Semantic Association and Lexical Decision Making Tasks In Individuals With Type 2 Diabetes Mellitus'

by Rajasudhakar R

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PROJECT PROPOSAL FORMAT

Part - A

1.0 Title of the Project: *'Semantic Association and Lexical Decision Making Tasks In Individuals With Type 2 Diabetes Mellitus'*

Area of Research: *a) Speech, Language, Hearing*

1.1 Principal Investigator: *Dr. R. Rajasudhakar*

1.2 Principal Co-Investigator(s): *-Nil-*

1.4 Collaborating Institution: *-Nil-*

1.5 Total Grants Required: *Rs. 5,13,000/- (Five lakhs & thirteen thousand only)*
(in figures and in words)

1.6 Duration of the Project: *One year (12 months)*

2.0 Project Summary (Max. 300 words):

Diabetes mellitus is a complex metabolic disease that can have devastating effects on multiple organs in the body. Diabetes is the leading cause of end stage renal disease also a common cause of vision loss, neuropathy, and cardiovascular disease. A less addressed and not as well recognized complication of diabetes is ***cognitive dysfunction****. Patients with type 1 and type 2 diabetes mellitus have been found to have cognitive deficits that can be attributed to their disease. Both hypoglycemia and hyperglycemia have been implicated as causes of cognitive dysfunction, and many patients fear that recurrent hypoglycemia will impair their memory over time.*

Diabetes is fast gaining the status of a potential epidemic in India with more than 62 million diabetic individuals currently diagnosed with the disease (Kumar, Goel, Jain, Khanna, & Chaudhary (2013). In 2000, India (31.7 million) topped the world with the highest number of people with diabetes mellitus followed by China (20.8 million) with the United States (17.7 million) in second and third place, respectively (Kaveeshwar & Cornwall, 2014).

Kodi & Seaquist (2008) reported that the individuals with type 2 diabetes mellitus negatively affected in cognitive domains like attention, verbal memory, working memory, immediate and delayed recall, processing speed, verbal fluency, and executive functions. Hence, there is necessity of assessment and rehabilitation of cognitive functions in these patients. Most of the earlier research considered the longitudinal study design where in they have found poorer cognitive function over a period of time but not at the initial stages of diabetes. It might be due to lack of sensitivity of the neuropsychological tests to rule out the cognitive dysfunction at the early stages.

More over there are limited empirical studies in Indian scenario on the cognitive functions in persons with diabetes. Therefore, present study aims to investigate the speed of information processing in semantic association task and lexical decision making task. Two groups will be considered where group 1 will have 60 individual with type 2 diabetes mellitus in the age range of 40-60 years and group 2 will have age and gender matched 60 individual without diabetes. All the participants will be ruled out by screening for other associated problems. Each subject will be administered two tasks, the semantic association and lexical decision making tasks.

Further, reaction time and accuracy will be measured. Results can be utilized to assess person with type 2 diabetes mellitus are at risk for information processing dysfunction at the earlier stage.

3.0 **Introduction** (under the following heads)

3.1 Definition of the problem : *Few cognitive domains that have found to negatively affected in individuals with type 2 diabetes are attention, memory, psychomotor speed, executive function, processing speed, complex motor function and verbal fluency (Kodi & Seaquist, 2008). Neurocognitive testing by administering a battery of tests to assess different aspects of cerebral function has long been the gold standard for the assessment of neurocognitive function. Different modalities has been used to assess the cognitive dysfunction in individuals with type 2 diabetes are neurocognitive testing, evoked response potentials, electro-encephalograhy (EEG), magnetic resonance imaging (MRI), functional magnetic resonance imaging (fMRI), single emission positron computed tomography (SPECT) and positron emission tomography (PET). Many of the above objective assessment are expensive. Also, these testing are not feasible and affordable for the assessment of cognitive-linguistic function to everyone.*

Type 2 diabetes mellitus may contribute to cognitive dysfunction through three other indirect mechanisms. First, cognitive dysfunction in patients with type 2 diabetes has been correlated to inflammatory markers and increased inflammatory markers may contribute to the development of macrovascular disease or Alzheimer's disease. Even studies have shown that types 2 diabetes and Alzheimer's disease share a common pathophysiology where patients with Alzheimer's disease demonstrate increased inflammatory markers as wee (Rosler, Wichart, & Jellinger, 2001). Second potential mechanism through which type 2 diabetes mellitus contribute to cognitive dysfunction is through the disruption of the hypothalamic-pituitary adrenal axis. In humans with type 2 diabetes mellitushave an up-regulation of the hypothalamic-pituitary-adrenal axis, with increased serum cortisol levels. Thus, the increased cortisol levels seen in them might contribute to cognitive dysfunction (Lee, Chan, Chow, Lau, Ko, Li, Cockram & Critchley, 1999). The third potential mechanism through which type 2 diabetes mellitus may indirectly contribute to cognitive dysfunction is by promoting the formation of senile plaques that is found in Alzhemer's disease. Intracellular neurofibrillary tangles and extracellular senile plaques composed of β-amyloid are the pathological hallmarks of Alzheimer's disease. Type 2 diabetes mellitus can affect the metabolism of β-amyloid thus increasing the burden of cerebral senile plaques that ultimately contribute for cognitive dysfunction. Due to these reasons, hypothetically, the cognitive-linguistic performances like semantic association and lexical decision making tasks in individuals with type 2 diabetes mellitus may be affected. There is dearth of literature in individuals with type 2 diabetes mellitus on cognitive linguistic abilities in general and particularly on semantic association and lexical decision making tasks in Indian context.

