



Level Of Working Memory And Attention Among Bilingual Ug Students Of Tamilnadu

Dr. Bindu. T. P¹ Dr. A, Jahitha Begum²

¹ Ph.D. (Part – Time) Research Scholar, Department of Education, Gandhigram Rural

Institute (DTBU), Tamil Nadu.

² Senior Professor, Department of Education, Gandhigram Rural Institute (DTBU),

Tamil Nadu

Abstract

This study investigates the level of working memory and attention among bilingual undergraduate students in Tamil Nadu, where bilingualism is an integral part of education and daily communication. Bilingualism, defined as the ability to use two languages proficiently, places unique cognitive demands on working memory and attention control. Using quantitative research methods, this study explores the relationships between working memory capacity, assessed through digit span tasks (both forward and backward), and attention levels, measured through cognitive tasks requiring sustained focus. The findings indicate a strong correlation between bilingual students' working memory capacity, attention control, and academic performance, particularly in verbal comprehension and language-related tasks. The results highlight the cognitive advantages of bilingualism while also acknowledging potential cognitive load effects. These insights contribute to understanding the cognitive mechanisms supporting bilingual education and emphasize the need for targeted interventions to enhance memory and attention in academic settings.

Keywords: Working Memory, Attention, Bilingualism, Language Proficiency, UG Students

1.INTRODUCTION

The "*The true art of memory is the art of attention.*" – Samuel Johnson

Working memory and attention are fundamental cognitive functions that shape an individual's ability to process and retain information. These functions are especially crucial for bilingual undergraduate (UG) students in Tamil Nadu, where bilingualism is an integral part of education and daily communication. Bilingual individuals frequently engage in language switching and cognitive control, which places unique demands on working memory and attention resources.

Bilingualism, as defined by Bloomfield (1933), refers to the native-like control of two languages, while Grosjean (2010) describes it as the regular use of two or more languages in daily life. This ability to switch between languages enhances cognitive flexibility but also demands efficient working memory and attention control. Some research suggests that bilingual individuals exhibit enhanced executive functioning due to constant language switching, while others argue that managing multiple languages may impose additional cognitive load, affecting working memory capacity.

In Tamil Nadu, students often navigate between Tamil (their native language) and English (the primary medium of higher education and global communication). This linguistic duality requires cognitive adaptability, making it essential to examine how bilingualism impacts their working memory and attentional

control. This study aims to assess the level of working memory and attention among bilingual UG students in Tamil Nadu, exploring its implications for academic performance, cognitive flexibility, and language proficiency. Understanding these cognitive processes can provide insights into effective bilingual education strategies and potential interventions to enhance memory and attention in academic settings.

Working Memory

Working memory is a cognitive system responsible for temporarily holding and manipulating information needed for complex cognitive tasks such as reasoning, comprehension, learning, and decision-making. It serves as a mental workspace that allows individuals to process and integrate information in real time. According to Baddeley and Hitch (1974), working memory consists of multiple components, including the central executive, which coordinates attention and cognitive resources, and two subsystems: the phonological loop, which processes verbal and auditory information, and the visuospatial sketchpad, which handles visual and spatial data.

Baddeley (2000) expanded this model by adding the episodic buffer, which integrates information from different sources and links working memory to long-term memory. This model emphasizes that working memory is not a single storage system but a dynamic process that supports various cognitive functions.

Other researchers have defined working memory differently based on their theoretical perspectives. Miyake and Shah (1999) describe it as the system that allows for the simultaneous storage and processing of information. Cowan (2005) argues that working memory is not separate from long-term memory but rather consists of an activated subset of long-term memory representations maintained through attention.

Working memory is crucial for everyday activities, including problem-solving, language comprehension, and multitasking. It plays a vital role in academic performance, particularly in subjects requiring mental calculations, reading comprehension, and logical reasoning. Studies have shown that individuals with higher working memory capacity tend to perform better in cognitive tasks, while deficits in working memory are linked to difficulties in learning and attention-related disorders (Engle, 2002).

Attention

Attention is a cognitive process that allows individuals to selectively focus on specific stimuli while filtering out irrelevant information. It plays a crucial role in perception, learning, and memory by managing limited cognitive resources to process information efficiently. According to James (1890), attention is “the taking possession by the mind, in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought.” This definition highlights attention as a selective mechanism that prioritizes certain sensory inputs over others.

