SELECTING THE MOST CHARACTERISTIC VESTIBULAR STIMULI TO BE USED FOR ALZHEIMER'S SUBTYPE DIAGNOSIS

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I. Introduction

The heterogeneity of dementia etiology and the overlapping of neuropathological features makes distinguishing Alzheimer's disease (AD) from Alzheimer's disease with cerebrovascular disease pathology (AD-CVD) challenging. Recent studies using vestibular responses recorded using electrovestibulography (EVestG) show promising results for the separation of AD from AD-CVD [1]. An EVestG measurement records average field potential responses to several different orthogonal physical stimuli (called tilts), of which select ones based on physiological intuition were used to classify AD from AD-CVD in previous studies [2]. The objective of this study was to implement well-known principal component analysis (PCA) to investigate all the tilt responses recorded by EVestG and rank them in terms of their capability to distinguish AD from AD-CVD.

II. Materials and methods

EVestG recordings have been previously detailed [3]. EVestG's chair controller provides passive motion via a number of tilts (sitting upright and supine) and phases (stationary, acceleration, deceleration). In this study, data of 28 AD and 24 AD-CVD individuals were adopted from our team's two previous studies [1, 2]. Medical specialists, including neurologists and neuropsychiatrists, conducted multiple clinical assessments, and utilized brain imaging techniques such as magnetic resonance imaging (MRI) and positron emission tomography (PET) to determine the diagnosis of the dementia subtype [1]. We used an algorithm based on PCA to rank the most effective vestibular stimulus (tilt) for differentiating AD from AD-CVD. Analyses were performed on the EVestG signals of 28 individuals with AD and 24 with AD-CVD. The efficiency in distinguishing AD from AD-CVD was calculated according to the mean contribution of tilts in the first 26 Principle Components (PCs) (81% of data variation). In order to identify the most effective tilts, we use the S_ave score, which is the average frequency of tilts in each rank resulting from 700 implementations of PCA each on 80% of the randomly chosen data.

$$S_{ave} = \sum_{i=1}^{7} i * \frac{700}{7} = 2800 \quad (1)$$

III. Results

For the purpose of finding the best tilts, each rank is multiplied by its frequency value, and the sum calculated. The best tilts are those whose summation is less than S_ave, i.e., 2800, (see eqn. 1) the lower ranks. This summation for the best 2 example tilts is shown in Table 1.

Table 1 Selected Tilts

Σ_Supine Up/down	1205
Σ_Up/down	1270

IV. Discussion and conclusions

We have tested the algorithm on 80% of a randomly selected database and confirmed its results based on previous studies. This algorithm selected the best tilts for performing feature extraction and classification without the need for prior physiological change knowledge. The Supine Up/down and (sitting) Up/down tilts predominantly stimulate the utricle and saccule (otolithic organs), respectively, were found as the most effective tilts in separating AD from AD-CVD. By considering the contribution of otolithic functional impairments i.e., having poor spatial memory and significant increased chance of AD, as well as the regulatory role of the vestibular system related to ischemic conditions support the PCA outcome in selecting the aforementioned tilts for separation of AD from AD-CVD.

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References

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