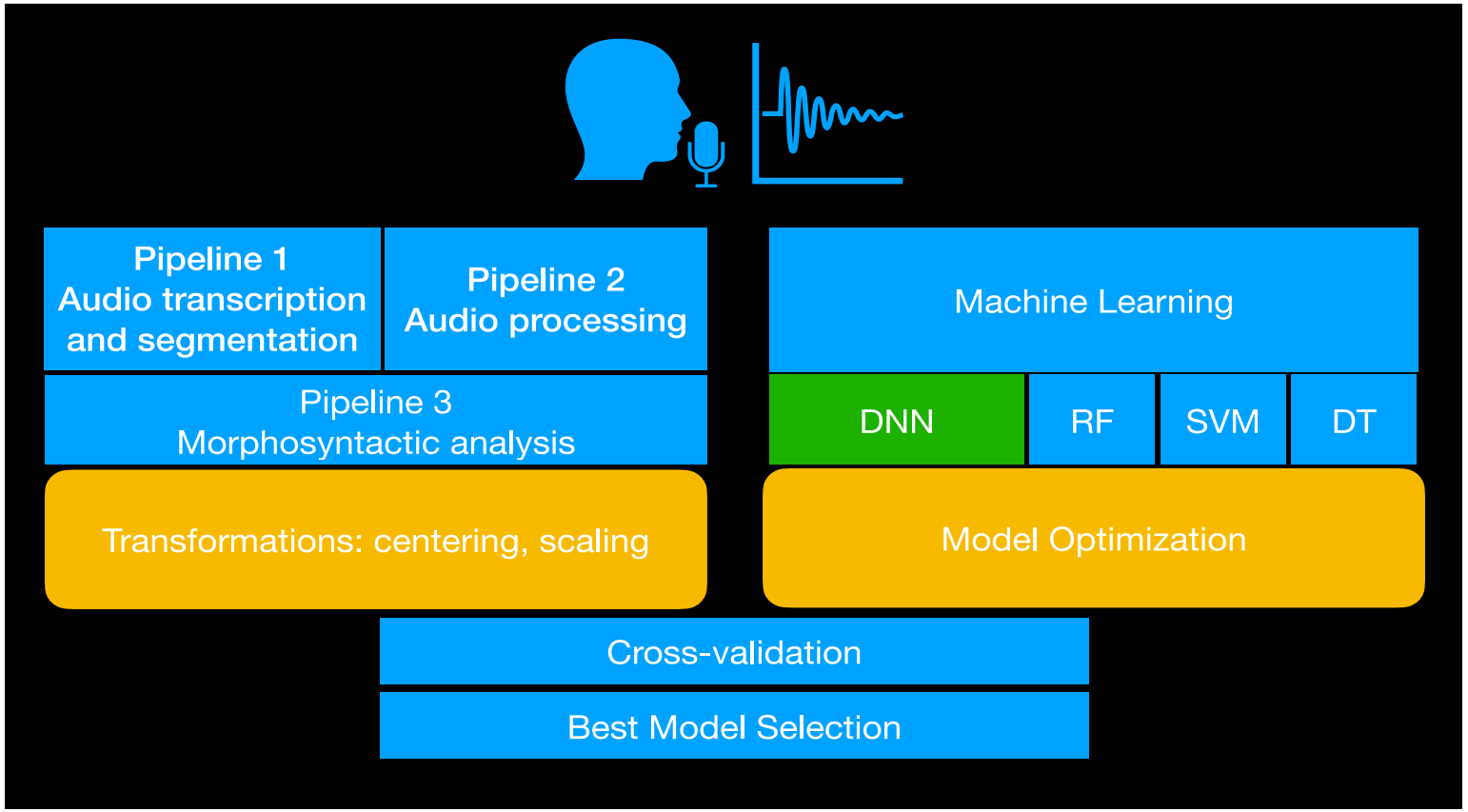
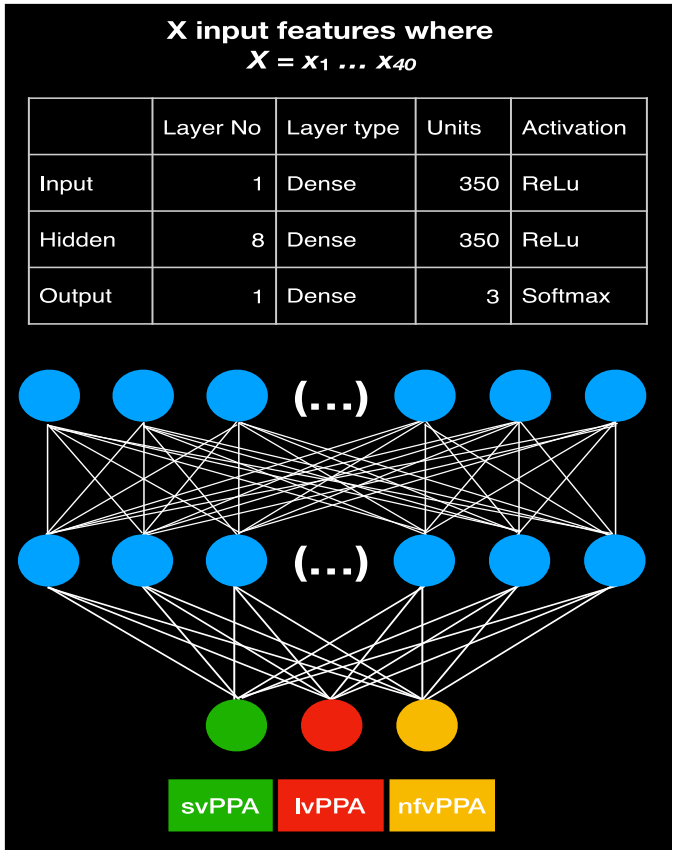
Analyzing Discourse/Connected Speech Automatically in Differential Diagnosis of Patients and Monitor and Score Performance in the lab and memory clinics, and everyday environments