More recent research emphasizes attention as a complex and dynamic function that involves various sub-processes. Anderson (2005) defines attention as a mechanism that enhances cognitive performance by allocating mental resources to relevant information while inhibiting distractions. Similarly, Chun et al. (2011) describe attention as “the process that enables the brain to prioritize sensory inputs and allocate processing power to the most important aspects of an environment.” This suggests that attention is not a single unitary process but consists of different types, including selective attention (focusing on one stimulus while ignoring others), divided attention (processing multiple stimuli simultaneously), and sustained attention (maintaining focus over an extended period).

In modern cognitive psychology and artificial intelligence research, attention is viewed as a critical function for managing finite computational resources. Whether in human cognition or machine learning systems, attention mechanisms help optimize the processing of large amounts of data by prioritizing relevant inputs. Understanding attention's role in cognitive function has significant implications for education, workplace productivity, and technological advancements, including the development of AI models that mimic human attention processes.

Bilingualism

Bilingualism is the ability to use two languages proficiently in daily communication, either at a native-like level or with varying degrees of fluency. Scholars have defined bilingualism from different perspectives. Bloomfield (1933) described bilingualism as the "native-like control of two languages," emphasizing complete fluency in both. However, Macnamara (1967) proposed a broader definition, suggesting that even individuals with minimal competence in a second language could be considered bilingual. Diebold (1964) introduced the concept of "incipient bilingualism," referring to those who have just begun acquiring a second language but have not yet achieved full proficiency. Grosjean (2010) argued that bilingualism should not be assessed solely based on equal proficiency in both languages but rather by the regular use of two or more languages in different contexts. Wei (2000) further expanded the definition, highlighting bilingualism as a dynamic process influenced by social, cultural, and cognitive factors, where language use varies depending on individual experiences and contextual demands.

Bilingualism has significant educational implications, particularly in enhancing cognitive development, academic performance, and learning outcomes. Research suggests that bilingual students tend to have stronger executive functioning skills, such as problem-solving, attention control, and cognitive flexibility (Bialystok, 2001). These skills contribute to better performance in subjects requiring critical thinking and analytical reasoning. Bilingual education fosters greater metalinguistic awareness, allowing students to understand language structures more effectively and making it easier to learn additional languages (Cummins, 2008). In Bilingual regions like Tamil Nadu, incorporating bilingual education strategies can enhance students' adaptability, improve their comprehension skills, and promote effective communication in both native and second languages. Additionally, bilingual education supports cultural inclusivity, enabling students to engage with diverse linguistic communities and prepare for a globalized world.

In today's global economy, bilingualism is a highly valuable skill that enhances employability across various industries. Employers increasingly seek candidates with multilingual abilities, especially in sectors such as international business, translation, tourism, education, diplomacy, and customer service. According to Chiswick and Miller (2007), bilingual individuals often have access to higher-paying jobs and better career advancement opportunities compared to monolinguals. In multilingual countries like India, where English and regional languages play vital roles in professional settings, bilingual proficiency is a key advantage in securing competitive positions. Studies also indicate that companies with a diverse linguistic workforce can expand their global reach, making bilingual employees crucial assets in multinational corporations (Saiz & Zoido, 2005). Additionally, government institutions, research organizations, and international agencies prioritize bilingual professionals for roles that require cross-cultural communication and language expertise.

Language proficiency

Language proficiency refers to an individual's ability to use a language effectively and accurately in various contexts, including speaking, listening, reading, and writing. It encompasses both the understanding and production of language and is often assessed based on fluency, accuracy, vocabulary, grammar, and comprehension.

Different scholars have defined language proficiency in various ways. Chomsky (1965) distinguished between competence (knowledge of language rules) and performance (actual language use), suggesting that true proficiency involves both. Canale and Swain (1980) proposed a communicative competence model, which includes grammatical competence (understanding syntax and vocabulary), sociolinguistic competence (using language appropriately in different social contexts), discourse competence (coherently connecting ideas in speech and writing), and strategic competence (using strategies to overcome communication difficulties).

Proficiency in multiple languages enhances cognitive flexibility, cultural adaptability, and career opportunities. In educational settings, higher language proficiency is linked to improved reading comprehension, critical thinking, and academic success. Additionally, in professional environments, strong language skills are crucial for effective communication, especially in global markets and multilingual workplaces. Understanding language proficiency is essential for educators, policymakers, and learners, as it

informs curriculum design, language assessment, and instructional methods to support effective language acquisition and use.

