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Automatic Characterization of Temporal Properties in Verbal Fluency Tests

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Abstract

Introduction

In the VF test, participants are asked to retrieve as many words in a category (e.g., animals) as possible in a short duration of time, typically one minute. Conventionally, the count of uniquely generated correct words comprises the final score. However, this does not consider other clinically relevant information such as the sequential pattern of produced words in a semantic fluency test.

Method

Capitalizing on the temporal aspects of the animal fluency test, we hypothesize that time related measures of the response will be useful in distinguishing mild cognitive impairment (MCI) from cognitively intact (CI) controls. Measuring temporal properties of the VF is costly and time-consuming as it requires a precise annotation of timestamps (i.e., when in time a word begins and ends). To address this drawback, we propose a computational approach that utilizes an automatic speech recognition (ASR) system, in which temporal properties of the verbal response is automatically characterized. Our model semantically clusters animal names and automatically characterizes the semantic search strategy of subjects in retrieving words from animal name clusters. Extracted time-based measures along with standard count-based features are then used in a support vector machine (SVM) classifier to examine the utility of these measures in distinguishing those with MCI from CI controls.

Results

We experimentally showed that the conventional test score cannot capture other clinically useful information from the test and once it is solely used for training a support vector machine (SVM) classifier, the resulting model achieved a poor performance. The combination of both count-based and time-based features, automatically derived from the test response, achieved 77% on AUC-ROC of the SVM classifier, outperforming the model

trained only on the raw test score (AUC, 65%), and well above the chance model (AUC,50%).