

## Introduction

- Current tools for point-of-care evaluation in hepatic encephalopathy (HE) are limited
- Validated evaluations of HE require a trained practitioner in an office setting, and over 10 minutes to perform
- There is a pressing need to develop simple yet reliable tools to remotely track cognitive dysfunction in cirrhotic patients
- We aimed to assess easy-to-obtain aspects of language as novel biomarkers for HE

## Methods

### Study Population:

- Adult (age  $\geq 18$ ), outpatients with cirrhosis
- Fluent in English

### Study Procedures:

- Performed the psychometric HE score (PHES), a validated neurocognitive test for HE
- Audio recorded while describing the Cookie Theft Scene from the Boston Diagnostic Aphasia Examination



Cookie Theft Scene, Image shown to patients, given standardized instructions

### Data Analysis:

- Audio analysed by Winterlight Labs speech analysis platform
- >500 acoustic and linguistic speech variables evaluated by natural language processing tools
- We compared scores between subjects with and without a history of OHE, or current MHE (PHES  $\leq -4$ ), by t-test or Mann-Whitney test depending on data normality

Figure 1: Patient Enrollment

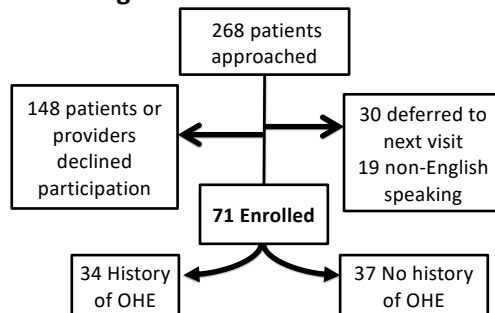


Table 1: Clinical Characteristics of Patients

Age in years, mean (range)	59 (27-82)
Male sex, n (%)	45 (63)
MELD	13 $\pm$ 5
Years of Education	16 $\pm$ 3
History of OHE, n (%)	34 (48)
MHE, n (%)	19 (27)
Etiology of Cirrhosis, n (%)	
EtOH	34 (48)
NASH	8 (25)
Viral	25 (21)

Data represented as mean  $\pm$  SD unless otherwise specified. MHE at testing defined as PHES  $\leq -4$

Figure 2: Slower Speech Rate in HE

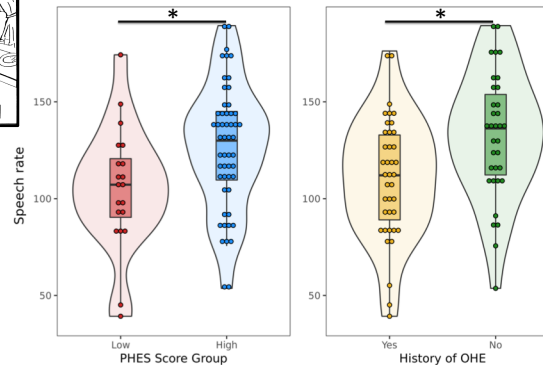


Table 2: Speech Differs by OHE and MHE

	OHE* (n=34)	No OHE (n=37)	P value
Speech Rate, words/min	111	132	0.007
Proportion of Words, % words in sample	85	89	0.02
Average Word Duration, sec/word	0.53	0.44	0.009
Proportion of Pauses, % pauses in sample	16	13	0.02
	MHE <sup>§</sup> (n=19)	No MHE (n=52)	P value
Speech Rate, words/min	106	127	0.02
Sentence Structure**	0.77	0.89	0.03

OHE = overt hepatic encephalopathy, MHE = minimal hepatic encephalopathy  
 \* Defined as  $\geq 1$  prior hospital admissions for OHE; <sup>§</sup> Defined as PHES score  $\leq -4$ , including patients with a history of OHE  
 \*\* Clauses per sentence

## Results

PHES score positively correlated with rate of speech ( $r=0.35$ ,  $P=0.002$ ) and negatively correlated with average word duration ( $r=-0.35$ ,  $P=0.002$ )

Figure 3: Speech Correlates with Cognition

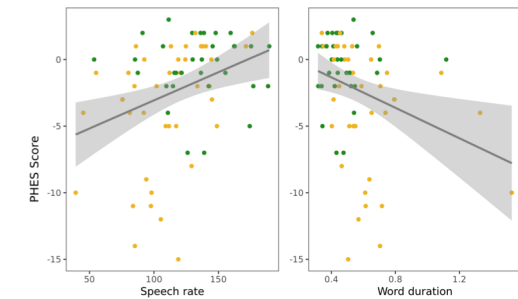
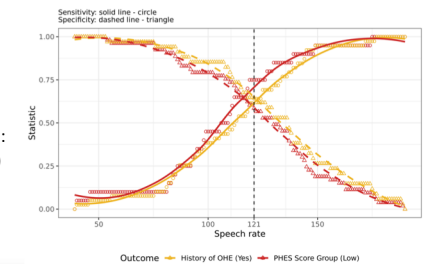


Figure 4: Sensitivity and Specificity

A speech rate cut-off of 121 words/min was found to optimize sensitivity (MHE: 0.74, OHE: 0.62) and specificity (MGH: 0.60, OHE: 0.65)



## Conclusions

- Patients with a history of OHE or current MHE have a slower speech rate than those without these diagnoses
- Pauses and word duration are also associated with HE
- Future research should explore using speech to predict future OHE and to evaluate treatment response

## References

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