Investigating the Use of Beacon for Cognitive Monitoring in People with Alzheimer's Disease and Lewy Body Dementia via the Critical Flicker Frequency

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Abstract

New and emerging medication for people with Alzheimer's disease and Lewy body dementia motivates the need for longitudinally self-administered cognitive monitoring to support timely interventions. We previously developed Beacon, a device for assessing cognitive function via the critical flicker frequency, and validated it in people with chronic liver disease and hepatic encephalopathy. In this WISH poster submission, we present: (1) initial progress collecting CFF data in people with neurocognitive disorders, including dementia patients; (2) discussion around expected findings from this data collection; and (3) future opportunities for this work, including the potential for at-home, self-monitoring of cognitive dysfunction.

Introduction

Dementia refers to a group of symptoms that affect psychological and cognitive processes, including conditions such as Alzheimer's disease and Lewy body dementia. New and emerging medication for people in this population motivate the need for early detection and longitudinal monitoring for timely intervention.[1] However, current methods largely rely on psychometric tests (e.g., Montreal Cognitive Assessment, Mini-Mental State Examination) which are strongly impacted by effort, training, age, interaction with a test administrator, literacy, numeracy, and education.[2,3]

Critical flicker frequency (CFF) is an excellent screening test of cognitive function. CFF is the frequency at which a rapidly flickering light appears fused (i.e., steadily on and not flickering). This phenomenon depends on both the brain and the retina, but does not require effort or training and is not subject to learning effects in repeated measures. Many conditions that result in inflammation of the central nervous system and cognitive dysfunction, including Alzheimer's disease, result in a reduction in CFF.[4,5]

We previously developed Beacon (shown in Figure 1) to support chronic liver disease patients in self-monitoring fluctuations in their cognitive processes (i.e., hepatic encephalopathy). This line of work has involved first reframing CFF from a clinical measure to one for at-home use[6] and then validating Beacon against commercial alternatives in a clinical setting.[7] We then demonstrated the feasibility of patient at-home self-measurement and showed that Beacon measurements are stable across people and environmental confounds (e.g., different times, different locations).[8]

In this WISH poster submission, we present an early-stage idea investigating the use of Beacon for cognitive monitoring in people with Alzheimer's disease and Lewy body dementia via CFF measurements. We present: (1) initial progress collecting CFF data in this patient population; (2) discussion around expected findings; and (3) future opportunities for this work, including the potential for at-home, self-monitoring of cognitive dysfunction.

Methods

Participants. We are currently recruiting people with mild and major neurocognitive disorders, including probable Alzheimer's disease or dementia with Lewy bodies, to participate in data collection. We are recruiting these participants from the Veterans Affairs Puget Sound hospital.

Procedure. All data collection sessions are completed in a controlled lab setting at the Veterans Affairs Puget Sound hospital and facilitated by a research coordinator. Participants are asked to complete CFF measurements using the

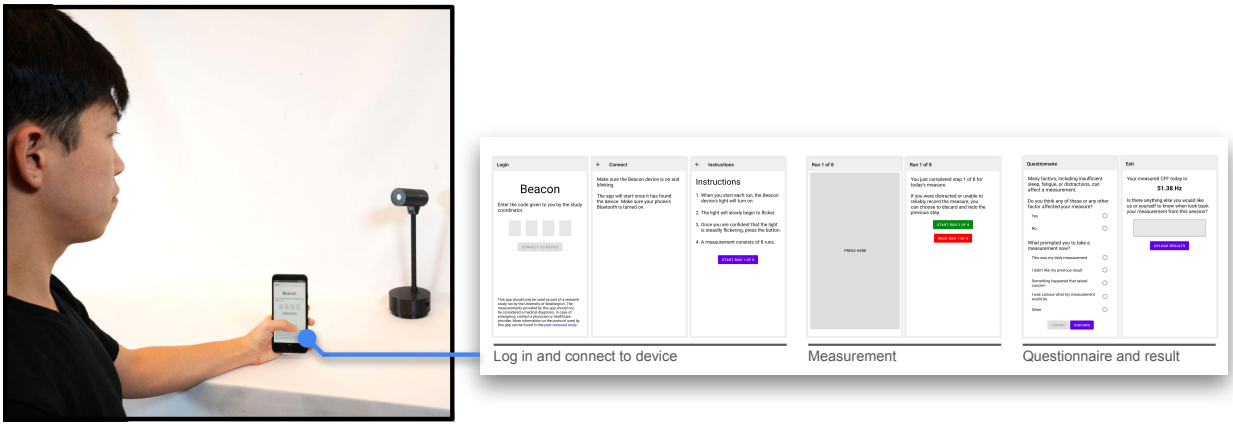

Figure 1: Beacon consists of a physical device and an accompanying app. The device is used to precisely render a flickering optical stimulus. The app is primarily used to control the device and facilitate measurements, but also provides basic functionality to support patients in selecting their desired measurement protocol and recording reflections on their measurement.

Beacon device alongside other standard psychometric tests for use in dementia populations. After completing a data collection session, participants are invited to return after 6-months to repeat the data collection process.

Analysis. We will first assess the feasibility of people in this patient population in using the Beacon device. We will then look for relationships between the CFF measurements produced by the Beacon device and the standard psychometric tests. Finally, we will examine the stability of the CFF measurements over time (i.e., by comparing measurements across the 6-month gap).

Discussion and Conclusion

What do we expect to see in this data? Prior work has shown that CFF is reduced in people with Alzheimer's disease.[5] Through our data collection, we first expect to demonstrate that CFF measurements produced by the Beacon device are consistent with the characterization described in the prior work. Similar to our own prior work in the chronic liver disease population,[8] we will then characterize how CFF measurements within a single person fluctuate over time (i.e., across a 6-month gap). We expect that in people with transient neurocognitive disorders, their CFF will remain stable, while in people with Alzheimer's disease or Lewy body dementia, we expect the sensitivity of the CFF measurements to show a clear decline.

How do we expect these findings to differ from our results in the chronic liver disease patient population? Hepatic encephalopathy (i.e., the cognitive fluctuations experienced by chronic liver disease patients) is a transient condition that can worsen on its own, but can also be improved via medication and lifestyle changes. Dementia, on the other hand, generally cannot be cured; interventions can only slow its progression and help patients manage symptoms. This difference in the nature of the conditions changes how we expect these patient populations to use Beacon. While people with hepatic encephalopathy can experience fluctuations on the hours and days timescale, motivating the need for daily CFF measurements, dementia progresses on the months and years timescale. As a result, we hypothesize that dementia patients will not need to complete CFF measurements as frequently as their liver disease counterparts in order to effectively monitor the progression of their condition.

What is next for this work? We look forward to continued data collection in this patient population. Our progress thus far has already surfaced opportunities for technical improvements in Beacon, specifically the need to reduce user burden by minimizing the time required to complete measurements. Addressing this challenge will support future work in demonstrating feasibility of longitudinal self-monitoring in home settings with this patient population.

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