

## Understanding the role of Second Language Proficiency and Personality Traits of Bilinguals on their Working Memory Capacity and Emotional Intelligence

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This study examines the influence of second language (L2) proficiency and personality traits on working memory capacity and emotional intelligence (EI) among 76 Hindi-English bilinguals. Participants were categorized into high, intermediate, and low proficiency groups on the basis of their LexTALE scores. Personality traits—Extraversion, Neuroticism, and Psychoticism—were measured using the Eysenck Personality Questionnaire-Revised Short Hindi version (EPQRS-H). Working memory capacity was assessed through the N-back test, utilizing hits, false alarms, and d prime as performance indicators. Emotional Intelligence was evaluated using Multidimensional Self-Report Emotional Intelligence Scale Revised (MSREIS-R) across four subscales: ability to express and appraise emotions, utilize emotions, manage emotions in self, and manage emotions in others. Results indicated that high proficient bilinguals demonstrated significantly higher working memory capacity and overall EI compared to low proficient bilinguals. Extraversion was positively associated with working memory and EI, while Neuroticism and Psychoticism were negatively correlated. Mediation analysis revealed that second language proficiency mediated the relationship between personality traits and over-all EI. These findings underscore the cognitive and emotional benefits of bilingualism, highlighting the role of personality in shaping these outcomes. The use of d prime as a measure offers a refined perspective on working memory. This research has implications for educational practices and cognitive training programs in multilingual contexts.

**Keywords:** second language proficiency, personality traits, working memory capacity, emotional intelligence, Hindi-English bilinguals, d prime, bilingualism.

Bilingualism is defined as the ability to use two languages simultaneously. It is a prevalent phenomenon globally, as individuals utilize multiple languages for social interactions, education, interpersonal relationships, and professional settings. With the increasing fusion of diverse cultures through globalization, the significance of bilingualism has become more pronounced. Bilingual individuals span a spectrum, ranging from those with low proficiency in one language to highly proficient bilinguals who

demonstrate proficiency in both languages (Bialystok, 2011). The mental demands associated with bilingualism, such as managing language interference while using other languages and switching between languages based on context and importance, are believed to have long-lasting effects on executive functions, including working memory (Bialystok et al., 2008; Costa et al., 2009). The active processing of both languages effectively may foster additional executive functions, resulting in cognitive

benefits for bilingual individuals. These benefits encompass enhanced task switching abilities, improved attentional control, and potentially greater working memory capacity (Mishra et al., 2023; Bialystok, 2009; Miyake & Friedmam, 2012). In addition to these cognitive advantages, bilingualism enhances emotional intelligence. Bilinguals frequently navigate diverse cross-cultural, social, and linguistic contexts, necessitating the adjustment of both language systems and emotional expression and communication styles accordingly (Grosjean, 2010). This adaptability in managing two language systems enhances certain aspects of executive functions, such as social skills and empathy. Bilinguals must frequently not only consider linguistic comprehension but also the underlying emotional nuances conveyed in different languages (Dewale, 2010). This practice leads to a deeper understanding of emotions and improved emotional regulation. Research has demonstrated that bilinguals exhibit and perceive emotions differently in their respective languages (Pavlenko, 2008). The foreign language effect suggests that using a foreign language instead of one's native language can enhance rational decision-making by reducing emotional reactivity (Costa et al., 2014). Consequently, the alternation between two linguistic systems has been associated with emotion regulation strategies. Dual mechanism control (DMC) theory provides an explanation for the relationship between extraversion neuroticism and working memory capacity. (Braver, Grey, Burgess, 2007). DMC theory posits that there are two types of attentional control mechanisms: proactive control and reactive control. Proactive control is future-oriented, engaging cognitive control when exposed to challenging environments. It operates on top-down attentional processes, responsible for maintaining goal-relevant information from the start to optimize performance. Reactive control, on the other hand, works on bottom-up attentional

mechanisms, engaging cognitive control only when stimuli or events occur unexpectedly in challenging or interfering situations. According to Braver et al. (2007), extraversion is associated with proactive control, while neuroticism is associated with reactive control. They suggest that extraverts will exhibit a greater propensity towards proactive control, leading to higher working memory performance and lower conflict monitoring. In contrast, individuals with high neuroticism will demonstrate a greater propensity towards reactive control, resulting in superior conflict monitoring. The relationship between psychoticism and working memory is relatively understudied compared to other personality traits. Research indicates that individuals scoring high in psychoticism may encounter difficulties in tasks that require seamless manipulation and updating of information (Gruszka et al., 2010).

