# EFFECT OF BILINGUALISM AND AGE ON EXECUTIVE FUNCTIONS: EVIDENCE FROM ALTERNATING VERBAL FLUENCY TASK

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# CERTIFICATE

This is to certify that this dissertation, entitled **"Effect of Bilingualism and Age on Executive Functions: Evidence from Alternating Verbal Fluency Task"** is a bonafide work submitted in part fulfilment for the degree of Master of Science (Speech Language Pathology) of the student Registration number P01II21S0037. This has been carried out under the guidance of a faculty of this institute and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

Mysore

September, 2023

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## DECLARATION

This is to certify that this dissertation entitled **"Effect of Bilingualism and Age on Executive Functions: Evidence from Alternating Verbal Fluency Task"** is the result of my own study under the guidance of of Dr. Abhishek B.P, Assistant Professor in Language Pathology, Department of Speech-Language Pathology, Center of Speech Language Sciences, All India Institute of Speech and Hearing, Mysore and has not been submitted earlier to any other University for award of any other Diploma or Degree.

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# CHAPTER I

## INTRODUCTION

It is the possession of language which distinguishes humans from other animals. Language is the means of communication by which members of a particular community interact with each other to convey their needs, thoughts, opinions, and feelings. Language is a social tool, a socially shared code or conventional system for representing concepts through arbitrary symbols and rule-governed combinations of those symbols (Owens,1998).

The interrelation between language and executive functions has been explored by researchers utilizing a variety of linguistic and non-linguistic tasks. It is assumed that language control functions through the same mechanisms which regulate the executive control mechanisms. These include aspects such as task planning and its execution, task switching, conflict monitoring and conflict resolution. The executive functions play a dynamic role during the act of speaking by helping the speaker to choose the correct word against the other competing words. It helps prevent wrong word generation (Badre & Wagner, 2007). Executive functions also help the listeners to focus on the meaning and ignore the preconceived notions, thereby facilitating the selection and grasping of relevant information from speech output (Ye & Zhou, 2009). It is also utilized during sentence comprehension in monitoring and selecting appropriately among competing sentence representations (Mohapatra, 2019).

Most of the researchers have defined bilingualism based on language use. According to ASHA (2004), bilingualism is an individual's usage and

proficiency in at least two languages. This can change depending on the opportunities to use the particular language and exposure to other speakers of the language. Grosjean (2010) described bilinguals as individuals who require and utilize more than one language or dialect in their daily lives.

Based on various definitions, researchers have described different types of bilinguals. Depending on the age at which bilinguals were exposed to the two languages, they are categorized as early and late bilinguals (Beardsmore, 1986). Based on how linguistic codes of the languages (two or more) are stored and organized by an individual, bilinguals are grouped as compound, coordinate and subordinate bilinguals (Weinreich, 1957). The classification into balanced and dominant types of bilinguals is based on proficiency and competency in both languages (Peal & Lambert, 1962). Balanced bilinguals have equal competency in both languages, whereas dominant bilinguals have greater competence in one language than the other.

Though bilinguals are classified based on different aspects, proficiency is an essential factor to be accounted for. Proficiency is defined as an individual's skill in using their second language, more or less like a fluent speaker. The four core skills considered for attaining bilingualism proficiency are understanding, speaking, reading, and writing. Based on their proficiency, bilinguals can be categorized as low and high-proficient.

There are a couple of advantages that bilinguals would experience compared to monolinguals. Young bilinguals have been reported to be faster in executing attentional network tasks and more adept in alerting and executive functions than monolingual individuals (Costa et al., 2008). The literature provides evidence of a bilingual advantage in cognitive control in

older adults too. In the study by Gold et al (2013), it was found that older adult bilinguals exhibit better performance in the perceptual task-switching paradigm than their monolingual peers.

Bilinguals avoid wrong language intrusions by using language control mechanisms that help in regulating both languages and aid in inhibiting the incorrect language (Green, 1998). Aspects such as inhibitory control, working memory, problem-solving and decision-making are important for these functions. Domain-general executive control mechanisms that include concentration on a single task, refraining from extraneous actions through inhibition, and recognizing conflicting inputs or situations are particularly crucial for bilingual language control (Ivanova et al., 2016).

Executive functions aid in alternating between two languages in bilinguals (Abutalebi & Green, 2007). Bilinguals exhibited faster and better performance in cognitive flexibility and inhibitory control tasks (Bialystok & Viswanathan, 2009). It has been found that controlled processing is done more efficiently by bilinguals. Bilingual advantage has also been reported on tasks that demand control of attention over competing cues, i.e., interference suppression (Martin-rhee & Bialystok, 2008). Also, few studies conclude that bilingualism helps offset the loss due to aging in certain executive functions (Bialystok et al., 2004).

Several studies have elucidated the notion that language abilities decrease with age. One of the most commonly reported deficits is in the domain of word retrieval (Burke & Shafto, 2004). Such deterioration has been reflected in the task of confrontation naming in older adults (Tsang &

Lee, 2003). It has also been observed that older age groups, as compared to younger groups, experience more tip-of-the-tongue events, where the person is not able to utter the word but is undoubtedly sure that he knows the specific term (Burke et al., 1991; Heine et al., 1999). Age-related declines in both propositional content and syntactical complexity have been reported. (Kemper et al., 2001).

As one ages there is a gradual deterioration in cognitive abilities (Grady, 2012; Hedden & Gabrieli, 2004). Executive functions are one such domain that exhibits deficits with age (Bopp & Verhaeghen, 2009). Studies that employed various tasks such as Stroop, Flanker, Digit Span, and trial-making tasks to tap executive functions have shown significant differences in the performance of older age groups, i.e., a decline in performance when compared to the younger age groups. Age-related changes found in executive control are linked to alterations seen in the prefrontal cortex due to aging (Raz,2000; West, 2008).

The alternating fluency task is considered as one of the overriding tasks in evaluating executive functions (Deepak et al., 2021). It is cognitively more complex compared to the other fluency tasks. In contrast to the other non-verbal tests like the Simon task, the Flanker task used to study executive functions, the alternating fluency task is linguistic in nature and hence a good estimate of language abilities. The task provides insight into different search strategies that will be used to probe lexicons. It requires intact functioning of cognitive flexibility and divergent thinking for alternating and abundant exposure to various lexical items.

There is a dearth of literature on the impact of age on various linguistic and executive functions drawing evidence from their performance on alternating verbal fluency tasks. Dean, Edith, & Kramer (2001) investigated how younger and older adults performed in the tasks of semantic fluency, phonemic fluency and semantic intra-dimensional alternating fluency task. On comparing these tasks, it was found that older adults showed lowered performance in the intra-dimensional alternating fluency task.

Few studies have applied alternation between languages to explore bilinguals' performance in various linguistic tasks. Ivanova, Murillo, Montoya, & Gollan (2016) probed into the decline in bilingual language control due to aging in thirteen older and thirteen younger bilinguals. They employed verbal fluency tasks, including completion of the same letter and category in each of the languages and alternation of languages after each category. The participants produced lesser correct responses after alternating languages and older adults produced lesser incorrect language intrusions in the letter fluency task. In the semantic fluency task, when compared to the younger bilinguals, older bilinguals experienced more intrusions. Additionally, compared to the letter fluency tasks, they displayed a greater number of intrusions during the semantic fluency task.

The studies that have utilized alternating verbal fluency tasks for probing into the executive functions done in Indian scenarios are limited. Deepak, Shalbiya, Poonthala, Kolakkadan & Panchakshari (2021) compared the alternate semantic verbal fluency task and alternate phonemic verbal fluency tasks across adolescents, young adults, and older adults.

Performance between young adults and older adults showed a significant difference. Also, the older adults exhibited poorer performance in the task of semantic verbal fluency in comparison to phonemic verbal fluency.

**Need for the study**

According to studies looking into the influence of bilingualism on executive control in young adults, bilingualism has a dynamic role in the development and fostering of executive functions. There are few studies that looked into how age affects executive functions, most of which have indicated that executive functions deteriorate with age (Grady, 2012; Hedden & Gabrieli, 2004). The combined impact of bilingualism and age on executive functions is less looked into, especially in the Indian scenario. Most of the previous studies that explored executive functions have employed non-verbal tasks such as Simon task, Flanker, or trial-making tasks (Calvo & Bialystok, 2014; Struys et al., 2018). Studies employing linguistic tasks have mainly utilized verbal fluency tasks such as semantic or phonemic verbal fluency tasks. The performance of bilinguals on alternating verbal fluency tasks, which places a greater cognitive load, is less explored. The methodology of alternating verbal fluency used in the present study is unique from the previous studies in that the participants will be asked to alternate between categories as well as between languages (L1 and L2). Also, most of the studies that have explored the effect of age on executive functions are done on populations of age greater than 60 years (Bopp & Verhaeghen, 2009; Dean et al.,2001). The executive functions in the age range selected for this study, 50-60 years, are less explored.

## Aim of the Study

The study aims to inspect the effect of bilingualism and age on executive functions by utilizing alternating verbal fluency task.

## Objectives

1. To compare the performance of younger and older bilinguals in cross-category alternating verbal fluency task in L1
2. To compare the performance of younger and older bilinguals in cross-category alternating verbal fluency task in L2
3. To compare the performance of younger and older bilinguals in cross-language forward alternating verbal fluency task
4. To compare the performance of younger and older bilinguals in cross-language backward alternating verbal fluency task.

# CHAPTER II

# REVIEW OF LITERATURE

## 2.1 Language

### 2.1.1 Language- definition

Language is defined as the system of arbitrary verbal symbols which is arranged in a conventional code. It evolved as a social tool for the exchange of ideas and impact others' behaviors (McLaughlin,2006). According to Goldstein (2008), language is a system of communication using symbols or sounds that enables an individual to express thoughts, ideas, feelings, and experiences. It is the possession of language which distinguishes humans from other animals. When using a particular language, various complex cognitive mechanisms interplay and work together to decipher and express information allowing an individual to communicate effectively. Kroll and DeGroot (2005) opine that people tend to use more than one language in daily life has become a common phenomenon in the current century. It is gauged that approximately half of the world's population speaks more than one language (Ansaldo et al., 2008).

### 2.1.2 Bilingualism-definition

Over the last few decades, the increasing research in the field of bilingualism has led to the emergence of numerous definitions of bilingualism. According to Giovannoli et al. (2020), there is no single definition of bilingualism. The definition by Edwards (2004), which claims that "everyone is bilingual" because there are no (adult) persons in

the world who do not know at least some words in a language apart from their native language, is the most encompassing among the definitions of bilinguals. Abdelgafar and Moawad (2015) take competency into account and assert that only those individuals who know both languages with the same level of competence as of a native speaker can be labeled as bilingual. Wei (2020) defines a bilingual as an individual who is able to perform in two languages in conversational interactions. Along the same lines as definitions, many classification systems pertaining to bilingualism have been proposed.

### 2.1.3 Bilingualism-Typology and Assessment

Bilingualism is a multifaceted phenomenon. Researchers have offered different classifications based on the various elements of bilingualism they highlighted, emphasizing the multi-dimensional nature of bilingualism (Hamzeh Moradi, 2014). The classification of early and late bilinguals is based on the age at which they were exposed to the two languages. Baetens Beardsmore (1986) defined early bilinguals as those who acquired greater than one language during the pre-adolescent phase of life. Late bilinguals are described as those individuals who acquired one language before and the other language after 8 years of age.

Based on the proficiencies in each language, bilinguals can be classified as the languages considered is another factor depending on which bilinguals can be categorized. Peal and Lambert (1962) described balanced bilinguals as those possessing similar proficiency in two languages whereas the bilinguals who have attained higher proficiency in

one language compared to the other language(s) are labeled as dominant (or unbalanced) bilinguals.

The differentiation between compound, coordinate, and subordinate bilinguals focus on how individuals organize and store two or more linguistic codes. This classification was proposed by Weinreich (1953). As per the classification, compound bilinguals are those who store linguistic codes of both languages into one unit of meaning. The individuals who store and organize each linguistic code separately in two meaning units are labeled as coordinate bilinguals. Subordinate bilinguals are individuals who understand and interpret linguistic codes of bilinguals' second language (L2) through their first language (L1). In other words, L1 accesses the interface in the interpretation of codes in L2.

Bilinguals can also be categorized on the basis of the status the languages hold in society. Fishman (1977) classified individuals into 'folk' and 'elite' bilinguals taking the social status of language into account. He used the term folk bilinguals to indicate a language minority group whose native language does not possess a prominent position in the major language culture where they live. Elite bilinguals, on the other hand, refer to the bilinguals who speak a predominant language in a particular society as well as speak another language that adds value to them leading to a benefit in the social community.

The influence of one language on the other is another aspect that can be utilized to classify the bilingual population. Lambert (1974) asserts that based on the influence of L2 in retaining their L1, individuals can be grouped into additive and subtractive bilinguals. Additive bilinguals are

those who can improve their L2 without seeing a decline in their L1 proficiency while the individuals whose L2 acquisition leads to a reduction in L1 proficiency are termed as subtractive bilinguals.

Proficiency is an essential criterion, based on which bilinguals are classified into high-proficient and low-proficient. The ability to utilize a second language in a way that resembles that of a native or fluent speaker is referred to as proficiency. There are four core skills that are considered for the attainment of bilingual proficiency. These include understanding, speaking, reading and writing. The easiest to attain among these skills is understanding, followed by speaking, reading followed by writing. No one-to-one connection between the ability of one skill or the other has been established theoretically. This, in fact, is true as a bilingual might have a good understanding of the language but may not be proficient enough while using the language for speaking (Anita & Abhishek,2017).

