Literature Review

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1 Introduction

According to a recent report commissioned by the Alzheimer's Society, they estimate the prevalence of Dementia in the UK at approximately 815,000 people. This represents 1 in 14 of the population aged 65 or over. This report also estimates an annual healthcare spend on 4.3 billion of which approximately 85 million is spend solely on diagnosis. They also estimate that the overall impact of dementia (excluding the costs associated with early onset dementia) is 26.3 billion annually. Globally, this picture is a lot bleaker. A recent report suggests that in 2015 there were 46 million people with a diagnosis of dementia and that number is expected to hit 131.5 million by 2050 [1]. The report also states that the worldwide cost of dementia in 2018 is estimated to be in the region of one trillon US dollars.

According to the DSM 5 [2], those with Mild dementia suffer from noticeable word-find difficulty. They may substitute general terms for more specific terms. They may avoid the use of specific names of acquaintances. There may be grammatical errors involving subtle omission or incorrect use of articles, prepositions, auxiliary verbs, etc. Those who have progressed from Mild to Major depression also have difficulties with expressive or receptive language. They will often use general-use phrases such as "that thing" and "you know what I mean," and prefers general pronouns rather than names. With severe impairment, sufferers may not even recall names of closer friends and family. Idiosyncratic word usage, grammatical errors, and spontaneity of output and economy of utterances occur. Stereotypy of speech occurs; echolalia and automatic speech typically precede mutism.

In assessing whether a client has AD, part of a clinicans job is to assess langugage capability. As described above, AD has a significant impact on language and a clinician has access to tools designed to test lanaguage capabilities. An example of this is part of the Boston Diagnostic Aphasia Examination (BDAE), called the Boston Cookie Theft picture description task [] . In this task participants are asked to describe a picture presented to them in as much detail as possible. The picture itself depicts a familiar domestic scene and would not require participants to use any vocabulary beyond that learned in childhood. It was originally designed to assess Aphasia, but has shown itself to be useful in the diagnosis of AD as well [**?**]

Test

It is clear from both the clinical diagnostic criteria and supporting research that language is impacted in those with AD. The purpose of this review is to seek to understand how dementia impacts speech and language production from a psychological and linguistic perspective. An understanding of this would allow the development of A search of the literature was conducted mainly from a psychological perspective using ProQuest (PsychArticles), SCOPUS, Web of Science. The following results were found.

Database	Number of Results	Search Terms
ProQuest(PsychArticles)	1484 Results	Language AND Decline AND Dementia
ProQuest(PsychArticles)	486 Results	Language AND Decline AND Dementia AND Speech
Web of Science	1207 Results	Language AND Decline AND Dementia
Web of Science	151 Results	Language AND Decline AND Dementia AND Speech
Scopus	791 Results	Language AND Decline AND Dementia
Scopus	91 Results	Language AND Decline AND Dementia AND Speech

All stages of this literature review were completed by myself.

2 Assessment of Language function in Dementia

Language can be defined as the ability to encode ideas into words and/or symbols for the means of communication. Difficulty in language, both spoken and written, are often described as symptoms of various types of Alzheimers' disease (AD). One of the challenges when using speech as a predictor is recognising whether there is a problem with language production or with the motor skills. Impairments in speech that arise from any process that disrupts the neuraxis from the cortex to muscle and encompass dysarthria (disturbance in articulation) and dysphonia (disturbance in the production in vocal sounds). However it is important to use language as a tool to aid the diagnosis of Dementia, as it provides vital clues to aid a clinician in differentiating in the different types of Dementia, which will in turn aid a clinician in an attempt to manage an individual case of Dementia. Due to the subtle nature of the languages changes that are experienced in those who suffer with different types of Dementia, it is often misdiagnosed.

Emery (2000) [3], takes the perspective of semiotics, and the idea that language and the processes involved in language are hierarchical. She proposes that language goes from simple units of construction, and build layers of complexity and sophistication. There are four levels of language according to this perspective: Phonology, Morphology, Syntax and Semantics. Emery conducted a review of research that looked at how AD impacted on each level of language. She found that people with AD generally had intact Phonology and Morphology but more impaired Syntax and Semantics.

Emery states that you can see language decline as Hierarchical. According to a semiotic model there are four ranks of language based on their cognitive complexity. These ranks are Phonology, Morphology, Syntax and Semantics. She conducted a review studies which looked at language decline from the perspective of these hierarchical ranks. Her conclusion is that language decline is related to the complexity of the language task given to a participant and that language decline is hierarchical in that the language forms we learn last (the most complex language forms) are the first to deteriorate.

3 Connected Speech

4 stuff to add

Annotated Bibliography for the project "Ambient Monitoring of Speech for Evidence of Cognitive Decline".