Personality traits are highly associated with emotional intelligence. Neuroimaging studies suggests that extraverts have more activities in medial prefrontal cortex and anterior cingulate cortex during tasks requiring processing of emotions and social cognition (Amodio & Frith, 2006). The amygdala, which plays a crucial role in emotional responses, exhibits a higher association with the prefrontal cortex in extraverts, resulting in improved emotional regulation (Cremers et al., 2010). Neuroticism which is associated with negative emotion like anxiety, frustration, worry, depressed mood are is generally negatively correlated with emotional intelligence. Neuroimaging studies suggests that individuals with high neuroticism score tend to show greater amygdala activity when exposed to negative stimuli, indicating difficulty in regulation of emotions (Hariri et al., 2002). The relationship between psychoticism and emotional intelligence has remained underexplored.

This research paper delves into the interplay between second language (L2) proficiency and personality traits in shaping working memory capacity and emotional intelligence (EI) among Hindi-English bilinguals. By adopting a comprehensive approach that integrates cognitive and emotional perspectives, the study explores the interrelatedness of these factors. Drawing upon empirical evidence demonstrating the impact of bilingualism on cognitive abilities such as working memory and executive control (Bialystok et al., 2012), the research employs the LexTALE proficiency test to categorize participants into high- and low-proficiency groups. This classification provides nuanced insights into the role of L2 proficiency in influencing cognitive-emotional outcomes within India's multilingual context (Ansaldò et al., 2008).

Personality factors, such as extraversion, neuroticism, and psychoticism, are assessed using the Short-form revised Eysenck Personality Questionnaire Hindi version (EPQRS-H; Tiwari et al., 2009). The study investigates the correlation between these personality traits and working memory, employing the N-back task to quantify metrics including hit rates, false alarms, and d-prime. This quantification elucidates the cognitive implications of personality variations (Matthews et al., 2000).

Emotional intelligence (EI) was assessed using the Multidimensional Self-Report Emotional Intelligence Scale Revised (MSREIS-R; Pandey & Anand, 2008). This assessment evaluates four subscales: perceiving, using, understanding, and managing emotions. The test hypothesis suggests that bilingual individuals demonstrate enhanced social engagement and cognitive flexibility, which positively influence their emotional intelligence (Hernández et al., 2019).

Furthermore, the research proposes L2 proficiency as a mediating factor between

Personality and Emotional Intelligence. It suggests that the improved cognitive flexibility associated with bilingualism facilitates enhanced emotional regulation (Bialystok & Craik, 2010; Pavlenko, 2005).

By adopting an integrative perspective, the study effectively bridges the gap between the cognitive (working memory) and affective (EI) domains. This comprehensive approach provides novel insights into Hindi-English bilinguals, an underrepresented population in Western scholarly literature. By addressing the knowledge gaps regarding bilingualism's cognitive-emotional dynamics within multilingual communities, the study contributes to the advancement of understanding in this field. Implications aim to guide educational and psychological practices by elucidating the processes through which bilingualism and personality influence cognitive and emotional well-being. This research contributes to a global understanding of multilingualism's advantages.

Based on these findings, the present study hypothesizes that High-proficient bilingual will exhibit significantly enhanced working memory capacity and overall emotional intelligence compared to low-proficient bilingual individuals. Extraversion will be positively correlated with improved overall emotional intelligence and working memory capacity while psychoticism and neuroticism will be negatively correlated with overall emotional intelligence and working memory capacity. Furthermore, second language proficiency will serve as a mediator in the relationship between personality dimensions and overall emotional intelligence.

These hypotheses are grounded in the bilingual advantage framework (Bialystok, 2011), which posits that managing two languages enhances cognitive flexibility. Additionally, they are supported by the dual mechanisms of control theory (Braver et al.,

2007), which links personality traits to variations in attentional and emotional regulation.

## Method

### Sample

In this study, 76 bilingual participants (42 high proficient and 34 low proficient) were recruited from various departments of Banaras Hindu University through random sampling procedure. Participants were classified into two groups (low proficient and high proficient bilingual individuals) based on their LexTALE scores.

### Experimental task and Tools

*Traditional N Back Task:* To assess working memory capacity, the classic N-back task was conducted using Inquisit 4.0 (Millisecond Software, 2015). The N-back task is a widely recognized cognitive assessment task that necessitates continuous monitoring of a sequence of stimuli, where participants identify whether the current stimulus corresponds to the one presented in a specific number ( $n$ ) of steps earlier. The current study employed three versions of the task: 2-back, 3-back, and 4-back. In each version, participants were required to recognize stimuli that were identical to those presented two, three, and four steps prior, respectively. This adaptive approach was selected due to its extensive application in cognitive psychology research investigating working memory capacity across diverse populations. Participants' performance was evaluated using key behavioural indicators such as hits, which signify correct identification of matching stimuli, false alarms, indicating incorrect responses where participants erroneously identified non-matching stimuli, and d-prime values, a sensitivity measure distinguishing signal detection accuracy from erroneous responses. The N-back paradigm, through its varied difficulty levels, offers a comprehensive examination of cognitive

flexibility and working memory capacity performance.