Themistocleous Charalambos, Bronte Ficek, Kimberly Webster, Dirk-Bart den Ouden, Argye E. Hillis, Kyrana Tsapkini (2021). Automatic subtyping of individuals with Primary Progressive Aphasia. Journal of Alzheimer's Disease,

Automated Scores of Phonetics, Spelling, Morphology

PLOS ONE

RESEARCH ARTICLE

Voice quality and speech fluency distinguish individuals with Mild Cognitive Impairment from Healthy Controls

Charalambos Themistocleous, Kris Eckerström, Dimitrios Kokkinakis

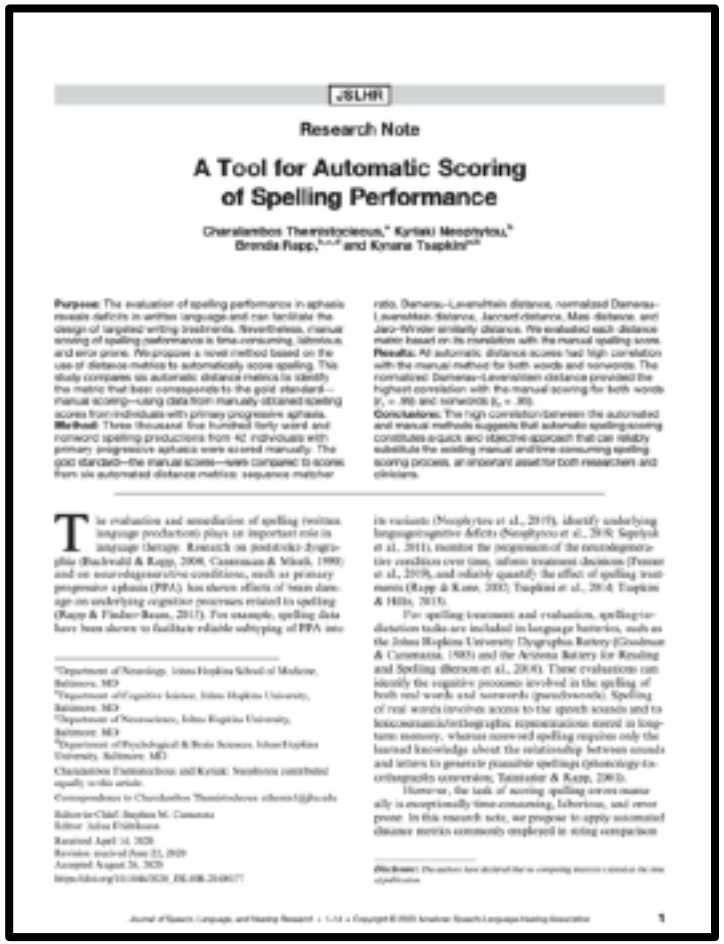
Abstract

Mild Cognitive Impairment (MCI) is a syndrome characterized by cognitive decline greater than expected for an individual's age and education level. This study aims to determine whether voice quality and speech fluency distinguish patients with MCI from healthy individuals to improve diagnosis of patients with MCI. We analyzed recordings of the Cookie Theft picture description task produced by 26 patients with MCI and 29 healthy controls from Sweden and calculated measures of voice quality and speech fluency. The results show that patients with MCI differ significantly from HC with respect to acoustic aspects of voice quality, namely H1-A3, cepstral peak prominence, center of gravity, and shimmer, and speech fluency, namely articulation rate and averaged speaking time. The method proposed along with the obtainability of connected speech productions can enable quick and easy analysis of speech fluency and voice quality, providing accessible and objective diagnostic markers of patients with MCI.

Introduction

Mild Cognitive Impairment (MCI) is a syndrome characterized by cognitive decline greater than expected for an individual's age and education level. Patients with MCI remain functional in their daily activities [1]. Progression rates vary across studies depending on the diagnostic criteria and methods being employed, although there are indications that about 58% of patients with MCI progress to Alzheimer's Disease (AD) within five years, yet many patients remain stable for several years [1–3]. Currently, there is no cure for AD, but identifying patients with MCI early and applying therapy in a timely manner can delay the progression of the MCI to AD [4]. It is of utmost importance to develop straightforward, non-intrusive, and reliable objective diagnostic measurements of cognitive impairment that can be conducted at primary care centers and memory clinics to determine whether an individual should seek further professional advice.

PLOS ONE | https://doi.org/10.1371/journal.pone.0236009 July 13, 2020 1 / 19



JSLHR

Research Note

A Tool for Automatic Scoring of Spelling Performance