Language Proficiency is assessed usually through self-rating measures. The Language Experience and Proficiency Questionnaire (Ramya &Goswami,2009) (LEAP -Q) is one such tool that efficiently assesses proficiency. It consists of a total of 18 questions. Most of these questions determine the language history of the individual. Question number 10 in the questionnaire is intended to gauge an individual's proficiency in each of the known languages. Here, the person is asked to rate his/her proficiency on a 4-point rating scale where 1 indicates zero proficiency, 2 for low, 3 for good, and 4 for native-like/perfect proficiency in the domains of understanding, speaking,reading, and writing.

Language proficiency is one of the fundamental components of

bilingualism. Therefore, it is a crucial variable for examining the advantages of being bilingual (Mishra, 2014). The ability to communicate in both languages, which is typically characterized as having a sufficient level of language proficiency (particularly for L2), is necessary for the emergence of bilingual advantage.

### 2.1.4 Bilingual Advantage

The bilingual advantage is described as the higher performance of bilinguals in tasks demanding executive processing compared to monolinguals. This enhances bilingual's cognitive processes across the lifespan and develops better cognitive functions (Bialystok & Martin, 2004). Studies have reported several cognitive benefits observed in bilinguals. The ability to suppress irrelevant information and activate the relevant ones, despite adverse interference, is one of the bilingual advantages reported (Bialystok et al.,2008). Bilingualism has also shown positive effects in shifting among sets of mental representations (Garbin et al., 2010; Prior & MacWhinney, 2010). Bilingual advantage has also been reflected in the greater potential of bilinguals to store information in working memory (Bialystok et al., 2004). A study by Bialystok (2010) revealed a slow decline in the symptom onset of dementia in aging adults. Similar effects are also reported in persons with Mild Cognitive Impairment (Bialystok et al, 2014) and in persons with Alzheimer's disease (Alladi et al., 2013) as well. Research has also indicated bilinguals are able to attain better cognitive recovery (Alladi et al., 2016). Bilingualism aids to improve cognitive function in the frontal, temporal, and parietal lobe processes controlling memory resulting in greater preservation of neurons in the inferior parietal

lobule and anterior temporal lobe in older populations (Schroeder et al., 2016).

Bilinguals are believed to have better executive functions than monolinguals due to the increased attentional demand they experience when choosing words in the required language while inhibiting the other language known to them (Kroll & Bialystok, 2013). Multiple components of executive functions have claimed the benefits of bilingualism (Miyake et al., 2000). Inhibition of pre-potent responses is one of the components of executive function on which bilingualism has shown a positive effect (Bialystok et al., 2008; Salvatierra & Rosselli, 2010). Another component where bilingual advantage has been reported is in the shifting between tasks as well as mental representations (Prior & MacWhinney, 2010; Wiseheart et al., 2016). Additionally, bilinguals perform better at updating and monitoring the working memory's contents. (Blom et al., 2014; Luo et al., 2013). Bilinguals activate both of their lexicons simultaneously, according to prior studies, even when only one language is needed (Kroll et al., 2012). The bilingual language system must control language selection into joint activation by focusing attention on the target language, while disregarding distractions from the competing language, through the activation of general attention processes (Bialystok, 2015). Selective attention, a key component of the executive function, is trained as a result of bilingual's unique experience in controlling attention to two concurrently activated languages (Chung-Fat-Yim et al., 2019). Executive functioning encompasses a cluster of cognitive skills that make the most of finite cognitive resources for actions like inhibition, attention switching, and working memory, which

may be influenced by the need to resolve conflict and focus attention in bilinguals (Akhtar & Menjivar, 2012; Miyake et al., 2000). It has been demonstrated that bilingual advantages are significant in the domain of shifting, indicating a connection between task and language switching (Garbin et al., 2010; Prior & Gollan, 2011).

In order to determine whether bilinguals' reaction inhibition and performance monitoring vary depending on language competency, Singh and Mishra (2012) studied Hindi-English bilinguals. The study's findings revealed that while inhibitory control was unaffected by language proficiency, performance monitoring was. The authors claimed that increased proficiency can result in superior cognitive flexibility and the capacity to modify behavior to help achieve the cognitive goal.

To examine whether bilingualism had an effect on executive functioning Kamat et al. (2012) conducted a study in Hindi and Marathi languages. On the basis of Hindi and Marathi proficiency which was self-reported by the participants, a bilingualism index was generated and the relationship between bilingualism and cognitive functioning was probed through tests that tapped three components of executive functions-response inhibition, shifting of mental sets, problem-solving. The authors found that the bilinguals exhibited superior performance on the inhibition task as well as the task-switching elements of executive functioning. Hence the authors concluded that being bilingual worked to their advantage for measures of executive functioning.

## 2.2 Executive functions

### 2.2.1 Executive functions-definition

Executive functions is often used as a collective term consisting of many cognitive processes such as response inhibition, cognitive flexibility, planning, sequencing, problem-solving, reasoning, capability to sustain attention, application of feedback, ability to perform multiple tasks at a time, and the potency to deal with unfamiliarity (Chan et al., 2008). It describes the mental processes that regulate attention, reflexive thinking, and other cognitive and behavioral processes (Diamond, 2013).

Bilinguals are assumed to have a higher executive function as stated by researchers (Anita & Abhishek, 2019; Bialystok, 2009; Kroll & Bialystok, 2013; Martin-rhee & Bialystok, 2008). Even though it has been demonstrated that these elements are somewhat related to one another, they are distinct entities that influence behavior in various ways. These elements are important for the cognitive control of human behavior (Miyake et al., 2000). The performance of bilinguals in various domains of executive functions has attracted researchers in the last few decades.

### 2.2.2 Domains of Executive Functions

Bilingual advantages in executive function, an area that has attracted researchers in the field of cognitive development can be assessed by tapping various domains of response inhibition, cognitive flexibility, attention, working memory using tasks that could be verbal or nonverbal (Bialystok, 2001). Response inhibition is one of the domains of executive function which plays a significant role in everyday life. It is the capability to suppress distracting stimuli so as to concentrate on a specific task. In

other words, it is the capacity to filter out irrelevant information so that one can focus on the relevant rules for interactions or tasks. Researchers have postulated that age-related alterations in a variety of cognitive functions are mostly due to a loss in the effectiveness of inhibitory mechanisms (Persad et al., 2002). Cognitive flexibility refers to the competence of an individual to alter rapidly between various sets of responses. (Anderson, 2002). Prior & MacWhinney in 2010 stated that this shifting requires the individual to select language appropriate to the situation from the two language systems which are being actively utilized.

Another important executive function that is essential for all routine tasks is attention. Attention is the potency of an individual to actively process particular information in the contexture. Working memory is an executive function that uses memory processing and storage capabilities (Zelazo et al., 2003). The ability to effectively monitor, activate, and select the proper target language requires effective working memory capacity (Bialystok et al., 2008; Luo et al., 2013).

There are also a couple of studies that contradict the concept of the bilingual advantage in executive functions. In a study by Anton, Carreiras, and Dunabeitia (2019), where they tested a large group of young bilingual and monolingual adults, a total of 180 young adults from Spain (90 bilinguals and 90 monolinguals) were recruited. A series of tasks i.e., Flanker's task, Simon's task, Verbal Stroop, Numerical Stroop and tasks for working memory (Corsi,Corsi inverse, Digit Span, Digit Span inverse) were administered. The results showed that there was no statistically significant difference between bilinguals' and monolinguals' performance.

The authors concluded that the results of the bilingual advantage in executive functions found in former studies may have resulted from the uncontrolled non-linguistic features of the subjects assessed.

### 2.2.3 Assessment of Executive Functions

Various linguistic and non-linguistic tasks have been employed to test executive functions. Non-linguistic tasks include Flankers task, Stroop object Task, Attentional network task (ANT), and Simon task while linguistic tasks include priming experiments that tap for listening comprehension, dichotic listening tasks, and Stroop task, etc.

The flanker task includes a central target stimulus, congruent flankers (pointing in the same direction), and incongruent flankers (pointing in the opposite direction). The central target stimulus will be given a specific direction, either left or right. The participants must respond to the direction of the central stimulus. Shorter reaction times, reduced conflict effects, and smaller switching costs in the flanker task response supported the better capacity of bilinguals to ignore incongruent stimuli that are irrelevant to a task. (Bialystok,2009). The Stroop test consists of coloured asterisks and colour words are presented in ink that is both congruent and incongruent. The difference between the subject's response time to all the asterisks and the response time for naming the incongruent stimuli is used to compute the Stroop effect. In the Stroop test, and the proactive interference task, which is efficient in testing the effect of prior incidents and learning on the capability of a person to memorize new information, bilinguals persistently exhibited better performance in tasks demanding executive control in spite of the minimal proficiency

observed in their vocabulary (Bialystok,2009; Bialystok,2010). In Simon's task, squares of different colors are presented on either side of the computer screen. The subjects are required to press either the right shift key or the left shift key based on the respective colors. The Simon effect is determined by comparing the response times for trials that are congruent and those that are not. In Attentional Network Task, three attentional networks are utilized to gauge the person's capability to focus on a specific task. to focus on a particular task. A local-global task is a nonverbal task used for measuring shifting, where a geometric, global, figure made up of many smaller, local, figures (i.e., Navon figures) are presented on the screen of a computer. In this task, congruent and incongruent trials are presented and the shifting effect is calculated.

Among the verbal tasks used for tapping executive functions, verbal fluency, alternatively known as generative naming is a frequently employed task. There are two primary cue variants of verbal fluency. These include semantic and phonemic verbal fluency. In the semantic verbal fluency task, the participant has to generate word lists for a specific category (e.g., animals) whereas in the phonemic verbal fluency task, the participant has to generate words that begin with specified letters (e.g., words starting with "s"). A normal adult is known to list out a minimum of 10-15 items for the semantic categories of vegetables, vehicles animals, fruits, and other categories (Harold, 2001).

Since the instructions for the particular task lead subjects to recall items in the semantic neighborhood, which has a direct connection with how entries connect in the mental lexicon and in daily use of language, the

semantic verbal fluency task may result in a lower effort rating than phonemic verbal fluency task (Luo et al., 2010). On the other hand, generating lexical items according to the first letter in phonemic verbal fluency is comparatively uncommon in daily activities and imposes more challenges mentally (Lam & Marquardt, 2022).

The better performance in the semantic verbal fluency task than the phonemic verbal fluency task can further be explained with respect to the anatomical regions activated during each of these tasks respectively. The letter fluency test necessitates a significant activation of phonological retrieval networks across interconnected networks. The approach employed for the letter fluency challenge relies exclusively on lexical representation for search and actively suppresses semantic memory. The left dorsolateral prefrontal cortex is principally responsible for this process. The letter fluency task is performed less well by older people because they are less able to actively use this area for phonological retrieval processes.

The semantic fluency task is mediated by a large portion of the prefrontal cortex including the left and right dorsolateral and the right ventromedial areas (Szatkowska et al.,2000). Numerous areas are simultaneously active during the semantic naming task, including the general amodal activation and modality-specific activation. Consequently, it might be claimed that semantic activation taps the cortex's total involvement. As a result, a compromise in one area's functions may be made up for by several other areas. Additionally, due to its higher demand, semantic memory is constantly activated, which might stabilize the entire

system.

There is extensive evidence available regarding the validity of the task in examining intricate cognitive abilities (Aita et al., 2018; Rosen & Engle, 1997; Shao et al., 2014). By evaluating settings with different demands on cognitive control, verbal fluency tests are expected to provide information on the interrelation between language abilities and executive control in healthy bilingual individuals and persons with bilingual aphasia (Carpenter et al., 2021).

To estimate the naming performance of persons with aphasia (PWA) and normal adults, Abhishek and Prema (2013) carried out a comparison study between 30 neurologically healthy adults and 8 PWA in the age range of 45 to 50 years. The participants were administered semantic and phonemic fluency tasks. The results reflected the significantly poor performance of PWA on both naming tasks.

With the aim to establish normative scores for generative naming task in Kannada, Pooja, and Goswami (2019) studied seven age groups from 18 to 88 years. The number of males and females in all the groups was equal. Generative naming was assessed using semantic fluency and phoneme fluency tasks. The study suggested that the adverse effect of age had an impact on naming only in the performance of individuals from 58-68 years and continues to decline with advancement in age. They also found that in generative naming, the highest number of responses are provided during the first 30 seconds and the least number of responses are obtained during the last 30 seconds.

To analyze the nature of naming deficits in older individuals,

Girija, Shahal and Narayanan (2022) conducted a study on neurotypical native Malayalam speakers between 30 and 80 years of age, 30 participants in five age groups with an age interval of 10 years. Four naming tasks were administered to them which included confrontation naming, generative naming, responsive naming and contextual naming. The results revealed that all the types of naming abilities showed a decreasing trend as the age advanced. This effect was predominantly exhibited in the generative naming task as it imposes a greater cognitive load compared to the other naming tasks.

To evaluate executive functioning across a range of age groups, a variety of cognitive tasks are performed. However, among the other tasks, the alternative fluency task will stand out as being particularly important. Alternating verbal fluency requires the participant to shift between the specific letters or semantic categories provided throughout the task. To track and get ready for forthcoming phonemic or semantic targets while shifting, more attentional resources are needed. Furthermore, shifting while alternating verbal fluency is present necessitates the deliberate suppression of clustering techniques, which should demand more effort than non-alternating verbal fluency (Lam & Marquardt, 2022). When evaluating alternating fluency, there are two main factors to be taken into account. (Downes et al., 1993). The first aspect is intra-dimensional shifting where the subject is required to shift between the probes belonging to the same domain. On these lines, there can be two variants of intra-dimensional shifting which are alternating semantic verbal fluency and alternating phonemic verbal fluency. On the contrary, in extra dimensional shifting the

participant's task is to generate the probes falling under different domains. The generation of a phonemic word first succeeded by a semantic word or vice versa is an example of extra-dimensional shifting. In contrast to alternating phonemic verbal fluency, semantic processing is necessary for correct shifting in the task of alternating semantic verbal fluency. Hence the semantic variant of the verbal fluency task may require greater effort than the phonemic verbal fluency task. (Lam & Marquardt, 2022). There is a paucity of literature in the Indian context employing the alternating verbal fluency task as one of the executive functioning measures in neurotypical participants.