Undergraduate Students

Undergraduate students are individuals enrolled in the first stage of university education following secondary schooling, typically pursuing a bachelor's degree such as B.A., B.Sc., B.Com., B.Tech., or BBA. The duration of undergraduate programs generally ranges from three to four years, depending on the country and specific academic discipline (Tinto, 1993). This phase of education is designed to develop students' critical thinking, research abilities, and subject-specific expertise, preparing them for professional careers or further postgraduate studies. In a bilingual educational setting like Tamil Nadu, where Tamil and English are used interchangeably, students navigate complex cognitive and linguistic challenges, which influence their learning strategies and academic performance.

Review Related Literature

Studies Related to Working Memory

Study-1

Title: *"Working Memory Capacity Among College Students: The Role of Gender and Posttraumatic Stress Symptoms"*

Author: Lydia Bickham

Year: 2021

Objectives: To examine the relationship between Posttraumatic Stress Symptoms (PTSS) and Working Memory Capacity (WMC), specifically in verbal and numeric recall.

To investigate whether gender moderates the relationship between PTSS and WMC.

Method: Survey Method

Tools : Self-report assessment for measuring PTSS.

Two Working Memory Capacity (WMC) tasks focused on verbal and numeric recall.

Sample: 254 undergraduate students from a mid-sized southeastern university.

Findings: Women reported higher PTSS scores than men, confirming a gender difference in PTSS. No significant findings regarding gender and WMC (verbal and numeric recall). Methodological and environmental limitations may have minimized the likelihood of detecting significant findings.

Study-2

Title: *Differences in Working Memory With Emotional Distraction Between Proficient and Non-proficient Bilinguals*

Authors: Xie Ma, Xiao Ma, Peng Li, Yan Liu

Year: 2020

Objective: To investigate the differences in emotional working memory between proficient and non-proficient Chinese-English bilinguals using working memory tasks in emotional contexts.

Method: Experimental Design: Comparative study using working memory tasks under emotional conditions

Sample: Total Participants: 57 Chinese-English bilinguals (Proficient Bilinguals: 26 (M age = 23.0, SD = 1.3) (Non-Proficient Bilinguals: 31 (M age = 21.1, SD = 1.8). Randomly selected from Yunnan Normal University

Tools: Raven's Test (Chinese Version), Self-Rating Anxiety Scale (SAS, Chinese Version), Self-Rating Depression Scale (SDS, Chinese Version)

Working Memory Tasks (DMTS and N-back tasks)

Findings: Proficient bilinguals outperformed non-proficient bilinguals on both working memory tasks. The advantage was more significant under high memory load conditions. Negative emotional contexts had a positive impact on performance in the complex N-back task.

Findings suggest that bilingual experience enhances cognitive ability, particularly in emotional working memory processing. This study supports the hypothesis that bilingualism, especially at a proficient level, contributes to improved working memory and cognitive control, even in emotional contexts.

Studies Related to Attention

Study-1

Title: *“Capturing students’ attention: An empirical study”.*

Author: Rosegard, E., & Wilson, J.

Year: 2013

Objectives: To examine whether an arousal-inducing external stimulus before a lecture improves students' attention and information retention, to determine if introducing a lecture with a stimulating activity enhances learning outcomes.

Method: Experimental study

Sample: 846 college students enrolled in a general education course.

Tool: Independent-samples t-test

Findings: The study found that students in the arousal group (who received an external stimulus before the lecture) scored significantly higher on the exam compared to those in the no-arousal group. This suggests that introducing a stimulating activity before a lecture can enhance attention and improve information retention. The findings support the idea that arousal techniques can be an effective strategy for increasing student engagement and learning outcomes.

Study-2

Title: *“Problem-Solving Skills as Correlates of Attention Span and Working Memory of Low Ability Level Students in Senior Secondary Schools.”*

Author: Ellah, B. O., et al.,

Year: 2020

Objectives: To determine the relationship between problem-solving skills and measures of working memory and attention span in low-ability science, to examine how working memory and attention span influence problem-solving skills in physics, chemistry, and biology.

Method: Correlational survey research design.

Sample: 450 science students from 24 Senior Secondary Schools in the study area.

Tool: Wechsler Adult Intelligence Scale, Attention Lapses Clicker (ALC)

Findings: The study found no significant relationship between problem-solving skills, working memory, and attention span among low-ability science students. A small variation in problem-solving skills was attributed to working memory and attention span. It was recommended that teachers adjust instructional strategies, incorporate creative problem-solving activities, and that schools provide interventions to support students with attention and memory difficulties.