3.2 Objectives : *(i) To investigate the speed of information processing in persons with type 2 diabetes mellitus on*

- *Semantic association task*
- *Lexical decision making task*

(ii) To examine the age and gender differences (if any) in the information processing abilities

3.3 Review of status of research and development in the subject : *Semantic association and lexical decision making tasks requires intact semantic memory system. Semantic memory deficits such as vocabulary, general knowledge, word recall and recognition was adversely affected in individuals with type 2 diabetes mellitus (Marseglia et al., 2016). Compared to non-diabetes individuals, type 2 diabetes mellitus persons performed poorly on verbal and visual memory tasks (Palta et al., 2014). In Indian context, the performance of individuals suffering from type 2 diabetes mellitus on semantic association and lexical decision making tasks are not documented when compared to western studies.*

3.4 International and national status : *Van den Berg et al. (2010) investigated the evolution of cognitive decrements in type 2 diabetes over time in 68 patients with type 2 diabetes and 38 controls between 56 to 80 years of age. Results revealed that patients with type 2 diabetes shown moderate decrements in information-processing speed, attention and executive functions compared with controls. After 4 years of follow-up, both groups showed a decline in abstract reasoning and attention and executive functioning. But there was no evidence for accelerated cognitive decline in the patients with type 2 diabetes as compared with control. Study suggested that cognitive decline over 4 years is largely within the range of what can be viewed in normal ageing. Apparently, diabetes-related cognitive changes develop slowly over a prolonged period of time.*

Takeuchi et al. (2012) investigated the neuropsychological profile in 42 patients with type 2 diabetes and 32 non diabetic control subjects were matched for age, sex ratio, and level of education. Attention & working memory, processing speed, verbal memory, visuospatial memory, vasoconstriction, and executive function were tested. Diabetic patients demonstrated mild cognitive deterioration in all domains and neuropsychological decline became prominent when tasks related with speed and verbal stimuli became unstructured and complex.

Reijmer et al. (2013) examined the association of type 2 diabetes with microstructural abnormalities in specific cerebral white matter tracts and to relate these microstructural abnormalities to cognitive functioning. Thirty-five nondemented older individuals with type 2 diabetes and 35 control subjects underwent a Tesla diffusion-weighted MRI scan and a detailed cognitive assessment. Tractography was performed to reconstruct several white matter tracts. Results reflected the microstructural white matter abnormalities in the diabetes group. These abnormalities are associated with slowing of information-processing speed and worse memory performance.

Functional magnetic resonance imaging (fMRI) during a memory encoding task, cognitive tests, showed that type 2 diabetes was associated with significantly reduced activation in left hemisphere temporoparietal regions including angular gyrus, supramarginal gyrus, and middle temporal gyrus and significantly increased activation in bilateral posteriorly distributed regions (Wood et al., 2016).

Marseglia et al. (2016) examined cognitive domains which are impaired in diabetes in the initial stages. 2305 cognitively intact participants aged ≥60 years were identified. Attention/working memory, perceptual speed, category fluency, letter

fluency, semantic memory, and episodic memory were assessed. Factors such as controlled and uncontrolled diabetes, vascular disorders (hypertension, heart diseases, and stroke) and vascular risk factors (VRFs, including smoking) were considered. The associations of diabetes with perceptual speed and category fluency were present only among participants with VRFs or vascular disorders. Diabetes, especially uncontrolled diabetes, is associated with poorer performance in perceptual speed, category fluency, and attention/primary memory. This was attributed to hyperglycemia, which is one of the mechanisms whereby high levels of glucose leads to selective death of neurons, and increase oxidative stress, which promotes chronic inflammation and cerebral micro vascular damage in turn resulting in cognitive dysfunction.

India leads the world with largest number of diabetic subjects earning the dubious distinction of being termed the "diabetes capital of the world". Mohan, Sandeep, Deepa, Shah & Varghese (2007) mentioned in their study about the findings of International Diabetes Federation (IDF). It estimates the total number of diabetic subjects to be around 40.9 million in India and this is further set to rise to 69.9 million by the year 2025 and 80 million by the year 2030. According to Kaveeshwar & Cornwall (2014) the aetiology of diabetes in India is multifactorial and includes genetic factors coupled with environmental influences such as obesity associated with rising living standards, steady urban migration, and lifestyle changes. There are very limited studies available in literature about the cognitive dysfunction in diabetes mellitus type 2 in Indian context which is the most rapidly growing disease in India. To be more precise, the effect of type 2 diabetes mellitus on semantic memory and lexical knowledge is uncertain.