In order to examine the age-related factors of production and perseveration on various fluency tasks, Henry and Philips (2006) conducted a study where younger and older persons were given standard fluency tests that demands greater set-switching, tests of phonemic fluency and semantic fluency. On the phonemic fluency task, older participants outperformed their younger counterparts, whereas there was no age effect on total output for the semantic fluency task. Perseverative errors were observed more in older participants considering the above criteria. Only when subjects had to switch between two semantic dimensions during alternating fluency tests was an age deficit found.

To inspect how various levels of cognitive demands on lexical retrieval influenced performance in two variants of verbal fluency tasks in healthy bilinguals, a study was conducted in the Spanish-English population in four language contexts (mean age = 47.2 years) and bilingual persons with aphasia (mean age = 52.9 years) (Carpenter et al., 2021). The four

conditions that were used included two No-Switch conditions (NS-L1 and NS-L2), where subjects were instructed to respond in one language, one Self-Switch condition (SS), where they could switch between languages at their discretion, and one Forced-Switch condition (FS), where they were supposed to switch languages after each response. A standard letter fluency task was also performed by individuals in both languages independently (LF-L1 and LF-L2). Overall, it was inferred from the results that healthy bilinguals fared better than Bilingual Persons with Aphasia. Importantly, language experience in L1 and L2 significantly affected semantic switching skills for BPWA as the task's language demands increased, emphasizing the significance of language intervention for successful lexical production after acquired brain damage.

**2.3 Studies done across various age groups**

The effect of Simon's task on younger and older monolinguals and bilinguals (Tamil-English) was investigated by Bialystok et al. (2004). Individuals in the age range of 30 to 54 and 60 to 88 were recruited for the study. They reported less Simon effect for bilinguals when compared to monolinguals. Also, larger response time for incongruent trials for both age and language groups. However, the magnitude was smaller for young adults and bilinguals.

A study was carried out to compare the young and old monolinguals and bilinguals on cognitive and executive function tasks (Bialystok et al., 2008). A total of 96 participants (mean age for young participants - 20 years and the mean age for old participants- 68 years), monolingual and bilinguals were recruited for the study. Tasks measuring

working memory, lexical retrieval, and executive control were administered. Results reveal that the performance of monolinguals and bilinguals was similar on working memory tasks, whereas for lexical retrieval tasks, monolinguals performed better and for executive control tasks, bilinguals performed better. These results were consistent in the younger age group, however, could not be generalized to the older subjects on the executive task, suggesting an increased heterogeneity in older participants.

To verify whether aging-related deficits in executive control lead to an increase in language control, Gollan et al. (2011) researched on Spanish-English bilinguals. The verbal fluency task required 18 younger (mean age=19.7 years) and 18 older participants (mean age=77 years) to produce word lists in eighteen categories (nine in Spanish and nine in English), as well as a flanker task. Age had a significant impact on performance on both tasks, although the verbal fluency measure showed distinct cross-language and within-language mistake patterns. Within-language errors were made quite frequently and less frequently as education levels increased in younger as well as older participants. Contrarily, the observation that cross-language incursions (e.g., accidentally stating an English word when given a trial in Spanish) were infrequently made, unrelated to educational level, and substantially related to errors found in flanker-task was held true only in older bilinguals. These findings demonstrate that executive functions influence language selection, but they also point to the existence of autonomous factors that guard against language-selection mistakes.

To unveil the link between bilingual language control system and the domain-general executive functions by evaluating the influence of age on these systems, Calabria et al. (2013), recruited younger (19-27 years), middle-aged (38-53 years) and older (62-77 years) highly-proficient bilinguals. They were administered two tasks which included one non-linguistic-alternating task and one language-alternating task. An age-related general slowing was observed in both tasks. This study also provides additional proof that the bilingual language control mechanisms do not completely subordinate the mechanisms of the domain-general executive function system.

To determine the degree of bilingual advantage in executive functions Bialystok et al. (2014) carried out two experiments on monolingual and bilingual young adults (mean age - 20 years) and old adults (mean age-70 years). In experiment 1, the Stroop task was administered to 130 participants, and in experiment 2, a complex working memory task was administered to 108 participants. In experiment 1, less interference was exhibited by young and old bilinguals, with a greater advantage for older adults. In experiment 2, less interference was exhibited by bilinguals compared to monolinguals. A greater bilingual advantage was observed in the older adults and in the nonverbal task. Hence it was concluded that the advantage seen in bilinguals on executive functions is influenced by the participants and the tasks involved.

With the intention of exploring if there are advantages for bilinguals in executive control and disadvantages for them in language tasks, a study (Kousaie, 2014) was conducted on young and older

monolingual English speakers, monolingual French speakers, and French/English bilinguals. They were required to perform linguistic tasks like the Boston Naming Test (BNT), category fluency, letter fluency, and the Wisconsin Card Sort Test (WCST). The executive function tasks administered included the Stroop test, Simon test, sustained attention to response test and digit span tests. The results failed to show any clear edge in executive function tasks in bilinguals. In addition, no linguistic group disparities were greater for older individuals than for younger individuals in any of the tasks. The findings cast doubt on the validity, robustness, and/or specificity of the "bilingual advantage".

The existence of advantages in bilingual older adults and the impact of language use and type of bilingualism (dominant bilingual or balanced bilingual) on the same was studied by Goral et al. (2015). A total of 106 Spanish-English bilinguals in the age group of 50 to 84 years took part in the study. Three tests were given: Simon task (targeting inhibition), Trail Making test (targeting alternating attention), and Month Ordering test (targeting working memory). Age and performance in the three domains were found to be negatively correlated. On Simon's task, which evaluates inhibition, bilingualism was a predictor of performance and varies with age. Balanced bilinguals showed a drop in inhibition with age. However, there were no aging-related alterations in the dominant bilinguals. Results implied that the cognitive benefits reported in older persons are only substantial for a small group of bilinguals.

The effect of executive control on the development of lexical retrieval and the influence of bilingualism on the same was investigated

by Friesen et al. (2015). For this, bilinguals and monolinguals in four age groups i.e.,7 years old, 10 years old, young adults, and older adults with respective mean ages of 20 and 70 were sought for the study. All participants were given verbal fluency tests, including category fluency and letter fluency tests. Results demonstrated that verbal fluency performance improved as people aged from young children to younger adults but remained largely stable in older adults. The efforts for letter fluency were less for bilinguals than for monolinguals right at the beginning of 10 years and an evident bilingual advantage started off in adulthood. Therefore, it can be inferred that letter fluency was influenced by bilingualism, whereas category fluency was influenced by age and vocabulary knowledge.

To investigate the trajectory of bilingual language control with age, Ivanovaa et al. (2016) performed a study on Spanish-English bilinguals. They employed a verbal fluency task on 13 older (mean age=77 years) and 13 younger bilinguals (mean age=22.23 years) where they had to complete the same letter and semantic categories in Spanish and English separately and alternating between Spanish and English after each category. They also performed a non-linguistic flanker task. It was found that bilinguals had fewer accurate responses post alternating languages in the letter fluency test. Older subjects exhibited more intruding responses in the task of semantic fluency than younger bilinguals. It was also observed that there were a greater number of intrusions in the task of semantic fluency than in letter fluency. Hence it can be concluded that when semantic priming between languages benefits bilinguals, they might have the

potency to adjust inhibition in a flexible manner. However, as they become older, this ability becomes less effective.

A study aimed to explore the executive functions in low-proficient and high-proficient bilinguals was conducted by Margaret and Abhishek (2017). Successive bilinguals with Kannada as L1 and English as their L2 range of 18-25 years were considered for the study. The groups were compared on the alternating fluency task where the person had to alternate between Kannada and English under each of the three lexical categories considered. The results revealed better performance by the high-proficient group compared to the low-proficient group. This was attributed to cognitive efficiency in switching.

With the aim of comparing the performance of Malayalam -English bilinguals in alternating verbal fluency across age groups, Deepak et al. (2021) conducted a study among adolescents (8-11 years), young adults (18-25 years) and older adults (50-75 years). The subjects were instructed to perform an alternate semantic fluency task and an alternate phonemic fluency task in Malayalam. It was observed revealed that adolescent performance was poor compared to younger adults in both tasks. Conversely, there was no difference between adolescents and older adults in both tasks. These findings demonstrate the maturation of cognitive flexibility with age and provide insight into the ways in which cognitive flexibility diminishes in the elderly.

From the literature review, it is clear that studies employing linguistic tasks to tap the executive functions in bilinguals have mainly utilized generative naming tasks such as semantic or phonemic verbal

fluency tasks. The number of studies done in the Indian population to explore the performance of bilinguals on alternating verbal fluency tasks, which places a greater cognitive load is limited. The methodology of alternating verbal fluency used in the present study is novel from the previous studies in that the participants were asked to alternate between categories as well as between languages in forward (L1- L2) and backward (L2- L1) directions. The executive functions in the age range selected for the current study, 50-60 years, are less investigated in the Indian scenario.

# CHAPTER III

# METHOD

The combined impact of bilingualism and age on executive functions is less looked into, especially in the Indian scenario. The study aims to inspect the effect of bilingualism and age on executive functions by utilizing alternating verbal fluency task with the following objectives:

1. To compare the performance of younger and older bilinguals in cross-category alternating verbal fluency task in L1
2. To compare the performance of younger and older bilinguals in cross-category alternating verbal fluency task in L2
3. To compare the performance of younger and older bilinguals in cross-language forward alternating verbal fluency task
4. To compare the performance of younger and older bilinguals in cross-language backward alternating verbal fluency task.

## 3.1 Research design

The research design utilized in this study is a standard group comparison with a cross-sectional study design.

## 3.2 Participants

Participants in two age groups i.e., between 18 to 30 years and 50 to 60 years were considered for the study. Thirty participants in each age group were recruited based on convenience sampling.

Participant selection criteria were as follows:

**Inclusion criteria**

1. All the participants were successive bilinguals with Malayalam as their L1

and English as their L2

2. They had a minimum of 10 years of exposure to L2
3. None of them had any history of physical, sensory, linguistic, or cognitive deficits

Informed consent was taken from the subjects prior to the recruitment for the study. Demographic details from each of the participants were elicited and profiled. These included age, gender, educational qualification, occupation, number of years of formal education and number of years of L2 exposure. Languages known to the participants were also profiled. The details of the participants in Group 1 and Group 2 are documented in Table 3.1 and Table 3.2 respectively. All the participants were briefly explained the aims, the method of the study, and the duration of testing.

**Table 3.1**

*Details of participants in Group 1*

| S.No | Age | Gender | Education | Occupation | Languages known | Formal education | L2 exposure |
|---|---|---|---|---|---|---|---|
| | Years | | | | | No. of years | No. of years |
| 1 | 19 | Female | 1st BSc | Student | M ,E | 16 | 16 |
| 2 | 19 | Female | 1st BSc | Student | M,E,A | 16 | 16 |
| 3 | 19 | Female | 1st BSc | Student | M,E | 15 | 15 |
| 4 | 19 | Female | 1st BSc | Student | M,E | 16 | 16 |
| 5 | 19 | Female | 1st BSc | Student | M,E | 14 | 14 |
| 6 | 20 | Female | 1st BSc | Student | M,E | 16 | 16 |
| 7 | 20 | Female | 2nd BSc | Student | M,E | 16 | 16 |
| 8 | 20 | Female | 1st BSc | Student | M,E | 16 | 16 |
| 9 | 20 | Female | 2nd BSc | Student | M,E | 17 | 17 |
| 10 | 20 | Female | 1st BSc | Student | M,E | 15 | 15 |
| 11 | 20 | Female | 1st BSc | Student | M,E | 16 | 16 |
| 12 | 20 | Female | 2nd BSc | Student | M,E,H | 16 | 16 |
| 13 | 20 | Female | 2nd BSc | Student | M,E,H | 16 | 16 |
| 14 | 20 | Female | 1st BSc | Student | M,E,H | 16 | 16 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 15 | 21 | Female | 1st BSc | Student | M,E | 16 | 16 |
| 16 | 21 | Female | 2nd BSc | Student | M,E | 16 | 16 |
| 17 | 22 | Female | 1st BSc | Student | M,E | 16 | 16 |
| 18 | 22 | Female | 2nd BSc | Student | M,E,H | 17 | 17 |
| 19 | 22 | Female | 2nd BSc | Student | M,E | 18 | 18 |
| 20 | 22 | Female | 2nd BSc | Student | M,E | 16 | 16 |
| 21 | 23 | Female | 2nd MSc | Student | M,E,T,H | 19 | 19 |
| 22 | 24 | Female | 2nd MSc | Student | M,E,H,T | 21 | 21 |
| 23 | 24 | Female | 2nd MSc | Student | M,E,T,H | 19 | 19 |
| 24 | 24 | Female | 2nd MSc | Student | M,E,H | 19 | 19 |
| 25 | 25 | Female | 2nd MSc | Student | M,E,H | 22 | 22 |
| 26 | 25 | Female | 2nd MSc | Student | M,E | 22 | 22 |
| 27 | 25 | Female | 2nd MSc | Student | M,E | 22 | 22 |
| 28 | 25 | Female | 2nd MSc | Student | ME,H | 19 | 19 |
| 29 | 26 | Female | 1st MSc | Student | M,E,T | 19 | 19 |
| 30 | 27 | Female | 2nd MSc | Student | M,E | 23 | 23 |

*Note*. M-Malayalam, E-English, H-Hindi, T-Tamil, A-Arabic

As shown in Table 3.1, all the participants in Group 1 were females with a mean age of 21.76 years. All of them were students, out of which 20 were undergraduate 10 were postgraduate students. They had an average of 17.5 years of formal education and an average of 17.5 years of exposure to L2 as well. Out of the 30 participants in Group 1, 18 of them were bilinguals and 12 of them were multilingual.