Charalambos Themistocleous, Kyriaki Neophytou, Brenda Rapp, and Kyrana Tsapkini

Purpose: The evaluation of spelling performance in aphasia reveals deficits in written language and can facilitate the design of targeted writing treatments. Nevertheless, manual scoring of spelling performance is time-consuming, laborious, and error prone. We propose a novel method based on the use of distance metrics to automatically score spelling. This study compares six automatic distance metrics to identify the metric that best corresponds to the gold standard—manual scoring—using data from manually obtained spelling scores from individuals with primary progressive aphasia.
Method: Three thousand five hundred forty word and nonword spelling productions from 42 individuals with primary progressive aphasia were scored manually. The gold standard—the manual scores—were compared to scores from six automated distance metrics: sequence matcher ratio, Damerau–Levenshtein distance, normalized Damerau–Levenshtein distance, Jaccard distance, Masi distance, and Jaro–Winkler similarity distance. We evaluated each distance metric based on its correlation with the manual spelling score.
Results: All automatic distance scores had high correlation with the manual method for both words and nonwords. The normalized Damerau–Levenshtein distance provided the highest correlation with the manual scoring for both words (r_s = .99) and nonwords (r_s = .95).
Conclusions: The high correlation between the automated and manual methods suggests that automatic spelling scoring constitutes a quick and objective approach that can reliably substitute the existing manual and time-consuming spelling scoring process, an important asset for both researchers and clinicians.

The evaluation and remediation of spelling requires language production) plays an important role in language therapy. Research on posterior dysgraphia (Buchwald & Rapp, 2006; Caramazza & Miceli, 1990) and on neurodegenerative conditions, such as primary progressive aphasia (PPA), has shown effects of brain damage on underlying cognitive processes related to spelling (Rapp & Fischer-Baum, 2014). For example, spelling data have been shown to facilitate reliable subtyping of PPA into its variants (Neophytou et al., 2018), identify underlying language/cognitive deficits (Neophytou et al., 2019; Saphyk et al., 2011), monitor the progression of the neurodegenerative condition over time, inform treatment decisions (Fraser et al., 2019), and reliably quantify the effect of spelling treatments (Rapp & Kane, 2002; Tsapkini et al., 2014; Tsapkini & Hillis, 2013).