3.5 Importance of the proposed project

in the context of current status : *Changing of lifestyle in present scenario is leading to early occurrence of diabetes but there are no studies taken into the consideration of cognitive functioning in individuals with type 2 diabetes mellitus in Indian context. There are no studies reported that the cognitive decline is purely because of diabetes mellitus or due to aging. As we know that India is one of the leading country in the growth of diabetes due to different food habits, life style and environmental factors that leads to the need of the research in Indian population. Furthermore, the information processing speed and functional organization of semantic memory in Kannada speaking individuals with type 2 diabetes is questionable. If the lexical processing speed is slow or altered compared to controls, the study would suggest further clinically on its detail assessment and management.*

4.0 Work Plan

4.1 Method

Subjects / Participants: *Two groups of individuals will be participated in the study. Group 1 will consist of 30 participants who is diagnosed as having type 2 diabetes mellitus by diabetologits with confirmation through clinical/lab test results. Group 2 will consist of 30 normal healthy individuals with no history of diabetic history/symptoms. Participants will be in the age range of 50 to 70 years and equal number of males and females will be considered in each groups.*

Subject selection criteria for experimental group:

- *Subjects should have confirmed diagnosis of type 2 diabetes mellitus by a diabetologist (atleast with the history of 5 years- minimum)*
- *Subjects should have no history of sensory issues and other neurological problems.*
- *Subjects should have no history of alcohol and drug abuse*
- *Mini Mental Status Examination (MMSE) will be administered and the individual who passess the test will be considered*
- *Subject should have Kannada as mother tongue*
- *Subjects should know to read and write Kannada*

Subject selection criteria for control group:

Individual should not have diabetes or at risk for diabetes which will be confirmed by a physician/ diabetologist based on the blood glucose measurement or through using simple screening tools like Indian Diabetes Risk Scores (IDRS). Subject should have Kannada as mother tongue and should know to read and write Kannada language.

Material: *120 word pairs will be used in the study for semantic association task. These words will be taken from Prema, Abhishek, & Prarthana (2013) study. Among 120 word pairs, 60 of them will be semantically related word pairs and the rest 60 will be semantically unrelated word pairs.*

For the lexical decision making task, 120 words will be chosen from the Prema (1998) study. Among 120 words, 60 of them will be words and remaining 60 of them will be non-words (pseudo-words).

Programming of stimuli:

Task 1: Semantic association task:

DMDX software (version 4.0) will be used for the presentation of the stimuli. Primes and target will be displayed in the centre line of the computer monitor (Laptop). On white background, words will be displayed in BOLD black letters. Each prime will be displayed for 500 milliseconds. An inter-stimulus interval of 300 milliseconds will be set following which target will be displayed for 2000 milliseconds. A duration of 4000 milliseconds will be given for the participants to respond. The reaction time will be measured as the time taken from the start of stimuli until the subject respond or until 4000 millisecond. If the subject failed to respond within 4000 millisecond, it will be considered as error, and inter trial interval will be initiated followed by the presentation of next prime. The left arrow in the keyboard will be used to denote 'NO' and right arrow will be used to denote 'YES' response.

Task 2: Lexical decision task:

DMDX software (version 4.0) will be used for the presentation of the stimuli. Here, words and non words in Kannada will be taken for stimuli. Words and non words will be presented randomly. Each word will be presented for 500 milliseconds and participant will be given 4000 milliseconds duration to respond. The left arrow in the keyboard will be used to denote 'NO' and right arrow will be used to denote 'YES' response.

Procedure: *The participants will be seated comfortably on a chair in a less ambient noise. The distance between the participants' eye and the monitor would be kept at 45-55 centimeters.*

Task 1: Semantic association task:
Semantically related word pairs and semantically unrelated word pairs will be presented randomly. Participant will be given 5 practice trials for the familiarization of the task. Participant will be instructed to judge whether word pairs presented is semantically related or not. If it is related, participant will be asked to press right arrow and if it is unrelated then to press left arrow.

Task 2: Lexical decision task
Here, words and non words will be presented randomly. 5 practice trials will be given for the familiarization of the task. Participant will be instructed to judge whether word presented has meaning or not. If it has meaning, participant will be asked to press right arrow and if it is meaningless then to press left arrow.

Analyses:
*Speed of processing will measured through **reaction time** that is time taken from the presentation of the stimuli to start of response. Also, **accuracy** of the response will be measured by considering the number of correct responses. The data will be analyzed and compared between two groups using appropriate statistical procedure.*

6.0 Implications of the results of the study
(Illustrative)

a) Presentation of scientific papers in professional seminars / publication of articles : *Yes*

b) Discussion with professionals : *Yes*

c) To utilize the results in the development of remediation : *Yes*

7.0 Utilization of results of the study :

Results of the study would augment the understanding of SLP's on information processing speed and accuracy in individuals with type 2 diabetes mellitus.
(2) Results of the study throws light on the effect of type 2 diabetes mellitus on cognitive linguistic performance in general and semantic association and lexical decision making task in particular.
(3) Results of the study also highlights on the status (intact versus decline) of semantic memory and its organization in individuals with type 2 diabetes mellitus and would suggest further clinically on its detail assessment and management.

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