**Table 3.2**

*Details of participants in Group 2*

| S.No | Age | Gender | Education | Occupation | Languages known | Formal education | L2 exposure |
|---|---|---|---|---|---|---|---|
| | Years | | | | | No. of years | No. of years |
| 1 | 55 | Male | UG | Business | M,E,H | 15 | 10 |
| 2 | 59 | Female | PG | Professor | M,E,K | 17 | 12 |
| 3 | 53 | Female | PG | Teacher | M,E,H,F | 17 | 14 |
| 4 | 54 | Male | UG | Engineer | M,E,H | 16 | 10 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 5 | 58 | Female | PG | Administration in software company | M,E,H | 17 | 14 |
| 6 | 53 | Female | PG | Teacher | M,E,H,T | 17 | 13 |
| 7 | 52 | Female | UG | Taluk supply officer | M,E,H,N | 17 | 17 |
| 8 | 57 | Male | Diploma | Pharmacist | M,E | 14 | 14 |
| 9 | 52 | Female | UG | Teacher | M,E, | 17 | 14 |
| 10 | 50 | Female | PG | Homemaker | M,E, | 19 | 19 |
| 11 | 53 | Male | PG | Priest | M,E | 24 | 19 |
| 12 | 56 | Male | PG | Retired .Employment officer | M,E,K | 17 | 11 |
| 13 | 54 | Female | PG | Retired Teacher | M,E,K,H | 22 | 17 |
| 14 | 52 | Female | UG | Teacher | M,E | 17 | 13 |
| 15 | 59 | Female | UG | Homemaker | M,E | 15 | 15 |
| 16 | 54 | Male | Phd | Professor | M,E | 30 | 16 |
| 17 | 50 | Female | Phd | Professor | M,E | 20 | 15 |
| 18 | 53 | Female | PG | Teacher | M,E | 20 | 14 |
| 19 | 60 | Male | UG | Business | M,E,K | 16 | 11 |
| 20 | 53 | Female | UG | Business | M,E | 15 | 10 |
| 21 | 56 | Male | UG | Teacher | M,E | 15 | 11 |
| 22 | 52 | Female | PG | School Librarian | M,E,T,H | 19 | 14 |
| 23 | 56 | Male | PG | Planter | M,E,H | 19 | 14 |
| 24 | 56 | Male | PG | Principal | M,E,K | 20 | 10 |
| 25 | 50 | Female | UG | Hospital administration | M,E | 18 | 18 |
| 26 | 59 | Male | PG | Bank employee | M,E,H | 17 | 17 |
| 27 | 58 | Female | UG | Bank employee | M,E,H | 17 | 13 |
| 28 | 58 | Male | UG | Cashier | M,E,H | 20 | 20 |
| 29 | 55 | Female | PG | Doctor | M,E,H,T | 20 | 16 |
| 30 | 59 | Male | PG | Doctor | M,E,H,T | 21 | 21 |

*Note*. M-Malayalam, E-English, H-Hindi, T-Tamil, K-Kannada, F-French UG-Undergraduates, PG-Post graduates

From Table 3.2 it can be inferred that among the participants recruited in Group 2, there were 13 males and 19 females. The participants had a mean age of

54.86 years and included 12 Undergraduates,15 postgraduates, 2 Phd holders and 1 diploma. The participants were from various professions, most of them were involved in teaching, business and had an average of 18.26 years of formal education. The mean years of exposure to L2 was 14.4 years. Out of the 30 participants in Group 2, 12 of them were bilinguals and 18 of them were multilingual.

### 3.3 Administration of LEAP-Q

Language Experience and Proficiency Questionnaire-LEAP Q is an assessment tool developed by Fledge,1999 and revised by Marian, Blumenfeld and Kaushanskaya,2007. It assesses bilingual proficiency based on 18 questions on language acquisition and usage. The Indian version of LEAP-Q was adapted by Ramya & Goswami,2009. Based on LEAP-Q findings, the participants were classified into high-proficient and low-proficient bilinguals. The participants were required to rate their proficiency for question 10 in the questionnaire, on a four-point rating scale where 1 indicates zero proficiency,2-low,3-good, and 4 indicates perfect proficiency. According to Hayward (2013), a bilingual scoring 3 or 4 in the speaking domain of L1 can be classified as high-proficient bilingual. Hickey (2010) claimed that a bilingual should receive a score of 4 in the understanding domain and a minimum score of 3 in all other domains of speaking, reading and writing to be classified as high-proficient bilingual. Based on Hickey's criteria participants were identified as high-proficient or low-proficient bilinguals as shown in. The LEAP -Q scoring of high and low-proficient bilinguals in Group 1 is shown in Table 3.3 and Table 3.4 respectively. Table 3.5 and Table 3.6 shows the LEAP -Q scoring of high and low-proficient bilinguals respectively.

**Table 3.3**

*LEAP -Q scoring of high-proficient bilinguals in Group 1*

| S. No | L2 Understanding | L2 Speaking | L2 Reading | L2 Writing |
|---|---|---|---|---|
| 1. | 4 | 3 | 3 | 3 |
| 2. | 4 | 3 | 3 | 3 |
| 3. | 4 | 3 | 3 | 3 |
| 4. | 4 | 3 | 4 | 3 |
| 5. | 4 | 3 | 3 | 3 |
| 6. | 4 | 3 | 3 | 3 |
| 7. | 4 | 3 | 4 | 3 |
| 8. | 4 | 3 | 3 | 3 |
| 9. | 4 | 3 | 3 | 4 |
| 10. | 4 | 4 | 3 | 3 |
| 11. | 4 | 3 | 3 | 3 |
| 12. | 4 | 3 | 3 | 3 |
| 13. | 4 | 3 | 3 | 3 |
| 14. | 4 | 3 | 3 | 3 |
| 15. | 4 | 3 | 3 | 3 |
| 16. | 4 | 3 | 3 | 4 |
| 17. | 4 | 4 | 4 | 4 |
| 18. | 4 | 3 | 3 | 3 |
| 19. | 4 | 3 | 3 | 3 |
| 20. | 4 | 3 | 3 | 3 |
| 21. | 4 | 3 | 3 | 3 |
| 22. | 4 | 3 | 4 | 3 |
| 23. | 4 | 3 | 4 | 4 |

**Table 3.4**

*LEAP -Q scoring of low-proficient bilinguals in Group 1*

| S. No | L2 Understanding | L2 Speaking | L2 Reading | L2 Writing |
|---|---|---|---|---|
| 1. | 3 | 3 | 3 | 4 |
| 2. | 3 | 2 | 2 | 3 |
| 3. | 3 | 3 | 3 | 3 |
| 4. | 3 | 3 | 3 | 3 |
| 5. | 3 | 3 | 3 | 3 |
| 6. | 3 | 3 | 3 | 3 |
| 7. | 3 | 3 | 3 | 3 |

**Table 3.5**

*LEAP -Q scoring of high-proficient bilinguals in Group 2*

| S. No | L2 Understanding | L2 Speaking | L2 Reading | L2 Writing |
|---|---|---|---|---|
| 1. | 4 | 3 | 3 | 3 |
| 2. | 4 | 4 | 4 | 4 |
| 3. | 4 | 3 | 4 | 3 |
| 4. | 4 | 3 | 4 | 3 |
| 5. | 4 | 4 | 4 | 3 |
| 6. | 4 | 3 | 3 | 3 |
| 7. | 4 | 4 | 4 | 4 |
| 8. | 4 | 3 | 4 | 3 |
| 9. | 4 | 3 | 4 | 4 |
| 10. | 4 | 4 | 4 | 4 |
| 11. | 4 | 3 | 4 | 4 |
| 12. | 4 | 4 | 3 | 4 |
| 13. | 4 | 3 | 4 | 4 |
| 14. | 4 | 3 | 4 | 4 |

| | | | | |
|---|---|---|---|---|
| 15. | 4 | 3 | 4 | 4 |
| 16. | 4 | 4 | 4 | 4 |
| 17. | 4 | 3 | 4 | 3 |
| 18. | 4 | 4 | 4 | 4 |
| 19. | 4 | 3 | 3 | 3 |
| 20. | 4 | 4 | 4 | 4 |
| 21. | 4 | 4 | 4 | 4 |

**Table 3.6**

*LEAP -Q scoring of low-proficient bilinguals in Group 2*

| S No | L2 Understanding | L2 Speaking | L2 Reading | L2 Writing |
|---|---|---|---|---|
| 1. | 3 | 3 | 2 | 2 |
| 2. | 3 | 3 | 3 | 4 |
| 3. | 3 | 3 | 3 | 3 |
| 4. | 3 | 3 | 3 | 3 |
| 5. | 3 | 3 | 3 | 3 |
| 6. | 3 | 3 | 3 | 3 |
| 7. | 3 | 3 | 3 | 2 |
| 8. | 3 | 3 | 3 | 3 |
| 9. | 3 | 3 | 3 | 3 |

From Table 3.3 and Table 3.4, it is evident that among the participants recruited for Group 1, 23 of them were high-proficient bilinguals and 7 were low-proficient bilinguals. There were 21 high-proficient bilinguals and 9 low-proficient bilinguals in Group 2 as shown in Table 3.5 and Table 3.6.

After the classification of participants into low and high-proficient bilinguals, they were provided with alternating verbal fluency tasks. The tasks were of two types- cross-language alternating verbal fluency and cross-category alternating verbal fluency. The cross-language alternating verbal fluency was done in both L1 and

L2. The cross-category alternating verbal fluency task was done in forward and backward conditions.

The participants were seated in a quiet environment and tested individually. Each participant was required to perform four tasks. The instruction for each task was clearly provided before each task. Each participant was provided with one test trial prior to the actual testing. Test trial was conducted with other lexical categories which are not used in the actual task. The order of tasks was different for each participant.

### 3.4 Tasks

**Task 1: Cross-category alternating verbal fluency in L1**

**Task description:** Two lexical categories, i.e., common objects and vegetables, were considered. A time of 2 minutes was provided to the participants, within which they had to retrieve as many items as possible, alternating between the two categories in L1. The participant was provided examples from lexical categories not considered in the given task. They were instructed to perform the task without reiterating previously named words or using words in L2.

**Instruction:** You will be given a time of 2 minutes. Within this time limit, you have to name as many common objects and vegetables as possible in the order of common object, vehicle, common object, vehicle, and so on in Malayalam. Repetition of previously named items or naming items in English would be considered an incorrect response. Naming items from other categories not considered for the given task such as fruits will also be considered as an incorrect response.

**Procedure:** The responses were audio recorded and transcribed for analysis.

**Example:**/meʃa/ and /t̪akkalɪ/ were considered a correct response since they are responses in L1 alternated correctly between the given categories, whereas /ṭabl/ and /ṭomaṭo/ is an incorrect response since the response is in L2. /meʃa/ and /alama:ra/ is an incorrect response since they are not alternated between the two categories.

**Analysis:** Quantitative and qualitative analysis were carried out. The number of correct responses was computed in terms of the number of pairs correctly alternated. A score of one was assigned to each of the correctly alternated pairs.

Error analysis was performed to analyze the number and types of cross-category and cross-language errors. The total number of pairs produced incorrectly in this task was found. Error responses were classified into single incorrect responses and double incorrect responses. A response was considered as a single incorrect response if only one item in the pair was incorrect whereas it was considered as a double incorrect response when both the items in a pair were incorrect. Each of the single incorrect responses and double incorrect responses were scored as 0.

The errors observed in this task were classified as repetitions, substitution from another category, substitution by L2 and omissions as shown in Table 3.7.

**Table 3.7**

*Types of error observed in Task 1*

| Error type | Description | Example |
|---|---|---|
| Repetition | If an item/s in the pair was already produced in another pair that was produced earlier, it is considered as a repetition. | /meʃa/ - /t̪akkalɪ/<br>/meʃa/ -/veṇḍakka/<br>Here, since /meʃa/is already produced in a pair produced earlier, /meʃa/ -/veṇḍakka/is considered as a repetition. |

| | | |
|---|---|---|
| Substitution from another category | If an item/s in the pair was substituted by an item from another category not considered in the given task it is considered as a substitution from another category. | /meʃa/ - /munḍiri/<br>Here, since /munḍiri/ is an item from another lexical category(fruits) which is not considered for this task, is counted as a substitution from another category |
| Substitution by L2 | If an item/s in the pair was produced in L2 instead of L1, it is considered as a substitution by L2. | /meʃa/ - /drumstik /<br>Here, since / drumstik / is produced in L2 instead of L1 it is counted as a substitution by L2. |
| Omissions | If an item in the pair was omitted, it is considered as an omission | /meʃa/ - /kasera/-/veṇḍakka/<br>Here, since an item is omitted in meʃa/ - , it is counted as an omission. |

**Task 2: Cross-category alternating verbal fluency in L2**

**Task description:** Two lexical categories, i.e., fruits and vehicles, was considered. Similar to task 1, a time of 2 minutes was provided to the participants, within which they had to retrieve as many items as possible, alternating between the two categories. Unlike task 1, the participant has to alternate between the categories in L2. The participant will be provided examples from lexical categories not considered in the given task. They will be instructed to perform the task without reiterating previously named items or naming them in L1.