*Personality Assessment:* The revised Eysenck Personality Questionnaire (EPQRS) in Hindi version (EPQRS-H; Tiwari et al., 2009) was employed to assess personality traits in participants. This standardized psychological assessment measures three fundamental personality dimensions: extraversion, neuroticism, and psychoticism. Extraversion evaluates an individual's level of sociability, enthusiasm, and preference for external stimulation. Neuroticism reflects emotional stability, including tendencies toward anxiety, mood fluctuations, and stress sensitivity. Psychoticism assesses aggression, impulsivity, and nonconformity to social norms. The EPQRS-H has been widely used due to its brevity, reliability, and applicability across populations in psychological research settings.

*Second Language Proficiency Test:* To assess participants' second language proficiency, the LexTALE test (Lemhöfer & Broersma, 2012) was employed. This validated instrument provides an efficient measure of lexical proficiency, facilitating the categorization of individuals into high, intermediate, and low proficiency groups based on their vocabulary recognition and comprehension abilities. Individuals in the high-proficiency group demonstrate advanced lexical knowledge and proficient comprehension, while those categorized in the low-proficiency group exhibit limited vocabulary knowledge and basic comprehension skills. The LexTALE test is commonly utilized in research investigating bilingualism and multilingualism, as it enables an objective evaluation of language competence.

*Emotional Intelligence Questionnaire:* Emotional intelligence (EI) was assessed

using the Multidimensional Self-Report Emotional Intelligence Scale Revised (MSREIS-R; Pandey & Anand, 2008), which is based on the ability model of emotional intelligence. This instrument comprises items designed to measure four primary dimensions of emotional intelligence: the capacity to express and appraise emotions, the ability to utilize emotions, the ability to manage emotions within oneself, and the ability to manage emotions in others. These dimensions collectively provide insights into emotional awareness, self-regulation, and social functioning. Furthermore, the MSREIS-R offers an overall measure of general emotional intelligence, enabling a comprehensive evaluation of participants' emotional competencies and adaptive behaviours.

### Procedure

Participants were provided with a comprehensive overview of the test and subsequently obtained informed consent. Subsequently, they were requested to complete a demographic questionnaire. The session commenced with the administration of the LexTALE test, followed by instructions on responding appropriately to both target and non-target words. Subsequently, participants were tasked with completing the *N-back* task, which was preceded by a practice session to familiarize them with the task's intricacies. Following the completion of behavioural assessments, participants were asked to complete the Hindi version of *EPQR*-short form and the *MSREIS-R*. To mitigate the impact of order effects, the order of self-reported tasks was systematically counterbalanced across participants. Clear instructions were provided to minimize response bias. Concluding the session, participants were debriefed, encouraged to pose any inquiries, and expressed gratitude for their participation.

### Data Analyses

Data analyses were conducted using Jefferson's Advanced Statistical Package (JASP) (Version 0.19.3; JASP Team, 2024). A one-way ANOVA was performed to assess the differences in working memory capacity and emotional intelligence among high and low proficient bilingual individuals. Pearson's correlation analysis was employed to investigate the impact of personality traits (extraversion, psychoticism, neuroticism) on working memory capacity and emotional intelligence. Structural Equation Modelling (SEM) was utilized to determine the role of second language proficiency as a mediator between personality traits and emotional intelligence.

### Results

The results, as shown in Table 1 and Figure 1, revealed significant differences in working memory measures and emotional intelligence (EI) subscales, including overall EI scores. Specifically, significant differences were observed in working memory (WM) performance measures, including correct responses ( $F(1, 74) = 5.29, p = .024$ ), false alarms ( $F(1, 74) = 6.89, p = .011$ ), and *d-prime* ( $F(1, 74) = 30.49, p < .001$ ). These findings suggest a strong statistical relationship between second language proficiency and working memory capacity.

Second language proficiency significantly impacted the Emotional Intelligence subscales. It affected the ability to express and appraise emotions ( $F(1, 74) = 52.11, p < .001$ ), utilized emotions ( $F(1, 74) = 45.56, p < .001$ ), manage emotions in oneself ( $F(1, 74) = 5.45, p = .022$ ), and manage emotions in others ( $F(1, 74) = 38.72, p < .001$ ). Overall EI scores also differed significantly between groups ( $F(1, 74) = 46.56, p < .001$ ).