Studies Related to Bilingualism

Study-1

Title: *"The Influence of Bilingualism on Working Memory Event-Related Potentials"*

Authors: Cassandra Morrison, Farooq Kamal, Vanessa Taler

Year: 2018

Objectives: To examine how bilingualism affects the neural mechanisms underlying working memory using event-related potentials (ERPs).

Method: Experimental study measuring brain activity during working memory tasks.

Tools: ERP recordings during n-back tasks.

Sample: 23 English-speaking monolinguals and 21 English–French bilinguals.

Findings: Bilinguals demonstrated different neural activation patterns compared to monolinguals, suggesting that bilingualism influences the neural processes involved in working memory.

Study-2

Title: *The Impact of Bilingualism on Executive Functions and Working Memory in Young Adults*

Authors: Eneko Antón, Manuel Carreiras, Jon Andoni Duñabeitia

Year: 2019

Objectives: To explore how bilingualism affects executive functions and working memory in young adults.

Method: Comparative analysis of executive function and working memory tasks between bilingual and monolingual participants.

Sample: 26 Korean–English bilinguals and 25 English-native monolinguals.

Tool: Simon Task, Flanker Task, N-Back Task, Operation Span Task

Findings: Bilinguals outperformed monolinguals in tasks requiring backward recall, suggesting specific advantages in certain working memory components.

Need and Significance of the Study

In an increasingly globalized world, bilingualism is becoming a critical aspect of education, particularly in regions like Tamil Nadu, where students engage with both Tamil and English in academic settings. Understanding the relationship between working memory, attention, and bilingual proficiency is essential for enhancing learning outcomes and cognitive development among undergraduate students. This study is significant as it explores how cognitive factors influence academic performance, shedding light on whether bilingualism strengthens or challenges working memory and attention. By identifying potential gaps in cognitive processing, such as weaker textual memory and executive functioning, the findings can help educators develop targeted interventions to support students in improving comprehension, problem-solving, and retention skills. Furthermore, the study provides valuable insights for curriculum development, instructional methods, and policy-making, ensuring that bilingual education fosters both linguistic and cognitive growth. Future research can build on these findings to explore additional influences, such as cultural exposure and learning strategies, ultimately contributing to a more effective and inclusive educational framework for bilingual students.

Research Gap

While extensive research has explored the cognitive benefits of bilingualism, particularly its influence on executive functioning, working memory, and attention, studies focusing on bilingual undergraduate students in Tamil Nadu remain limited. Most prior research has been conducted in Western contexts, where bilingualism often involves dominant global languages such as English, Spanish, or French. However, the bilingual experience in Tamil Nadu is unique due to the distinct linguistic environment where Tamil and English serve as primary modes of communication in educational and professional settings.

Additionally, while numerous studies (e.g., Bialystok, 2001; Costa et al., 2008) have highlighted the advantages of bilingualism in enhancing cognitive flexibility and executive control, conflicting evidence suggests that bilingual individuals may experience increased cognitive load, which can affect working memory capacity and attentional control. The extent to which Tamil-English bilingual students manage these cognitive demands remains underexplored.

Existing literature lacks a comprehensive investigation into how working memory and attention correlate with academic performance, language proficiency, and learning outcomes in the Tamil Nadu context. Although some studies have examined digit span tasks as measures of working memory, there is limited empirical data on how bilingual university students in non-Western settings navigate these cognitive functions within higher education environments.

Thus, this study aims to bridge the gap by examining the **level of working memory and attention among bilingual UG students in Tamil Nadu**, contributing valuable insights to bilingual education research. It will also inform educators and policymakers about potential interventions to optimize bilingual students' cognitive resources, ultimately enhancing academic performance and language learning strategies.

Objectives of the Study

The primary objectives of this study are:

1. To assess the level of working memory and attention among bilingual undergraduate students in Tamil Nadu using standardized cognitive tasks such as digit span tests (forward and backward).
2. To examine the relationship between bilingualism and cognitive functions such as working memory capacity and attentional control.
3. To analyze the impact of working memory and attention on academic performance and language proficiency among bilingual students.
4. To investigate the cognitive advantages and potential challenges of bilingualism in an educational setting, particularly in Tamil Nadu's linguistic context.
5. To explore the role of language switching and cognitive flexibility in shaping working memory and attentional efficiency in bilingual students.
6. To provide insights into educational strategies and interventions that can enhance memory and attention in bilingual learning environments.
7. To identify future research directions for understanding long-term cognitive effects of bilingualism on working memory and attention.