**Instruction:** You will be given a time of 2 minutes. Within this time limit, you have to name as many fruits and vehicles as possible in the order of fruit, vehicle, fruit, vehicle, and so on in English. Repetition of previously named items or naming items in Malayalam would be considered an incorrect response. Naming items from other categories not considered for the given task such as vegetables will also be considered as an incorrect response

**Procedure:** The responses were audio recorded and transcribed for analysis.

**Example:** /appl/ and /ca:r/ is a correct response since they are responses in L2 alternated correctly between the given categories, whereas /pazham/ and /vima:nam/ is an incorrect response since the response is in L1. /appl/ and /bana:na/ is an incorrect response since they are not alternated between the two categories.

**Analysis:** Quantitative and qualitative analysis were carried out. The number of correct responses was computed in terms of the number of pairs correctly alternated. A score of one was assigned to each of the correctly alternated pairs.

Error analysis was performed to analyze the number and types of cross-category and cross-language errors. The total number of pairs produced incorrectly in this task was found. Error responses were classified into single incorrect responses and double incorrect responses. A response was considered as a single incorrect response if only one item in the pair was incorrect whereas it was considered as a double incorrect response when both the items in a pair were incorrect. Each of the single incorrect responses and double incorrect responses were scored as 0.

The errors observed in this task were classified as repetitions, substitution from another category and omissions as shown in Table 3.8. Unlike task 1, substitutions from the other language (Malayalam) were not observed in any of the participants.

**Table 3.8**

*Types of error observed in Task 2*

| Error type | Description | Example |
|---|---|---|
| Repetition | If an item/s in the pair was already produced in another pair that was produced earlier, it is considered as a repetition. | /appl/ - /ca:r/<br>/bana:na/ - /ca:r/<br>Here, since /ca:r/ is already produced in a pair produced earlier, it is considered as a repetition. |
| Substitution from another category | If an item/s in the pair was substituted by an item from another category not considered in the given task it is considered as a substitution from another category. | /poṭaṭo/ - /ca:r/<br>Here, since /poṭaṭo/ is an item from another lexical category(vegetables) which is not considered for this task, is counted as a substitution from another category |
| Omissions | If an item in the pair was omitted, it is considered as an omission | /appl/ - /ca:r/<br>- /boṭ/<br>Here, since an item is omitted in - /boṭ/, it is counted as an omission. |

**Task 3: Cross-language forward alternating verbal fluency**

**Task description:** The lexical category of animals was considered for this task. Similar to previous tasks, a time of 2 minutes was provided to the participant, within which they had to retrieve as many items as possible. Unlike tasks 1 and 2,

here, the alternation was between the two languages in the forward direction (first L1, then L2). The participant was provided examples from a lexical category not considered in the given task. They were instructed to perform the task without reiterating previously named words or using translation equivalents.

**Instruction:** You will be given a time of 2 minutes. Within this time limit, you have to name as many animals as possible in Malayalam and English. The first animal should be named in Malayalam, the second animal in English, the third animal in Malayalam and the fourth animal in English and so on. and so on. Repetition of previously named items or translating items already named would be considered an incorrect response. Naming items from other categories not considered for the given task such as fruits will also be considered as an incorrect response.

**Procedure:** The responses were audio recorded and transcribed for analysis.

**Example:** /a:d/ and /dog/ is a correct response since they are distinct responses in the given lexical alternated correctly between the languages, whereas /a:d/ and /goṭ/ is an incorrect response since they are translation equivalents. /ka:ka/ and /a:d/ is an incorrect response since they belong to distinct lexical categories.

**Analysis:** Quantitative and qualitative analysis were carried out. The number of correct responses were computed in terms of number of pairs correctly alternated. A score of one was assigned to each of the correctly alternated pairs.

Error analysis was performed to analyze the number and types of cross-category and cross-language errors. Total number of pairs produced incorrectly in this task was found. Error responses were classified into single incorrect responses and double incorrect responses. A response was considered as a single incorrect response if only one item in the pair was incorrect whereas it was considered as a

double incorrect response when both the items in a pair was incorrect. Each of the single incorrect responses and double incorrect responses were scored as 0.

The errors observed in this task were classified as repetitions, substitution from another category, substitution by translation equivalents and omissions as shown in Table 3.9.

**Table 3.9**

*Types of error observed in Task 3*

| Error type | Description | Example |
|---|---|---|
| Repetition | If an item/s in the pair was already produced in another pair that was produced earlier, it is considered as a repetition. | /a:d/ - /dog/<br>/a:d/ - /kat/<br>Here, since /a:d/ is already produced in a pair produced earlier, it is considered as a repetition. |
| Substitution from another category | If an item/s in the pair was substituted by an item from another category not considered in the given task it is considered as a substitution from another category. | /t̪at̪a/ - /dog/<br>Here, since /t̪at̪a/ is an item from another lexical category(birds) which is not considered for this task, is counted as a substitution from another category |
| Substitution by translation equivalent | If an item/s in the pair was already produced in the other language earlier, it is considered as a | /a:d/ - /dog/<br>/a:na/-/got/<br>Here, since / got/ is the translation equivalent of an |

| | | |
|---|---|---|
| | substitution by translation equivalent.it is considered as a substitution by translation equivalent. | already produced item (/a:d/) it is counted as a substitution by translation equivalent |
| Omissions | If an item in the pair was omitted, it is considered as an omission | /a:d/ - /dog/<br>- /kat/<br>Here, since an item is omitted in - /kat/ it is counted as an omission |

**Task 4: Cross-language backward alternating verbal fluency**

**Task description:** The lexical category of birds was considered for this task. Similar to task 3, a time of 2 minutes was provided to the participant, within which they had to retrieve as many items as possible, alternating between the two languages. In this task, the alternation is in the backward direction (first L1, then L2), unlike task 3. The participant was provided examples from a lexical category not considered in the given task. They were instructed to perform the task without reiterating previously named words or using translation equivalents.

**Instruction:** You will be given a time of 2 minutes. Within this time limit, you have to name as many birds as possible in English and Malayalam. The first bird should be named in English, the second bird in Malayalam, the third bird in English, the fourth bird in Malayalam and so on. Repetition of previously named items or translating items already named would be considered an incorrect

response. Naming items from other categories not considered for the given task such as fruits will also be considered as an incorrect response

**Procedure:** The responses were audio recorded and transcribed for analysis.

**Example:**/cro/ and /majil/ is a correct response since they are distinct responses in the given lexical category alternated correctly between the languages, whereas /cro/ and /ka:ka/ is an incorrect response since they are translation equivalents. /cro/ and /a:d/ is an incorrect response since they belong to distinct lexical categories.

**Analysis:** Quantitative and qualitative analysis were carried out. The number of correct responses was computed in terms of the number of pairs correctly alternated. A score of one was assigned to each of the correctly alternated pairs. Error analysis was performed to analyze the number and types of cross-category and cross-language errors. The total number of pairs produced incorrectly in this task was found. Error responses were classified into single incorrect responses and double incorrect responses. A response was considered as a single incorrect response if only one item in the pair was incorrect whereas it was considered as a double incorrect response when both the items in a pair were incorrect. Each of the single incorrect responses and double incorrect responses were scored as 0.

The errors observed in this task were classified as repetitions, substitution from another category, substitution by translation equivalents and omissions as shown in Table 3.10.

**Table 3.10**

*Types of error observed in Task 4*

| Error type | Description | Example |
|---|---|---|
| Repetition | If an item/s in the pair was already produced in another pair that was produced earlier, it is considered as a repetition. | /cro/ - /majil/<br>/hen/ - /majil/<br>Here, since /majil/ is already produced in a pair produced earlier, it is considered as a repetition. |
| Substitution from another category | If an item/s in the pair was substituted by an item from another category not considered in the given task it is considered as a substitution from another category. | /cro/ - /a:ma/<br>Here, since /a:ma/ is an item from another lexical category (animals) which is not considered for this task, is counted as a substitution from another category |
| Substitution by translation equivalent | If an item/s in the pair was already produced in the other language earlier. it is considered as a substitution by translation equivalent. | / cro/ - /majil/<br>/hen/ - /ka:ka /<br>Here, since /ka:ka/ is the translation equivalent of an already produced item(/ cro/) it is counted as a substitution by translation equivalent |
| Omissions | If an item in the pair was omitted, it is considered as an omission | / cro/ - /majil/<br>- /t̪at̪a/<br>Here, since an item is omitted in - /t̪at̪a/<br>, it is counted as an omission. |

**Statistical Analysis:**

The data collected from 60 participants were tabulated in terms of the number of correctly alternated pairs and the number of error responses according to their age groups. For qualitative analysis, the error responses were further tabulated as the number of single incorrect and double incorrect responses. The type of error was also tallied for error analysis. The tabulated data were cross-checked to ensure that no erroneous data was used for statistical analysis.

Statistical Package for the Social Sciences (SPSS software, version 26.0) was utilised for statistical analysis and the data was entered in the appropriate form required for the software. The data was subjected to the Shapiro-Wilk test of normality. It was found that the data does not follow a normal distribution($p<0.05$). Therefore, a non-parametric test Mann-Whitney U test was performed to compare the performance of the two groups across the four tasks. Descriptive statistics was performed to find the median of the alternating verbal fluency tasks.

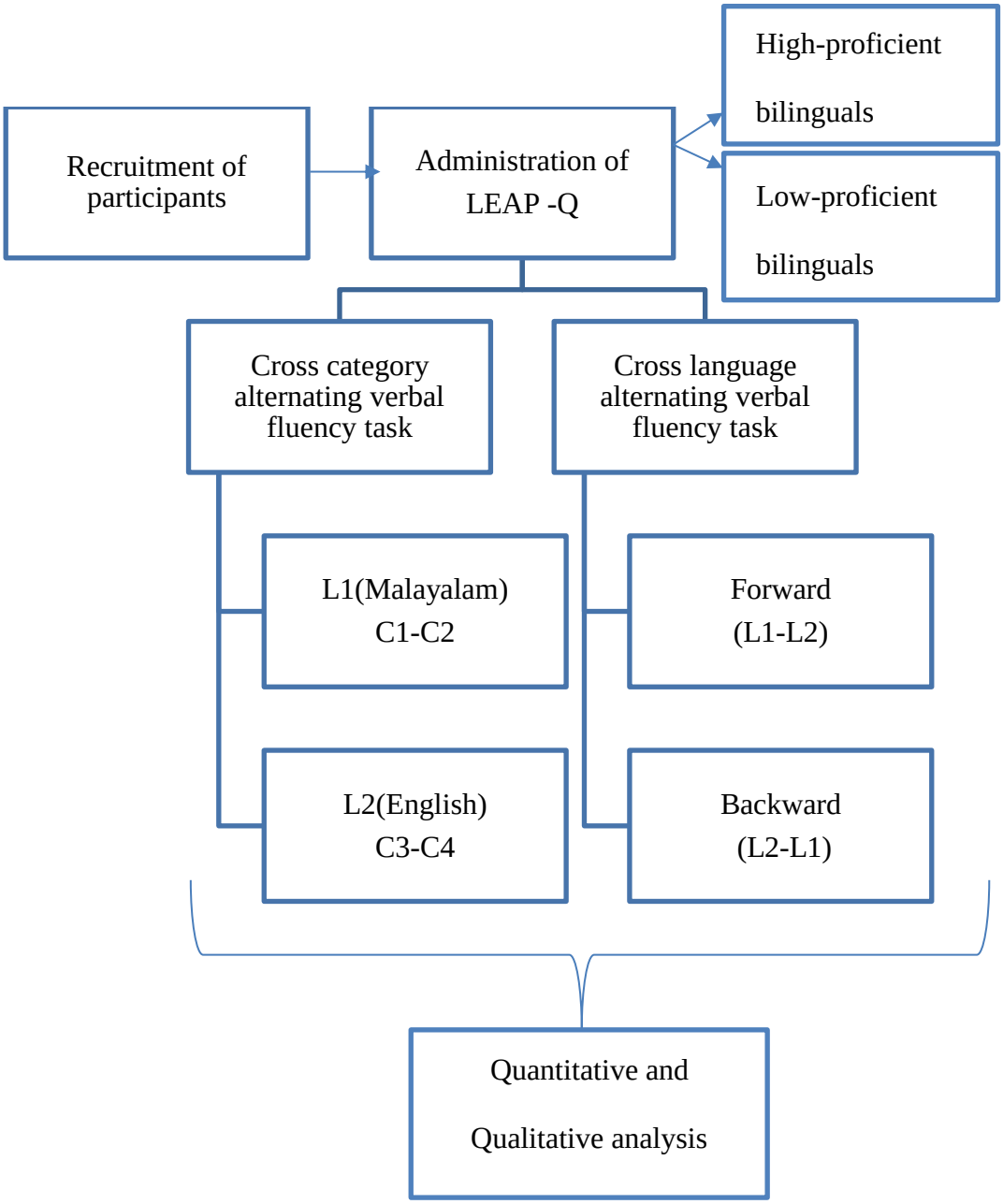



*Fig 1: Schematic representation of the method*

# CHAPTER IV

# RESULTS

The aim of the study was to explore the effect of bilingualism and aging on executive functions by employing alternating verbal fluency task. A total of 60 participants in two age groups i.e., between 18 to 30 years and 50 to 60 years were considered for the study. There were 30 participants in each age group. Four tasks were administered to all the participants. The tasks were of two types-cross-language alternating verbal fluency and cross-category alternating verbal fluency. The cross-language alternating verbal fluency was done in both L1 and L2. The cross-category alternating verbal fluency task was done in forward and backward conditions.

## 4.1 Task 1: Cross-category alternating verbal fluency in L1

In this task, the participants were provided a time of 2 minutes within which they had to name as many items as possible, alternating between the two categories i.e., common objects and vegetables in L1. They were instructed to perform the task without reiterating already named items or using translation equivalents.

## 4.2 Task 2: Cross-category alternating verbal fluency in L2

Two lexical categories, i.e., fruits and vehicles, were considered. The subjects were required to retrieve as many items as possible, alternating between the two categories in L2 within a time of 2 minutes. They were also instructed that repetition of previously named items or naming items in L1 would be considered an incorrect response.