There is an increasing body of literature which supports the use of machine learning to analyse speech to evidence cognitive decline. Orimaye et al (2017) investigate the use of machine learning algorithms to detect differences in syntactic, lexical and n-gram linguistic biomarkers to distinguish between those with probably AD and healthy controls, The authors found significant differences in the uses of all three types of biomarkers for those with AD and healthy controls. Their results show that the top 1000 n-gram features plus the twenty-three syntactic and lexical features was the most successful at differentiating the two groups (0.93 AUC)). However, there were some limitations of the study. The context of the audio content was very specific, limited to one specific description task, and therefore using general speech as proposed in this project would potentially use a different set of linguistic features which may or may not have similar predictive power. In addition, the transcriptions were encoded using the CHAT format which is a framework for manually annotating speech and the challenge would be finding a way to automate this. This paper is noteworthy as it provides evidence that using machine learning to identify participants with MCI is possible and it provides some ideas of potential features which can be used. Unique to this paper is the use of n-gram features, which could be explored in the proposed project.

Asgari, Kaye and Dodge (2017) also looked at the linguistic characteristics of older adults with mild cognitive impairment (MCI) vs healthy controls where they hypothesised that they would be able to predict those with MCI, a distinguishing characteristic of Alzheimer's disease and other variations of dementia. Using recordings of unstructured conversations (with standardized preselected topics across subjects) between interviewers and interviewees they grouped spoken words using Linguistic Inquiry and Word Count (LIWC) which is a technique used to categorize words into features such as negative and positive words. They then applied support vector machines (SVM's) and random forest classification algorithms to investigate whether machine learning could be used to distinguish between those with MCI and healthy controls. They were able to successfully used machine learning algorithms to distinguish between these two groups with an accuracy of 84. The authors report that this method is highly reliant on high-fidelity transcription of the conversations which is labour intensive, but they anticipate that technology is advancing sufficiently quickly that automated high-quality transcriptions are possible in the near future. This paper provides a different perspective in how to tackle the problem deriving language features from speech using a different framework. The challenges both Orimaye et al and these authors experienced were around the automation of transcription and this would potentially be an area to explore in the proposed project. Asgari et al (2017) used the Linguistic Inquiry and Word Count (LIWC) methodology, developed by Pennebaker et al (2007) to generate features for their paper. Pennebaker, Boyd, Jordan and Blackburn (2015) have since developed their framework. The LIWC is designed to categorize and evaluate the various emotional, cognitive and structural components which are present within samples of speech and/or written text. This method, Linquistic Inquiry and Word Count (LIWC) has evolved from it's initial incarnation in 1993 to it's last update in 2015. The premise is the use of words from particular categories provide an insight into the psychological processes and/or diagnoses an individual has.

The latest version of this methodology uses a dictionary of 6400 words, word stems and select emoticons and assigns these constructs to various categories. This has been updated to include modern uses of language such as 'text speak'. This manual goes summarises the process of constructing the framework as well as discussing the reliability and validity of the measure and a review of studies using the LIWC was conducted by Tausczik and Pennebaker (2010) support the notion that the LIWC is valid across multiple psychological domains. This paper is useful as it provides a useful and validated framework from which the proposed project can potentially derive language features.

Currently formal diagnosis of depression is expensive and time-consuming involving both the use of questionnaires and the use of a trained professional to assess an individual. Schwartz et al, explored the use of language as an aid to diagnose depression in a naturalistic setting i.e. facebook status updates. The authors used both the LIWC (described above) and n-grams as features to distinguish those with depression from healthy individuals and were able to track participants levels' of depression through language successfully.Whilst the authors were able to use a reasonably sound method of measure degree of depression and have evidenced a methodology that is able to track a levels of depression over time, it would be more helpful to use a more clinically relevant measure of depression and anxiety i.e., PHQ-9 (Kroenke, 2001) and GAD-7 (Spitzer et al, 2006) to add validity to their findings. This paper is interesting as it uses both LIWC and n-grams as a method of deriving features from text / speech for depression which, as described above, have also been used as features to distinguish MCI from healthy participants. Given the comorbity of depression and dementia (Meyers, 1998), it would be interesting for the proposed project to further analyse the link between dementia and clinical depression via the use of language. This paper also supports the idea that language changes over time and is a marker for deterioration in both those with depression and dementia.

5 Conclusion

Identification of language impairment is important in Dementia because it aids diagnosis of specific types of dementia, which in turn can alter the prognosis and change the management of the degenerative disorder. As these differences in language are quite subtle, the varying subtypes of dementia are frequently misdiagnosed.

Given the burden on the diagnosis of dementia on clinicians, it appears to be useful to find some non-invasive protocols for the early diagnosis of dementia. It has already been shown that analysis of speech and language has shown markers that pre-date the official diagnosis of dementia (Snowdon et al, 1996;)[5].

References

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