Table 1. Descriptive Statistics for Working Memory and Emotional Intelligence Measures by Language Proficiency Group

Working Memory and Emotional Intelligence Measures	N	Proficiency levels	Mean	SD	F	df	p
WM correct responses	4234	HighLow	30.09524.324	10.21911.646	5.289	74	0.024
WM false alarms	4234	High,Low	27.38139.441	16.95523.068	6.891	74	0.011
WM d prime	4234	HighLow	0.300-1.654	1.4671.612	30.489	74	<0.001
Ability to express and appraise emotions	4234	HighLow	78.66762.382	1.7591.249	52.112	74	<0.001
Ability to utilize emotions	4234	HighLow	73.42958.118	11.3467.531	45.588	74	<0.001
Ability to manage emotions in self	4234	HighLow	43.95239.059	10.6986.550	5.451	74	0.022
Ability to manage emotions in others	4234	HighLow	34.38127.412	5.2644.293	38.719	74	<0.001
Overall emotional intelligence	4234	HighLow	33.78118.991	5.2123.257	46.555	74	<0.001

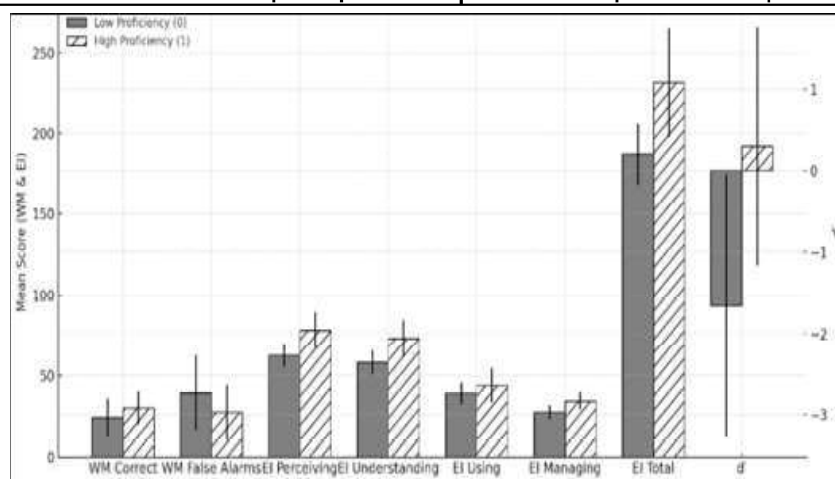


Figure 1. Comparison of Working Memory measures and Emotional Intelligence subscales by Second Language proficiency (L2)

Pearson's correlation analysis was conducted to assess the correlation between personality traits, working memory (WM) measures, and all the subscales of emotional intelligence (EI), including the overall EI score. A positive correlation was observed between extraversion and all the components of emotional intelligence, including the ability to express and appraise emotions. ( $r=0.607$ ,  $p<.001$ ), ability to utilize emotional intelligence ( $r=0.423$ ,  $p<.001$ ), ability to manage emotions in oneself ( $r= 0.275$ ,  $p=0.01$ ), ability to manage emotions in others

( $r=0.463$ ,  $p<.001$ ). The overall emotional intelligence score exhibited a significant positive correlation with extraversion ( $r=0.527$ ,  $p<0.001$ ). These findings indicate that extraverted individuals tend to demonstrate heightened emotional intelligence. Furthermore, extraversion showed positive correlation with WM correct responses ( $r= 0.52$ ,  $p<0.001$ ), WM d prime ( $0.03$ ,  $p<0.001$ ) showing that individuals with higher extraversion tend to show better working memory capacity.

A substantial negative correlation was discovered between the psychoticism trait and all four components of emotional intelligence, encompassing the ability to express and appraise emotions ( $r = -0.667$ ,  $p < 0.001$ ), capacity to utilize emotions ( $r = -0.611$ ,  $p < 0.001$ ), Self-emotional management ability ( $r = -0.296$ ,  $p < 0.001$ ), Ability to manage emotions in others ( $r = -0.671$ ,  $p < 0.001$ ) and the overall emotional intelligence score ( $r = -0.658$ ,  $p = 0.001$ ). These findings suggested a correlation between elevated psychoticism and diminished emotional intelligence.