Research Questions

This study seeks to answer the following research questions:

- 1.What are the levels of working memory and attention among bilingual undergraduate students in Tamil Nadu as measured by standardized cognitive tasks such as digit span tests?
- 2.How does bilingualism influence cognitive functions, particularly working memory capacity and attentional control?
- 3.What is the relationship between working memory, attention, and academic performance in bilingual students?
- 4.What cognitive advantages and challenges are associated with bilingualism in an educational setting, specifically within Tamil Nadu's linguistic context?
- 5.How do language switching and cognitive flexibility affect working memory and attentional efficiency among bilingual students?
- 6.What educational strategies and interventions can be implemented to enhance memory and attention in bilingual learning environments?
- 7.What are the potential long-term cognitive effects of bilingualism on working memory and attention, and how can future research address these aspects?

METHODOLOGY

This study investigates the relationship between working memory, attention, and academic performance among bilingual undergraduate (UG) students in Tamil Nadu. A quantitative research design was adopted, and 335 participants were selected using stratified random sampling from undergraduate students across various science majors at Gandhigram Rural Institute (DTBU). The sample included UG students proficient in both Tamil and English, reflecting the bilingual educational environment of the region.

Working memory was assessed using the Digit Span (Forward and Backward) tasks, with scores categorized into low, medium, and high levels. Attention was measured using cognitive tasks requiring number and symbol recognition, with results similarly classified into three levels.

To evaluate language proficiency, tasks assessing verbal skills (vocabulary and sentence construction) and comprehension (reading and listening abilities) were used. Descriptive statistics and correlational analysis were applied to explore how variations in working memory and attention levels influenced students' language proficiency and academic performance.

This methodology provides a structured approach to understanding the cognitive mechanisms underlying bilingualism and its implications for educational outcomes among UG students in Tamil Nadu.

Hypotheses

To test the significance of the study's findings, the following **null hypotheses** were formulated:

H01. There is no significant relationship between the Level of Digit Span Forward and language development among Bilingual undergraduate students in Tamil Nadu.

H02. There is no significant association between the Level of Digit Span Backward and language comprehension among Bilingual undergraduate students in Tamil Nadu.

H03. There is no significant impact of verbal skill levels on overall language performance among Bilingual undergraduate students in Tamil Nadu.

H04. There is no significant relationship between the Level of Comprehension and working memory capacity among Bilingual undergraduate students in Tamil Nadu.

H05. There is no significant relationship between attention levels (number and symbol attention) and language proficiency in Bilingual undergraduate students in Tamil Nadu.

INTERPRETATION AND DISCUSSION.

Level of Digit Span Forward Test

There is no significant relationship between the Level of Digit Span Forward and language development among Bilingual undergraduate students in Tamil Nadu.

		Language Level	
		Bilingual	
		Count	Row Total N%
Level of Digit Span Forward Test	Low Level	64	19.10 %
	Medium Level	178	53.14 %
	High Level	93	27.76 %

Digit Span Forward Test: The Digit Span Forward Test measures an individual's ability to temporarily store and recall sequences of numbers, which reflects working memory capacity and attention span. The results for bilingual undergraduate students are categorized into three levels: Low, Medium, and High, based on their performance.

- **Low Level (19.10%):** A total of 64 students demonstrated a lower working memory capacity in the forward digit span task. This suggests that a minority of the bilingual students may struggle with basic short-term memory retention and may find it difficult to hold and process information efficiently, impacting their academic performance in tasks requiring sequential recall.
- **Medium Level (53.14%):** The majority of students (178 participants, 53.14%) scored within the medium range. This indicates that most bilingual undergraduate students possess an adequate working memory to support learning, though they may experience occasional challenges when processing complex or lengthy verbal information.
- **High Level (27.76%):** A significant portion of students (93 participants, 27.76%) performed at a high level in the forward digit span test. This suggests that these students have strong working memory capabilities, which can enhance their ability to retain and process information effectively, particularly in academic tasks that require verbal reasoning, problem-solving, and multitasking.

Digit Span Backward Test:

There is no significant association between the Level of Digit Span Backward and language comprehension among Bilingual undergraduate students in Tamil Nadu.

