	13.615	<.001***
Depressive symptoms: baseline (CES-D, centered)	−0.016	0.004	−4.248	<.001***
Depressive symptoms: time-varying	−0.005	0.002	−3.100	0.002**
APOE ε4 status (carrier)	−0.066	0.054	−1.223	0.222
p-tau217 Status: Intermediate	−0.005	0.067	−0.079	0.937
p-tau217 Status: Positive	−0.040	0.067	−0.597	0.551
Time since baseline (years)	−0.024	0.003	−7.387	<.001***
Subjective Hearing Difficulty: Moderate	−0.026	0.062	−0.423	0.673
Subjective Hearing Difficulty: High	−0.062	0.065	−0.955	0.340
Time × Subjective Hearing Difficulty: Moderate	−0.003	0.005	−0.643	0.520
Time × Subjective Hearing Difficulty: High	−0.017	0.005	−3.369	<.001***

Notes: Participants were categorized into three bins (Low, Moderate, or High Difficulty) based on their subjective hearing assessment scores. Executive Function Composite score is the average of the z-scores of Trails B time (Reitan, 1958), Digit Symbol Substitution Test (Wechsler, 1981), and Controlled Oral Word Association Test Letters C,F,L (Benton, 1983). Plasma p-Tau217-ALZpath cut-offs at 0.40pg/mL and 0.63pg/mL.

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Measurement: Subjective Hearing Questionnaire is comprised of Likert-scale items reflecting hearing and auditory abilities where the lowest score (1) indicates no hearing difficulty and the highest (10) indicates the greatest amount of hearing difficulty.

*p < 0.05, **p < 0.01, ***p < 0.001.

Conclusions

Higher hearing difficulty is associated with faster decline in executive functioning over time after controlling for AD risk factors and depressive symptoms.

Our findings suggest **subjective assessments of hearing difficulty may serve as an indicator of dementia-related cognitive decline.** Future work will examine item-level subjective hearing questions and individual neuropsychological tests as outcomes to better characterize the relationship between self-assessments of hearing and executive function.

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