### 4.3 Task 3: Cross-language forward alternating verbal fluency

Similar to previous tasks, a time of 2 minutes was provided to the participants, within which they had to produce as many words as possible in the category of animals. Unlike tasks 1 and 2, here, the alternation was between the two languages in the forward direction (first L1, then L2). Repetition of previously named items or translating items already named was considered an incorrect response. Naming items from other categories not considered for the given task such as fruits was also considered as an incorrect response.

### 4.4 Task 4: Cross-language backward alternating verbal fluency

The lexical category considered for this task was birds. Similar to task 3, the participants were required to name as many items as possible, alternating between the two languages within a time of 2 minutes. In this task, the alternation was in the backward direction (first L1, then L2), unlike task 3. They were instructed to perform the task without reiterating previously named words or using translation equivalents.

### 4.5 Objectives of the Study

1. To compare the performance of younger and older bilinguals in cross-category alternating verbal fluency task in L1
2. To compare the performance of younger and older bilinguals in cross-category alternating verbal fluency task in L2
3. To compare the performance of younger and older bilinguals in cross-language forward alternating verbal fluency task
4. To compare the performance of younger and older bilinguals in cross-language backward alternating verbal fluency task

### 4.5.1 Objective 1

**To compare the performance of younger and older bilinguals in cross-category alternating verbal fluency task in L1**

The aim was to find out if age has any significant effect on cross-category alternating verbal fluency task in L1.

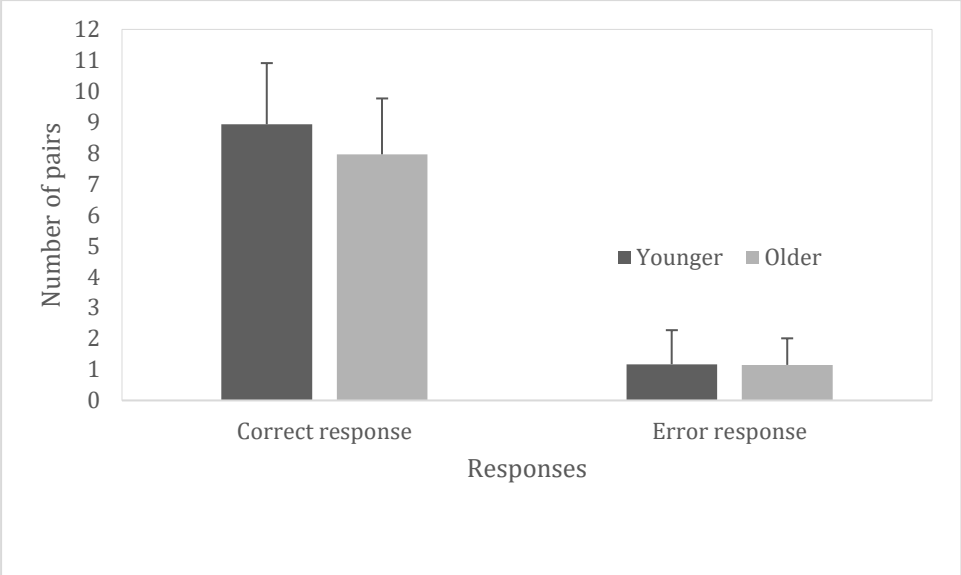
**Table 4.1**

*Descriptive values for number of correct and error responses for younger and older bilinguals on Task 1.*

| Number of responses | Younger bilinguals | Older bilinguals |
|---|---|---|
| Correct responses | | |
| Mean | 8.93 | 7.96 |
| Median | 9.00 | 8.00 |
| SD | 1.981 | 1.808 |
| Error responses | | |
| Mean | 1.17 | 1.15 |
| Median | 1.00 | 1.00 |
| SD | 1.104 | 0.86 |

**Figure 4.1.1**

*Mean of the number of correct and error responses for tasks 1 younger and older bilinguals*




As shown in Table 4.1, the mean number of correct responses in younger bilinguals on task was 8.93 whereas, for older bilinguals, it was 7.96. The median for the number of correct responses in younger bilinguals was 9. In case of older bilinguals, the median for the number of correct responses was 8. The SD for the number of correct responses was 1.981 and 1.808 for younger and older bilinguals respectively. The mean for the number of error responses in younger individuals was 1.17. For older bilinguals, the mean number of error responses was 1.15. The median for the same was found to be 1.00 in younger and older individuals. The SD for the number of error responses was 1.104 and 0.86 for younger and older bilinguals respectively. The mean and median scores for correct responses were higher for younger bilinguals compared to older bilinguals.

In order to verify any significant difference in the performance between the two groups - younger and older bilinguals (between-group comparisons),

statistical analysis was carried out. The data were subjected to the test of normality using the Shapiro-Wilk test and it found that the data was not normally distributed ($p<0.05$) for both younger and older bilinguals.

Since the data was not normally distributed, a non-parametric test, the Mann-Whitney-U test was performed for the comparison of younger and older adults.

(i) It was found that in Task 1 -cross-category alternating verbal fluency task in L1 the |Z| score obtained was 2.063 and the corresponding p-value showed a significant difference ($p<0.05$) across the age groups in terms of the number of correct responses.

(ii) With respect to the error analysis in this task, the |Z| score obtained was 0.208 and the corresponding p-value indicated no significant difference ($p>0.05$) across the age groups in the number of error responses.

To summate, younger bilinguals exhibited superior performance with respect to the number of correct responses whereas the number of error responses was found to be similar in both the groups in cross-category alternating verbal fluency in L1.

### 4.5.2 Objective 2

**To compare the performance of younger and older bilinguals in cross-category alternating verbal fluency task in L2**

The aim was to find out if age has any significant effect on cross-category alternating verbal fluency task in L2.

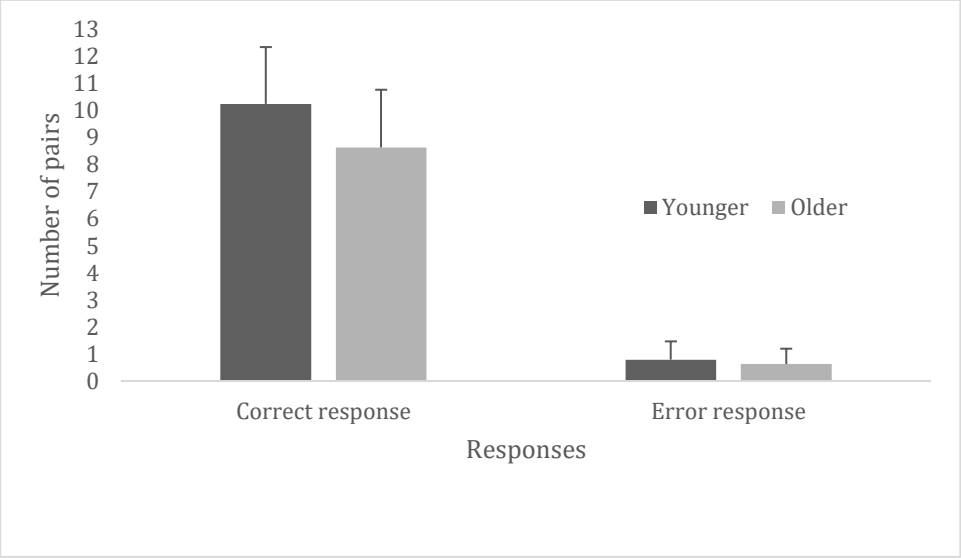
**Table 4.2**

*Descriptive values for number of correct and error responses for younger and older bilinguals on Task 2.*

| Number of responses | Younger bilinguals | Older bilinguals |
|---|---|---|
| Correct responses | | |
| Mean | 10.24 | 8.63 |
| Median | 10.00 | 9.00 |
| SD | 2.099 | 2.133 |
| Error responses | | |
| Mean | 0.79 | 0.63 |
| Median | 1.00 | 1.00 |
| SD | 0.675 | 0.565 |

**Figure 4.1.2**

*Mean of the number of correct and error responses for task 2 in younger and older bilinguals*



As shown in Table 4.2, the mean number of correct responses in younger bilinguals on cross-category alternating verbal fluency task in L2 was 10.24 whereas, for older bilinguals, it was 8.63. The median for the number of correct responses in younger bilinguals was 10. In case of older bilinguals, the median for the number of correct responses was 9. The SD for the number of correct responses was 2.099 and 2.133 for young and old bilinguals. The mean for the number of error responses in younger individuals was 0.79. For older bilinguals, the mean number of error responses was 0.63. The median for the same was found to be 1.00 in younger as well as in older individuals. The SD for the number of error responses was 0.675 and 0.565 for younger and older bilinguals respectively. The mean and median scores for correct responses were higher for younger bilinguals compared to older bilinguals.

In order to verify any significant difference in the performance between the two groups - younger and older bilinguals (between-group comparisons), statistical analysis was carried out. The data were subjected to the test of normality using the Shapiro-Wilk test and it found that the data was not normally distributed ($p<0.05$) for both younger and older bilinguals.

Since the data was not normally distributed, a non-parametric test, the Mann-Whitney-U test was performed for the comparison of young and old adults.

(i) It was found that in Task 2 -cross-category alternating verbal fluency task in L2, the |Z| score obtained was 2.619 and the corresponding p-value showed a significant difference ($p<0.05$) across the age groups in terms of the number of correct responses.

(ii) With respect to error analysis in this task, the |Z| score obtained was 0.865 and the corresponding p-value indicated no significant difference ($p>0.05$) across

the age groups in the number of error responses.

To summarize, in Task 2 -the cross-category alternating verbal fluency task in L2, younger bilinguals exhibited superior performance compared to older bilinguals in terms of the number of correct responses. However, there was no significant difference with respect to the error responses across the age groups.

### 4.5.3 Objective 3

**To compare the performance of younger and older bilinguals in cross-language forward alternating verbal fluency**

The aim was to find out if age has any significant effect in cross-language forward alternating verbal fluency task.

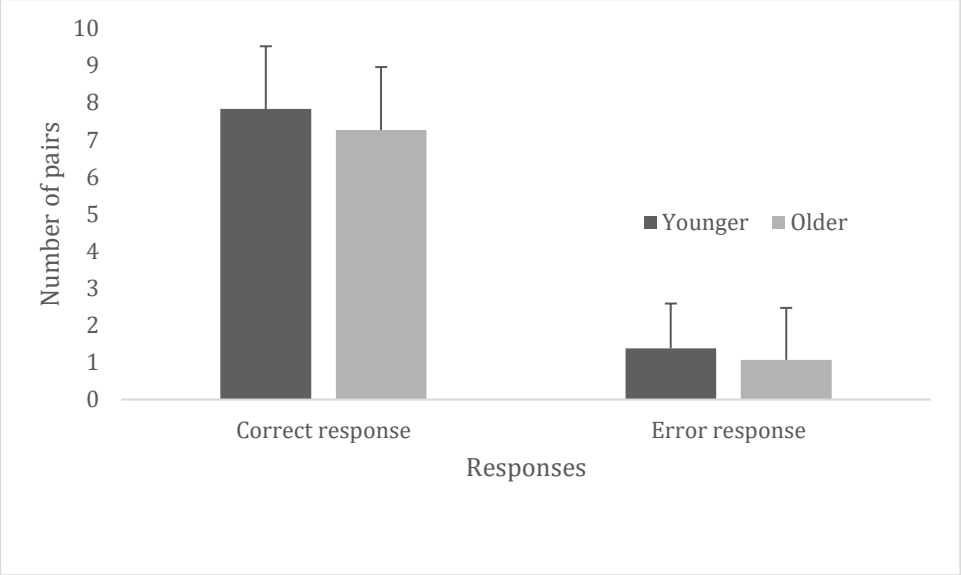
**Table 4.3**

*Descriptive values for number of correct and error responses for younger and older bilinguals on Task 3.*

| Number of responses | Younger bilinguals | Older bilinguals |
|---|---|---|
| Correct responses | | |
| Mean | 7.83 | 7.26 |
| Median | 7.00 | 7.00 |
| SD | 1.692 | 1.701 |
| Error responses | | |
| Mean | 1.38 | 1.07 |
| Median | 1.00 | 1.00 |
| SD | 1.208 | 1.40 |

**Figure 4.1.3**

*Mean of the number of correct and error responses for task 3 in younger and older bilinguals*




As shown in Table 4.3, the mean number of correct responses in younger bilinguals on cross-language forward alternating verbal fluency task was 7.83 whereas, for older bilinguals, it was 7.26. The median for the number of correct responses in younger as well as older bilinguals was 7. The SD for the number of correct responses was 1.692 and 1.701 for younger and older bilinguals respectively. The mean for the number of error responses in younger individuals was 1.38. For older bilinguals, the mean number of error responses was 1.07. The median for the same was found to be 1.00 in younger as well as in older individuals. The SD for the number of error responses was 1.208 and 1.40 for younger and older bilinguals respectively.

In order to verify any significant difference in the performance between the two groups - younger and older bilinguals (between-group comparisons), statistical analysis was carried out. The data were subjected to the test of normality using the Shapiro-Wilk test and it found that the data was not normally distributed

($p<0.05$) for both younger and older bilinguals.

Since the data was not normally distributed, a non-parametric test, the Mann-Whitney-U test was performed for the comparison of young and old adults.

(i) It was found that in Task 3 -cross-language forward alternating verbal fluency task, the |Z| score obtained was 1.154 and the corresponding p-value did not exhibit any significant difference ($p >0.05$) across the age groups in terms of the number of correct responses.

(ii) With respect to the error analysis in this task, the |Z| score obtained was 0.981 and the corresponding p-value did not exhibit any significant difference ($p >0.05$) across the age groups in the number of error responses.

In summary, younger and older bilinguals exhibited similar performance in terms of the number of correct responses and number of error responses in cross-language forward alternating verbal fluency task.