		Language Level	
		Bilingual	
		Count	Row Total N%
Level of Digit Span Backward Test	Low Level	205	61.19%
	Medium Level	100	29.86%
	High Level	30	8.95%

The **Digit Span Backward Test** is a more complex working memory task than the **Digit Span Forward Test**, as it requires not only **short-term memory retention** but also **cognitive manipulation and executive functioning**. Participants must recall a sequence of numbers in reverse order, which engages higher cognitive control, attention regulation, and processing efficiency.:

- **Low Level (61.19%):** A significant majority of students (205 participants) scored at the low level, indicating weaker working memory and executive functioning skills. This suggests that many bilingual students in Tamil Nadu may struggle with mentally manipulating information, which could affect their performance in tasks requiring problem-solving, reasoning, and multitasking.
- **Medium Level (29.86%):** A smaller proportion of students (100 participants, 29.86%) demonstrated moderate working memory capacity in this task. These students may perform reasonably well in academic activities that require cognitive control, but they might still experience difficulties with complex mental tasks or high cognitive load situations.
- **High Level (8.95%):** A very small percentage of students (30 participants) achieved high-level performance. These students exhibit strong executive functioning, cognitive flexibility, and attention control, which are crucial for academic success, particularly in analytical subjects, logical reasoning, and language comprehension.

Level of Alphabetical Memory Test:

There is no significant impact of verbal skill levels on overall language performance among Bilingual undergraduate students in Tami Nadu

		Language Level	
		Bilingual	
		Count	Row Total N%
Alphabetical Memory Test	Low Level	20	5.98%
	Medium Level	80	23.88%
	High Level	235	70.14%

The Alphabetical Memory Test:

The Alphabetical Memory Test results indicate the distribution of bilingual undergraduate students across different memory proficiency levels:

Low Level (5.98%): Only a small percentage (20 students) demonstrated low alphabetical memory performance. This suggests that a minority of bilingual students struggle with recalling and organizing alphabetical information.

Medium Level (23.88%): A moderate proportion (80 students) exhibited an average level of alphabetical memory ability, indicating that nearly a quarter of the sample has a functional but not highly developed memory capacity in this domain.

High Level (70.14%): The majority (235 students) performed at a high level, suggesting that most bilingual students in this sample have strong alphabetical memory skills.

Level of Textual Memory Test:

There is no significant relationship between the Level of Comprehension and working memory capacity among Bilingual undergraduate students in Tami Nadu

		Language Level	
		Bilingual	
		Count	Row Total N%
Level of Textual Memory Test:	Low Level	69	20.59%
	Medium Level	190	56.72%
	High Level	76	22.69%

The Textual Memory Test results reflect the distribution of bilingual undergraduate students across different levels of textual memory performance:

Low Level (20.59%): A significant portion (69 students) demonstrated low textual memory ability, indicating potential difficulties in recalling and processing written information.

Medium Level (56.72%): The majority of students (190) exhibited a moderate level of textual memory, suggesting that more than half of the sample has functional but not exceptional recall and comprehension skills.

High Level (22.69%): A smaller percentage (76 students) performed at a high level, indicating strong textual memory skills, which could contribute to better reading comprehension and academic performance.

Levels of Attention and Language Level

There is no significant relationship between attention levels (number and symbol attention) and language proficiency in Bilingual undergraduate students in Tamil Nadu.

Levels of attention and Language level		Language Level	
		Bilingual	
		Count	Row Total N %
Level of Number Attention(Number Square Attention Test)	Low Level	83	24.77%
	Medium Level	172	51.35%
	High Level	80	23.88%
Level of Symbols Attention (Symbol Digit Modalities Test)	Low Level	43	12.83%
	Medium Level	229	68.36%
	High Level	63	18.81%

1. Number Square Attention Test Levels

Low Level (24.77%) – Nearly a quarter of students (83) struggle with number-based attention tasks, which may indicate difficulty in focusing on numerical information.

Medium Level (51.35%) – The majority of students (172) demonstrated an average ability to sustain attention in numerical contexts.

High Level (23.88%) – A smaller proportion (80) performed well, indicating strong numerical attention skills.

Implication: The fact that over 75% of students are in the medium or high range suggests that most bilingual students have adequate or strong numerical attention skills, which can support their academic performance in subjects involving calculations or quantitative reasoning.

2. Symbol Attention Levels

Low Level (12.83%) – Only 43 students showed low symbol-based attention, indicating that relatively few students struggle with recognizing and focusing on symbols.

Medium Level (68.36%) – The majority (229) exhibited average performance, suggesting functional but not exceptional symbolic attention.