For spelling treatment and evaluation, spelling-to-dictation tasks are included in language batteries, such as the Johns Hopkins University Dysgraphia Battery (Goodman & Caramazza, 1985) and the Arizona Battery for Reading and Spelling (Beeson et al., 2010). These evaluations can identify the cognitive processes involved in the spelling of both real words and nonwords (pseudowords). Spelling of real words involves access to the speech sounds and to lexical-semantic/orthographic representations stored in long-term memory, whereas nonword spelling requires only the learned knowledge about the relationship between sounds and letters to generate plausible spellings (phonology-to-orthography conversion; Tainturier & Rapp, 2001).

However, the task of scoring spelling errors manually is exceptionally time-consuming, laborious, and error prone. In this research note, we propose to apply automated distance metrics commonly employed in string comparison

Journal of Speech, Language, and Hearing Research • 1–14 • Copyright © 2020 American Speech-Language-Hearing Association 1

AJSLP

Research Article

Part of Speech Production in Patients With Primary Progressive Aphasia: An Analysis Based on Natural Language Processing

Charalambos Themistocleous, Kimberly Webster, Alexandros Afthinos, and Kyrana Tsapkini

Background: Primary progressive aphasia (PPA) is a neurodegenerative disorder characterized by a progressive decline of language functions. Its symptoms are grouped into three PPA variants: nonfluent PPA, logopenic PPA, and semantic PPA. Grammatical deficiencies differ depending on the PPA variant.
Aims: This study aims to determine the differences between PPA variants with respect to part of speech (POS) production and to identify morphological markers that classify PPA variants using machine learning. By fulfilling these aims, the overarching goal is to provide objective measures that can facilitate clinical diagnosis, evaluation, and prognosis.
Method and Procedure: Connected speech productions from PPA patients produced in a picture description task were transcribed, and the POS class of each word was estimated using natural language processing, namely, POS tagging. We then implemented a twofold analysis: (a) linear regression to determine how patients with nonfluent PPA, semantic PPA, and logopenic PPA variants differ in their POS productions and (b) a supervised classification analysis based on POS using machine-learning models (i.e., random forests, decision trees, and support vector machines) to subtype PPA variants and generate feature importance (FI).
Outcome and Results: Using an automated analysis of a short picture description task, this study showed that content versus function words can distinguish patients with nonfluent PPA, semantic PPA, and logopenic PPA variants. Verbs were less important as distinguishing features of patients with different PPA variants than earlier thought. Finally, the study showed that among the most important distinguishing features of PPA variants were elaborative speech elements, such as adjectives and adverbs.

Morphosyntactic deficits have been identified as one of the key symptoms of primary progressive aphasia (PPA; Mesulam et al., 2014, 2012; Mesulam & Weintraub, 2014), a neurodegenerative condition that results in a considerable deterioration of speech and language skills (Thompson, Lukic, et al., 2012; Thompson & Mack, 2014). PPA is characterized by substantial variability of symptoms as an effect of the degree of neurodegenerative decline, underlying pathology, and areas of brain damage (Mesulam, 2013; Thompson, Lukic, et al., 2012; Thompson & Mack, 2014). To understand the symptoms, recently established consensus criteria classify patients into three main PPA variants: the nonfluent/PPA variant (nfvPPA), the logopenic PPA variant (lvPPA), and the semantic PPA variant (svPPA; Gorno-Tempini et al., 2011; Gorno-Tempini & Ponsaran, 2016).

Morphosyntactic production is key for language communication, and as it becomes impaired in PPA, it can provide objective markers for the classification of patients with PPA into variants, for clinical evaluation, prognosis of the condition, and intervention. Patients with nfvPPA are characterized by sparsity of function words and abnormal syntax due to peak atrophy at the posterior inferior frontal gyrus (Broca's area; Gorno-Tempini et al., 2011; Thompson et al., 1997, 2013; Thompson, Cho, et al., 2012).