### 4.5.4 Objective 4

**To compare the performance of younger and older bilinguals in cross-language forward alternating verbal fluency**

The aim was to find out if age has any significant effect on cross-language backward alternating verbal fluency task.

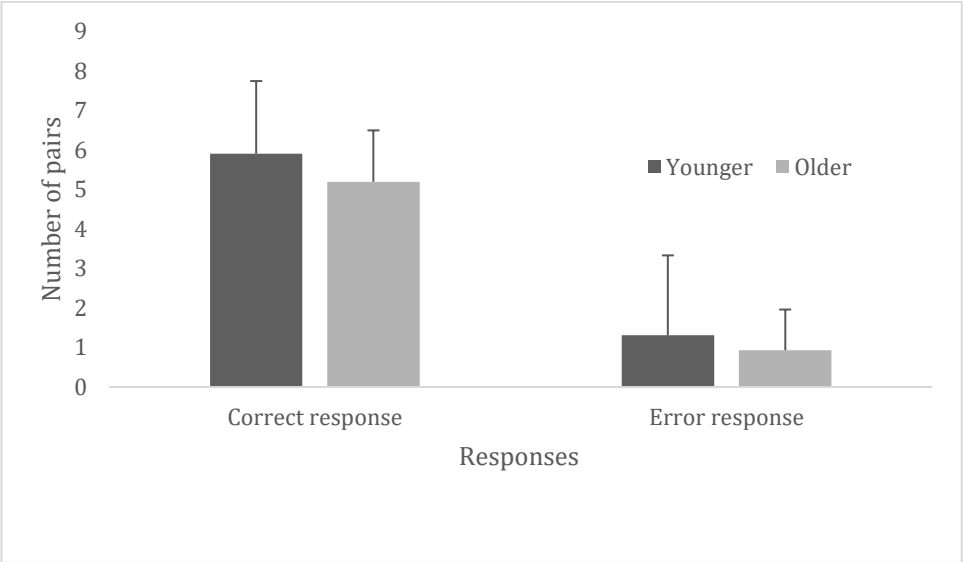
**Table 4.4**

*Descriptive values for number of correct and error responses for younger and older bilinguals on Task 4.*

| Number of responses | Younger bilinguals | Older bilinguals |
|---|---|---|
| Correct responses | | |
| Mean | 5.90 | 5.19 |
| Median | 6.00 | 5.00 |
| SD | 1.839 | 1.302 |
| Error responses | | |
| Mean | 1.31 | 0.93 |
| Median | 1.00 | 1.00 |
| SD | 2.02 | 1.03 |

**Figure 4.1.4**

*Mean of the number of correct and error responses for task 4 in younger and older bilinguals*



As shown in Table 4.4, the mean number of correct responses in younger bilinguals on cross-language backward alternating verbal fluency task was 5.90 whereas, for older bilinguals, it was 5.19. The median for the number of correct responses in younger bilinguals was 6. In older bilinguals, the median for the number of correct responses was 5. The SD for the number of correct responses was 1.839 and 1.302 for younger and older bilinguals respectively. The mean for the number of error responses in younger individuals was 1.31. For older bilinguals, the mean number of error responses was 0.93. The median for the same was found to be 1.00 in younger as well as in older individuals. The SD for the number of error responses was 2.02 and 1.03 for younger and older bilinguals respectively.

In order to verify any significant difference in the performance between the two groups - younger and older bilinguals (between-group comparisons), statistical analysis was carried out. The data were subjected to the test of normality using the Shapiro-Wilk test and it found that the data was not normally distributed ($p<0.05$) for both younger and older bilinguals.

Since the data was not normally distributed, a non-parametric test. the Mann-Whitney-U test was performed for the comparison of young and old adults.

(i) It was found that Task 4 -cross-language backward alternating verbal fluency task |Z| score obtained was 1.575 and the corresponding p-value did not exhibit any significant difference ($p >0.05$) across the age groups in terms of the number of correct responses.

(ii) With respect to the number of error analysis in this task, the |Z| score obtained was 0.0408 and the corresponding p-value did not exhibit any significant difference ($p >0.05$) across the age groups.

To summarize, younger and older bilinguals exhibited similar performance in terms of the number of correct responses and the number of error responses in cross-language backward alternating verbal fluency task.

In addition to the pre-set objectives, the comparison of the performance of each group across cross-language alternating verbal fluency task and cross-category alternating verbal fluency task was also done. The descriptive statistics for the total number of correct responses for younger and older bilinguals in cross-category alternating verbal fluency and cross-language alternating verbal fluency are depicted in Table 4.5.

**Table 4.5**

*Descriptive values for the total number of correct responses for younger and older bilinguals in cross-category alternating verbal fluency and cross-language alternating verbal fluency task.*

| Total number of correct responses | Cross-category | Cross-language |
|---|---|---|
| Younger bilinguals | | |
| Mean | 18.93 | 13.53 |
| Median | 19.50 | 12.50 |
| SD | 3.27 | 3.25 |
| Older bilinguals | | |
| Mean | 17.16 | 12.40 |
| Median | 17.00 | 13.00 |
| SD | 3.98 | 2.66 |

As shown in Table 4.5, the mean total number of correct responses in younger bilinguals on the cross-category alternating verbal fluency task was 18.93 whereas for the cross-language alternating verbal fluency task, it was 13.53. The median for the total number of correct responses on the cross-category alternating verbal fluency task was 19.50. The median for the total number of correct responses in the cross-language alternating verbal fluency task was 12.50. The SD for the total number of correct responses was 3.27 and 3.25 for the cross-category alternating verbal fluency task and cross-language alternating verbal fluency task respectively. The mean and median scores for the total number of correct responses were higher for cross-category alternating verbal fluency compared to cross-language alternating verbal fluency task in younger bilinguals.

In older bilinguals, the mean total number of correct responses on the cross-category alternating verbal fluency task was 17.16 whereas for the cross-language alternating verbal fluency task, it was 12.40. The median for the total number of correct responses on the cross-category alternating verbal fluency task was 17.00. The median for the total number of correct responses in the cross-language alternating verbal fluency task was 13.00. The SD for the total number of correct responses was 3.98 and 2.66 for the cross-category alternating verbal fluency task and cross-language alternating verbal fluency task respectively. The mean and median scores for the total number of correct responses were higher for cross-category alternating verbal fluency compared to cross-language alternating verbal fluency task in older bilinguals.

In order to verify any significant difference in the performance of each group (younger and older bilinguals) across the two types of tasks i.e., cross-language alternating verbal fluency and cross-category alternating verbal fluency

(within group comparison), statistical analysis was carried out using Wilcoxon's signed rank test.

(i) Within younger bilinguals, on comparing the performance in cross-category alternating verbal fluency tasks with the cross-language alternating verbal fluency tasks, the |Z| score obtained was 4.587 and the corresponding p-value showed a significant difference ($p<0.05$).

(ii) Within older bilinguals, on comparing the performance in cross-category alternating verbal fluency tasks with the cross-language alternating verbal fluency tasks, the |Z| score obtained was 4.632 and the corresponding p-value showed a significant difference ($p<0.05$).

To summarize, the within-group comparison of each age group across the two types of tasks revealed that both younger and older bilinguals performed better in cross-category alternating verbal fluency compared to cross-language alternating verbal fluency task.

**4.6 Error analysis**

Both younger and older participants exhibited a very small rate of errors. As mentioned above, it was found from the Mann-Whitney U test that there was no significant difference ($p >0.05$) between the number of error responses of younger and older bilinguals in any of the tasks provided. Similar types of errors were found in both younger and older adults. Following are the observations made by the researcher with respect to the errors found in each task in both age groups.

**4.6.1 Task 1: Cross-category alternating verbal fluency in L1**

(i) Both younger and older bilinguals exhibited a relatively higher number of single incorrect responses when compared to the double incorrect responses.

(ii) The errors observed in this task were repetitions, substitution from another

category, substitution by L2 and omissions

(iii) Omissions were the most frequent error observed in cross-category alternating verbal fluency task in L1 in younger and older bilinguals.

**4.6.2 Task 2: Cross-category alternating verbal fluency in L2**

(i) Both age groups exhibited a relatively higher number of single incorrect responses when compared to the double incorrect responses.

(ii) The errors observed in this task were classified as repetitions, substitution from another category and omissions. Unlike task 1, substitutions from the other language (Malayalam) were not observed in any of the participants.

(iii) Omissions were the most frequent error observed in cross-category alternating verbal fluency task in L2 in younger and older bilinguals.

**4.6.3 Task 3: Cross-language forward alternating verbal fluency**

(i) The younger and older bilinguals exhibited a relatively higher number of single incorrect responses when compared to the double incorrect responses.

(ii) The errors observed in this task were repetitions, substitution from another category, substitution by translation equivalents, and omissions.

(iii) Omissions were the most frequent error observed in cross-language forward alternating verbal fluency task in both age groups.

**4.6.4 Task 4: Cross-language backward alternating verbal fluency**

(i) Both younger and older bilinguals exhibited a relatively higher number of single incorrect responses when compared to the double incorrect responses.

(ii) The errors observed in this task were repetitions, substitution by translation equivalents and omissions. Unlike the previous three tasks, substitutions from another category were not observed in this task in any of the age groups.

(iii) Omissions were the most frequent error observed in cross-language forward alternating verbal fluency task in both age groups.

In a nutshell, younger bilinguals outperformed older bilinguals in cross-category alternating verbal fluency tasks. Both groups exhibited similar performance in cross-language alternating verbal fluency tasks. Considering the within-group performances, both groups exhibited superior performance in cross-category alternating verbal fluency task compared to cross-language alternating verbal fluency task.

# CHAPTER V

# DISCUSSION

The current study sought to determine the influence of bilingualism and age on executive functions by utilizing alternating verbal fluency task. Participants of two age groups were recruited for the study i.e., younger bilinguals between 18 and 30 years and older bilinguals between 50 to 60 years. The performance of the participants was compared on two types of tasks i.e., cross-language alternating verbal fluency and cross-category alternating verbal fluency. The cross-language alternating verbal fluency task was performed separately in L1 and L2. The cross-category alternating verbal fluency task was done in forward (L1-L2) and backward conditions (L2-L1).

The first objective was to examine if there was any difference in the performance of younger and older bilinguals in cross-category alternating verbal fluency task in L1. It was inferred from the descriptive statistics that the mean and median scores for correct responses were higher for younger bilinguals compared to older bilinguals. The results of the Mann-Whitney U test indicated a |Z| score of 2.063 and the corresponding p-value showed a statistically significant difference ($p<0.05$) across the age groups in terms of the number of correct responses. There was no significant difference across the age groups with respect to the number of error responses ($|Z| =0.208$, $p>0.05$) in this task. In other words, younger bilinguals exhibited better performance in terms of the number of correct responses, however with respect to the number of error

responses, the difference was not statistically significant. This holds true for the comparison made across the groups in cross-category alternating verbal fluency in L1.

The second objective was to compare the performance of younger and older bilinguals in cross-category alternating verbal fluency task in L2. Similar to the first task, the mean and median scores for correct responses were higher for younger bilinguals compared to older bilinguals. On the Mann Whitney-U test, the |Z| score obtained was 2.619 and the corresponding p-value showed a significant difference ($p<0.05$) across the age groups in terms of the number of correct responses whereas there was no significant difference across the age groups with respect to the number of error responses ($|Z| =0.865$, $p>0.05$) in this task. Thus, the younger bilinguals outperformed the older bilinguals in terms of the number of correct responses and whereas the number of error responses was found to be similar in both the groups in cross-category alternating verbal fluency in L2.

The third objective was to investigate if there was any difference in the performance of younger and older bilinguals in cross-language forward alternating verbal fluency task. The results from the Mann Whitney-U test revealed that there was no statistically significant difference across the age groups in terms of the number of correct responses ($|Z| =1.154$, $p>0.05$) as well as in the number of error responses ($|Z| =0.981$, $p>0.05$) in this task. In other words, younger and older bilinguals exhibited similar performance in terms of the number of correct responses and the number of error responses in cross-language forward alternating verbal fluency.

The last objective was to compare the performance of younger and older bilinguals in cross-language backward alternating verbal fluency task. The results of the Mann Whitney-U test indicated that there was no statistically significant difference across the age groups in terms of the number of correct responses ($|Z| = 1.575$, $p > 0.05$) in this task. A similar trend was observed with respect to the error responses too ($|Z| = 0.0408$, $p > 0.05$). There was no significant difference across the age groups with respect to the number of error responses in this task. Thus, it was inferred that the younger and older bilinguals performed similarly in this task with respect to the number of correct responses and the number of error responses in cross-language backward alternating verbal fluency.

In addition to the pre-set objectives, the comparison of the performance of each group across cross-language alternating verbal fluency task and cross-category alternating verbal fluency task was also evaluated. The mean and median scores for the total number of correct responses were found to be higher for the cross-category alternating verbal fluency task compared to the cross-language alternating verbal fluency task in younger bilinguals. The within-group comparison of the performance of younger bilinguals across the two types of tasks using Wilcoxon's sign rank test revealed a $|Z|$ score of 4.587 and the corresponding p-value showed a significant difference ($p < 0.05$). Hence, the younger bilinguals performed better in cross-category alternating verbal fluency compared to cross-language alternating verbal fluency task.

On comparing the performance of older bilinguals across the two tasks, it was found that the mean and median scores for the total number of

correct responses were higher for the cross-category alternating verbal fluency task compared to the cross-language alternating verbal fluency task in older bilinguals. On performing Wilcoxon's signed rank test, the |Z| score obtained was 4.632 and the corresponding p-value showed a significant difference ($p<0.05$) between the two types of tasks. In other words, the older bilinguals showed better performance in cross-category alternating verbal fluency compared to cross-language alternating verbal fluency task.