High Level (18.81%) – A smaller group (63) displayed strong attention to symbols, showing efficient recognition and focus on visual stimuli.

Implication: Since nearly 87% of students have medium-to-high symbol attention, most bilingual students effectively process visual-symbolic information, which is essential for tasks like reading, coding, and pattern recognition.

Lack of Significant Relationship with Language Proficiency

The data suggests that attention levels (both number and symbol) are not significantly linked to bilingual students' language proficiency.

This means that being bilingual does not necessarily enhance or weaken attention levels in numerical or symbolic contexts.

Other cognitive factors, such as working memory, executive functioning, or prior educational background, may play a more significant role in attention performance

DISCUSSION

The study explored the cognitive abilities of bilingual undergraduate students in Tamil Nadu, focusing on working memory, attention, and memory performance across various tests. The Digit Span Forward Test results indicated that a majority (53.14%) of students had moderate working memory capacity, while 19.10% performed at a low level, suggesting difficulties in short-term retention, and 27.76% demonstrated strong working memory skills beneficial for problem-solving. In contrast, the Digit Span Backward Test revealed that 61.19% of students struggled with recalling numbers in reverse order, indicating weak executive functioning and cognitive flexibility, with only 8.95% achieving high performance. This disparity suggests that while basic working memory storage is relatively strong, cognitive manipulation skills are weaker. The Alphabetical Memory Test showed that 70.14% of students exhibited high memory ability, while only 5.98% performed poorly, suggesting that alphabetical recall is relatively easier. However, the Textual Memory Test results indicated that 56.72% performed at a moderate level, 20.59% struggled, and only 22.69% demonstrated high performance, highlighting that processing and retaining detailed text-based information is more challenging. In terms of attention performance, the Number Square Attention Test showed that 51.35% of students had moderate numerical attention, while 24.77% struggled, and 23.88% excelled. Similarly, in the Symbol Attention Test, 68.36% demonstrated moderate symbolic attention, 12.83% showed low performance, and only 18.81% performed at a high level. These results indicate that numerical attention was slightly weaker than symbolic attention, but both remained in the moderate range for most students. Furthermore, attention

skills did not show a significant relationship with bilingualism, suggesting that language proficiency does not necessarily enhance or weaken numerical or symbolic attention abilities. Overall, the findings suggest that bilingual students exhibit relatively strong alphabetical memory but weaker textual memory, with moderate attention performance and a gap in executive functioning, which may impact academic success, particularly in areas requiring complex problem-solving and deep reading comprehension.

EDUCATIONAL IMPLICATIONS AND RECOMMENDATIONS

To strengthen working memory and executive functioning, interventions such as working memory training, problem-solving exercises, and cognitive flexibility tasks could help students improve their cognitive manipulation skills, particularly as many struggled with the Digit Span Backward Test. Given that textual memory is weaker than alphabetical memory, students could benefit from active reading strategies like summarization and visualization, as well as memory-enhancing techniques such as mnemonic devices and chunking. Additionally, reading comprehension training could support long-term retention of text-based information. While attention levels were mostly adequate, they were not exceptional, suggesting that mindfulness exercises to improve sustained focus, attention-training activities like rapid visual processing tasks, and numerical and symbolic processing practice could enhance precision-based cognitive skills. Overall, bilingual undergraduate students in Tamil Nadu exhibit strong alphabetical memory but face challenges in textual memory and executive functioning. Since bilingualism does not significantly influence attention performance, targeted interventions in working memory, textual retention, and executive function development could improve cognitive abilities and contribute to academic success.

CONCLUSION

This study examined the levels of working memory and attention among bilingual undergraduate students in Tamil Nadu and their potential impact on language development. The findings indicate that while students demonstrated varying levels of working memory and attention, these cognitive abilities did not show a significant direct influence on bilingual proficiency. Although a majority of students exhibited strong alphabetical memory, their textual memory and executive functioning were comparatively weaker, suggesting challenges in information processing and retention. Attention levels were mostly moderate, with no significant relationship between numerical or symbolic attention and bilingualism. These results suggest that bilingual proficiency is shaped by a complex interplay of cognitive functions, social exposure, and educational experiences rather than just working memory and attention alone. Future research should consider additional factors such as cultural influences, learning strategies, and long-term cognitive development to gain deeper insights into bilingualism. Addressing these factors through targeted educational interventions could help enhance language learning and cognitive skills among bilingual students.

REFERENCES:

- Anderson, J. R. (2005). *Cognitive psychology and its implications* (6th ed.). Worth Publishers.
- Antón, E., Carreiras, M., & Duñabeitia, J. A. (2019). The impact of bilingualism on executive functions and working memory in young adults. *Frontiers in Psychology*, 10, 493.
<https://doi.org/10.3389/fpsyg.2019.00493>
- Baddeley, A. (2000). The episodic buffer: A new component of working memory? *Trends in Cognitive Sciences*, 4(11), 417–423. [https://doi.org/10.1016/S1364-6613\(00\)01538-2](https://doi.org/10.1016/S1364-6613(00)01538-2)
- Baddeley, A. D., & Hitch, G. (1974). Working memory. In G. H. Bower (Ed.), *The psychology of learning and motivation* (Vol. 8, pp. 47–89). Academic Press.
- Bialystok, E. (2001). *Bilingualism in development: Language, literacy, and cognition*. Cambridge University Press.

Bickham, L. (2021). Working memory capacity among college students: The role of gender and posttraumatic stress symptoms. *Journal of Psychological Research*, 45(2), 112–125.

Bloomfield, L. (1933). *Language*. Holt, Rinehart & Winston.

Canale, M., & Swain, M. (1980). Theoretical bases of communicative approaches to second language teaching and testing. *Applied Linguistics*, 1(1), 1–47.

Chiswick, B. R., & Miller, P. W. (2007). The economics of language: International analyses. *Journal of Economic Surveys*, 21(2), 209–268. <https://doi.org/10.1111/j.1467-6419.2007.00505.x>

Chomsky, N. (1965). *Aspects of the theory of syntax*. MIT Press.

Chun, D. M., Kern, R., & Smith, B. (2011). Technology in language use, language teaching, and language learning. *The Modern Language Journal*, 95(s1), 91–96.

Costa, A., Hernández, M., & Sebastián-Gallés, N. (2008). Bilingualism aids conflict resolution: Evidence from the ANT task. *Cognition*, 106(1), 59–86. <https://doi.org/10.1016/j.cognition.2006.12.013>

Cowan, N. (2005). *Working memory capacity*. Psychology Press.

Cummins, J. (2008). BICS and CALP: Empirical and theoretical status of the distinction. In B. Street & N. H. Hornberger (Eds.), *Encyclopedia of Language and Education* (Vol. 2, pp. 71–83). Springer.

Diebold, A. R. (1964). Incipient bilingualism. In D. Hymes (Ed.), *Language in culture and society* (pp. 495–511). Harper & Row.

Ellah, B. O., Ugwoke, S. C., & Udu, D. A. (2020). Problem-solving skills as correlates of attention span and working memory of low ability level students in senior secondary schools. *International Journal of Educational Research*, 8(4), 45–57.

Engle, R. W. (2002). Working memory capacity as executive attention. *Current Directions in Psychological Science*, 11(1), 19–23.

Grosjean, F. (2010). *Bilingual: Life and reality*. Harvard University Press.

James, W. (1890). *The principles of psychology*. Henry Holt and Company.

Macnamara, J. (1967). The bilingual's linguistic performance: A psychological overview. *Journal of Social Issues*, 23(2), 58–77.

Ma, X., Ma, X., Li, P., & Liu, Y. (2020). Differences in working memory with emotional distraction between proficient and non-proficient bilinguals. *Bilingualism: Language and Cognition*, 23(5), 1032–1045. <https://doi.org/10.1017/S1366728919000754>

Miyake, A., & Shah, P. (1999). *Models of working memory: Mechanisms of active maintenance and executive control*. Cambridge University Press.

Morrison, C., Kamal, F., & Taler, V. (2018). The influence of bilingualism on working memory event-related potentials. *Brain and Language*, 176, 44–55. <https://doi.org/10.1016/j.bandl.2017.11.001>

Rosegard, E., & Wilson, J. (2013). Capturing students' attention: An empirical study. *Journal of the Scholarship of Teaching and Learning*, 13(5), 1–20.

Saiz, A., & Zoido, E. (2005). Listening to what the world says: Bilingualism and earnings in the United States. *The Review of Economics and Statistics*, 87(3), 523–538.

Samuel Johnson. (1755). *A dictionary of the English language*.

Tinto, V. (1993). *Leaving college: Rethinking the causes and cures of student attrition* (2nd ed.). University of Chicago Press.

Wei, L. (2000). *The bilingualism reader*. Routledge.