The results of the study that age has an adverse impact on executive functions as observed from the cross-category alternating verbal fluency task is in line with the findings from the past where researchers have found that young bilinguals outperformed old bilinguals on executive functions. Deepak et al. (2021) conducted a study among adolescents, young adults, and older adults where the participants were required to perform an alternate semantic fluency task and an alternate phonemic fluency task in Malayalam. Results revealed that older adults performed poorer compared to younger adults.

The findings of the current study with respect to the cross-category alternating verbal fluency task are in consonance with the other studies that have employed other neuropsychological tests tapping several executive functions, including attention and inhibition. Tests that measure inhibition, such as the Stroop Test, have, for instance, shown that performance declines with age (Van der Elst et al., 2006; West & Alain, 2000). Similar results are also reported in the studies which have employed the Simon task (Bialystok et al., 2004; Van der Lubbe & Verleger, 2002). The negative impact of age on executive functions is further supported by studies that tested working

memory spans (Park et al., 2002) and tests measuring the potential to shift attention, such as the Trail Making test (Salthouse & Fristoe, 1995). The study conducted by Goral et al. (2015) on Spanish-English bilinguals employed the Simon task, the Trail Making test, and the month ordering test age. The results of this study, which indicated a negative correlation between performance in the three domains and age, are consistent with those of the present study.

There are also a couple of studies that contradict the negative impact of age on executive functions. In a study by Kousaie (2014) where young and older French/English bilinguals were tested on language tasks of executive function, including the Stroop task, Simon task, sustained attention to response (SART), and digit span tests, no linguistic group disparities were greater for older individuals than for younger adults in any of the cases. In the study by Luo, Luk & Bialystok, (2015), bilinguals of four age groups i.e., 7 years, 10 years, young adults, and older adults with respective mean ages of 20 and 70 were given category and letter fluency tests. Results demonstrated that verbal fluency performance improved as people aged from young children to younger adults but remained largely stable in older adults.

There are limited studies that have employed cross-language alternate verbal fluency as an index of executive functions to the best of our knowledge. In the present study, the results revealed that there was no significant difference between the performance of younger and older bilinguals in cross-language alternate verbal fluency in both forward and backward directions. Girija et al. (2022) conducted a study on neurotypical

native Malayalam speakers between 30 and 80 years of age. The participants were administered a generative naming task for which the results revealed that as the age advanced, the generative naming task showed a decreasing trend. The authors state that age-related deterioration in generative naming is more prominent beyond age 60 years. The current study recruited older participants in the age range of 50-60 years. This might be the reason no significant difference was seen between the younger and older bilinguals in the cross-language alternate verbal fluency task in the present study.

However, there are a couple of studies that have reported a significant difference between the performance of younger and older bilinguals in cross-language alternate verbal fluency as well. Calabria et al (2013) reported that younger, middle-aged and older highly-proficient bilinguals when tested on a language-alternating and a non-linguistic-alternating task exhibited age-related general slowing.

The findings of the current study that both younger and older bilinguals exhibited poorer performance in cross-language alternate verbal fluency compared to cross-category verbal fluency are in similar lines with results obtained in the study done by Ivanova et al. (2016) on Spanish-English bilinguals. Verbal fluency tasks were utilized in the study where the participants had to complete letter fluency task and semantic fluency task in each language and switch languages after each category. Bilinguals had fewer accurate responses after switching languages in the letter fluency test. Semantic fluency incursions were found to be higher in older bilinguals than in younger bilinguals.

The error analysis in the current study revealed that younger and older adults exhibited similar types of errors. In cross-category alternating verbal fluency in L1, the errors observed were repetitions, substitution from another category, substitution by L2, and omissions. Similar errors were observed in cross-category alternating verbal fluency in L2 too except that substitutions from the other language were not observed in this task. Repetitions, substitution by translation equivalents and omissions were the errors observed in both variants of cross-language alternate verbal fluency. In addition, substitutions from another category were observed in cross-language forward alternating verbal fluency but not in cross-language backward alternating verbal fluency. The number of single incorrect responses was found to be greater when compared to the double incorrect responses in all the tasks. With respect to the type of errors, omissions were more frequently observed across the four tasks in both younger and older bilinguals.

The earlier studies which employed error analysis on generative naming has been done on clinical population such as dementia. According to Rosen and Engle (1997), most repetitions also called perseverations arise due to constrictions in working memory capacity and self-monitoring. As a result, perseverations are observed to be more common among older persons (Ramage et al., 1999) and in persons with memory and executive impairments, such as Alzheimer's disease (Azuma, 2004). The substitutions from other categories otherwise known as intrusions arise due to deficiency in selection and judgment abilities (Itaguchi et al., 2022).

According to the review of the literature, the effect of age on verbal fluency was uneven. Additionally, there were contradictory results regarding the claim that as people age, their responses to executive function will alleviate. Only a few studies have reported significant age effects on alternating verbal fluency task. The results of the current study indicate that the cross-category alternate verbal fluency task is efficient enough to tap even the slight change in executive functions due to age in individuals older than 50 years. Nonetheless, such changes may not be detected in cross-language alternate verbal fluency tasks.

The older participants selected for the current study were of age 50 to 60 years since the executive functions in this age group are less explored. The earlier studies which aimed to examine the impact of age on executive functions have considered age groups greater than 60 years and have indicated a gradual deterioration in executive functions as measured through various non-linguistic and linguistic tasks, However, these studies have not explored the performance of older age groups in the task paradigm employed for the current study i.e. cross-category alternating verbal fluency in L1 and L2 as well as the cross-language alternating verbal fluency in the forward and backward direction. Hence the present study can be extended to bilinguals aged more than 60 years where executive functions have been shown to decline with age.

# CHAPTER V1

## SUMMARY AND CONCLUSION

Bilingualism is the capability of an individual to utilize two languages in daily life and can be regarded as a mental activity that is complex in nature. Even if bilinguals does not require to utilize both languages in an active manner for communication, their executive functions should be effective enough to enable the individuals to use the correct language in a fluent manner and to suppress the other language. Executive functioning encompasses a cluster of cognitive skills that make the most of finite cognitive resources for actions like inhibition, attention switching, and working memory. Older bilinguals often exhibit an alteration in their executive functions compared to younger bilinguals.

The current study aimed to examine the influence of bilingualism and age on executive functions by employing alternating verbal fluency task. Thirty younger bilinguals of the age range 18-30 years and thirty older bilinguals of the age range 50 -60 years were selected for the study. They were administered a self-rating proficiency questionnaire-LEAP Q and based on their ratings, they were identified as high or low-proficient bilinguals. Question 10 on LEAP-Q was considered for the same which included rating their proficiency on four domains: understanding, speaking, reading, and writing on a four-point rating scale**.** A participant was classified as a high-proficient bilingual if they received a score of 4 in the understanding domain and a minimum score of 3 in all the other domains i.e., speaking, reading and writing (Hickey, 2010).

All the participants were administered two types of alternating verbal fluency tasks i.e., cross-category alternating verbal fluency and cross-language

alternating verbal fluency. The cross-category alternating verbal fluency was administered in L1 and L2 separately. The cross-language alternating verbal fluency was done in both forward and backward directions. The number of correctly alternated pairs and the number of error responses were calculated for each of the tasks. These scores were tabulated and analyzed statistically using SPSS version 26.0. Statistical analysis was carried out in terms of between-group (younger and older bilinguals) and within-group (cross-category task and cross-language task) comparisons.

The first objective was to compare the performance of younger and older bilinguals in cross-category alternating verbal fluency task in L1. The descriptive statistics revealed that the mean and median scores for the number of correct responses were higher for younger bilinguals compared to older bilinguals. Since the data did not follow a normal distribution, the Mann-Whitney-U test was performed to investigate if there was any significant difference between the two groups in this task. The results of the Mann-Whitney-U test indicated a statistically significant difference across the age groups in terms of the number of correct responses. However, there was no significant difference across the age groups in the number of error responses.

The second objective was to compare the performance of younger and older bilinguals in cross-category alternating verbal fluency task in L2. It was inferred from the descriptive statistics that the mean and median scores for the number of correct responses were higher for younger bilinguals compared to older bilinguals. The data was not normally distributed and the Mann-Whitney-U test was performed to examine if there was any significant difference between the two groups in this task. Similar to task 1, the results of the Mann-Whitney-U

test in this task revealed a statistically significant difference across the age groups with respect to the number of correct responses. With respect to the number of error responses, there was no significant difference across the age groups.

The third objective was to compare the performance of younger and older bilinguals in cross-language forward alternating verbal fluency task. Descriptive statistics indicated that the mean and median scores for the number of correct responses were similar for younger bilinguals and older bilinguals. Since the data did not follow a normal distribution, the Mann-Whitney-U test was performed to identify if there was any significant difference between the two groups in this task. Unlike the previous tasks, the results of the Mann-Whitney-U test in the cross-language forward alternating verbal fluency task revealed that there was no statistically significant difference across the age groups in terms of the number of correct responses. A similar trend was observed for the number of error responses too i.e., there was no significant difference between the younger and older bilinguals in the number of error responses in this task.

The last objective was to compare the performance of younger and older bilinguals in cross-language backward alternating verbal fluency task. Descriptive statistics indicated that the mean and median scores for the number of correct responses were similar for younger bilinguals and older bilinguals. The data did not follow a normal distribution, hence Mann Whitney-U test was done to examine if there was any significant difference between the two age groups in this task. In similar lines with Task 3, the results of the Mann-Whitney-U test in cross-language backward alternating verbal fluency task revealed that there was no statistically significant difference across the age groups in terms of the number of correct responses as well as in the number of error responses.

In addition to the pre-set objectives, the within-group comparison of the performance of each age group across the two types of tasks was also evaluated. It was evident from the descriptive statistics that the mean and median scores for the total number of correct responses were higher for the cross-category alternating verbal fluency task compared to the cross-language alternating verbal fluency task in younger bilinguals. The results of Wilcoxon's signed rank test unveiled a significant difference across the two types of tasks in younger bilinguals.

Similar to the performance of the younger bilinguals, the older bilinguals exhibited higher mean and median scores for the total number of correct responses in the cross-category alternating verbal fluency task compared to the cross-language alternating verbal fluency task. According to the results of Wilcoxon's signed rank test, a significant difference was present across the two types of tasks in older bilinguals too.

The error analysis revealed similar types of errors in younger and older adults. In cross-category alternating verbal fluency in L1, the errors observed were repetitions, substitution from another category, substitution by L2 and omissions. Similar errors were observed in cross-category alternating verbal fluency in L2 too except that substitutions from the other language were not observed in this task. Errors such as repetitions, substitution by translation equivalents and omissions were observed in both variants of cross-language alternate verbal fluency. Substitutions from another category were observed in cross-language forward alternating verbal fluency but not in cross-language backward alternating verbal fluency. In all tasks, the number of single incorrect responses was found to be greater when compared to the double incorrect

responses. Out of the errors seen, omissions were more frequently observed in all the tasks.

In a nutshell, it can be observed that the older bilinguals exhibited poorer performance in cross-category alternating verbal fluency tasks in L1 and L2 when compared to younger bilinguals with respect to the number of correct responses. Both the groups performed in a similar manner in cross-language forward alternate verbal fluency and cross-language backward alternate verbal fluency task. Also, both younger and older bilinguals exhibited poorer performance in cross-language alternate verbal fluency task when compared to cross-category alternate verbal fluency task.

Hence it can be concluded that age has a negative effect on executive functions in `bilinguals as observed from cross-category alternating verbal fluency task. However, the similar performance of the older bilinguals and younger bilinguals in cross-language alternating verbal fluency tasks point to the fact that this deterioration cannot be generalized across all tasks for the age range 50- 60.

**The clinical implications of the present study**

1. The majority of the research on the language abilities of bilinguals has placed the focus on either their L1 or L2 performance. The performance of bilinguals across the languages is less explored in the Indian scenario. The present study enables researchers to compare the performance of bilinguals in each language as well as their ability to alternate between the languages.
2. The study provides an understanding of how language and executive functions interact with each other. It helps in analyzing the linguistic

performance of individuals with respect to task planning, task execution, task switching, conflict monitoring, and conflict resolution. The current study could be used to design an assessment tool for assessing cognitive flexibility in typical and atypical bilingual populations. The findings of the study could also be used to design an intervention procedure for bilinguals with language disorders that uses alternate verbal fluency tasks to work on improving executive functions.

3. The study compares the younger and older bilinguals' performance in language and executive functions. Most of the earlier studies that explored the differences due to age in language and executive functions of bilinguals were done on older age groups greater than 60 years. This study helps to understand the cognitive performance in adults aged 50-60. It gives an insight into the effect of age on alternating verbal fluency performance between categories as well as between languages, and this knowledge can be applied in clinical settings while assessing bilinguals across different age groups.

**Limitations of the present study**

1. All four tasks employed in the current study were variants of semantic fluency. Phonemic fluency was not considered in the present study.
2. The groups were not balanced on the basis of bilingual proficiency.
3. The current study tapped the executive functions in general, specific executive functions were not looked into.

**Future directions**

1. Older age groups greater than 60 years can be included in future studies

to compare the performance of younger, middle-aged, and older bilinguals in alternate verbal fluency tasks.

2. The performance of bilinguals in alternate phonemic verbal fluency across various age groups can be explored.
3. The study can be extended to senile populations like Mild Cognitive Impairment and Dementia.

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# APPENDIX

Question No. 10 in LEAP Q (Ramya & Goswami,2009) which was used to self-rate the bilingual proficiency.

On a scale from one to five, mark your level of proficiency in each of the skill (1-Zero proficiency, 2- Low, 3- Good, 4- Native like/perfect)

| Language | Understanding | Speaking | Reading | Writing |
|---|---|---|---|---|
| L1 | | | | |
| L2 | | | | |