A substantial negative correlation was discovered between neuroticism and all four components of emotional intelligence,

including the ability to express and appraise emotions ( $r = -0.600$ ,  $p < 0.001$ ), ability to utilize emotions ( $r = -0.521$ ,  $p < 0.001$ ), ability to manage emotions in self ( $r = -0.426$ ,  $p < 0.001$ ), emotional management abilities in others ( $r = -0.546$ ,  $p < 0.001$ ) and the overall emotional intelligence score ( $r = -0.591$ ,  $p = 0.001$ ). These findings suggest a positive correlation between higher levels of neuroticism and lower emotional intelligence.

Overall, the results indicate a positive association between extraversion and enhanced working memory performance and higher emotional intelligence. Conversely, Psychoticism and Neuroticism are associated with diminished working memory capacity and lower emotional intelligence.

Table 2. Correlation matrix between Personality Traits, Working Memory, and Emotional Intelligence

Personality Dimensions	Working memory correct responses	Working memory false alarms	Working memory d prime	Ability to express and appraise emotions	Ability to utilize emotions	Ability to manage emotions in self	Ability to manage emotions in others	Overall emotional intelligence
Extraversion	0.516***	0.038	0.295**	0.607***	0.423***	0.275*	0.463***	0.527***
Psychoticism	-0.233*	0.316*	0.552***	0.667***	0.611***	-0.296**	0.671***	-0.658***
Neuroticism	-0.214	0.252*	0.460***	0.600***	0.521***	0.426***	0.546***	-0.591***

Table 3. Mediation Analysis of L2 as a Mediator between Personality Traits (E, P, N) and Emotional Intelligence

Path	B (Estimate)	SE	95% CI	p
<b>Indirect Effects</b>				
Extraversion → Language → EI	0.109	0.028	[0.054, 0.165]	<0.01
Psychoticism → Language → EI	-0.098	0.031	[-0.158, -0.039]	0.001
Neuroticism → Language → EI	-0.114	0.030	[-0.173, -0.056]	<0.01
<b>Direct Effects</b>				
Extraversion → EI	0.094	0.038	[0.021, 0.168]	0.012
Psychoticism → EI	-0.136	0.040	[-0.215, -0.057]	<0.001
Neuroticism → EI	-0.126	0.041	[-0.206, -0.046]	0.002
<b>Total Effects</b>				
Extraversion → EI	0.204	0.038	[0.130, 0.277]	<0.001
Psychoticism → EI	-0.234	0.031	[-0.294, -0.174]	<0.001
Neuroticism → EI	-0.241	0.038	[-0.314, -0.167]	<0.001

A mediation analysis was conducted to determine whether second language proficiency mediates the relationship between personality traits and emotional intelligence. The direct effect of extraversion on the overall EI score was statistically significant. (Estimate =  $p < 0.001$ ) indicated a positive correlation between higher levels of extraversion and higher overall EI scores. The indirect effect mediated by second language proficiency is also statistically significant (Estimate = 0.094.  $p=0.001$ ) suggesting that second language proficiency partially mediates the relationship between extraversion and the overall EI score. The effect of extraversion on the overall EI score was also significant (Estimate =0.266,  $p < 0.001$ ) confirms the overall positive relationship. The direct effect of psychoticism on overall EI score was statistically significant. (Estimate =- 0.136,  $p < 0.001$ ) indicates a positive correlation between psychoticism and lower overall EI scores. The indirect effect mediated by language proficiency was also statistically significant (Estimate=-0.098,  $p = 0.001$ ) suggesting that language proficiency partially mediates the relationship between psychoticism and the overall EI score. The effect of psychoticism on the overall EI score is significant (Estimate = - 0.234). The data demonstrated a significant negative correlation between neuroticism and overall emotional intelligence (EI), with a  $p$ -value  $< 0.001$ .

Further, A mediation analysis was also conducted to assess whether second language proficiency serves as a mediator in the relationship between neuroticism and overall EI. The direct effect of neuroticism on the overall EI score was statistically significant (Estimate =- 0.126  $p=0.002$ ). This indicates that higher levels of neuroticism were associated with lower overall EI scores. The indirect effect through language proficiency was also significant (Estimate =-0.114  $p < 0.001$ ), indicating that language proficiency

partially mediates the association between neuroticism and the overall EI score. The overall impact of neuroticism on the overall EI score is statistically significant (Estimate =- 0.241  $p<0.001$ ) confirming the overall negative correlation.

### Discussion

The findings of this cross-sectional study provide valuable insights into the influence of second language proficiency and personality traits of bilingual individuals on their working memory capacity and emotional intelligence. The results indicated that high L2 proficient bilingual individuals performed significantly better than low proficient bilingual individuals on the traditional n-back task, which measures working memory capacity in terms of hits, false alarms, and d prime. These findings align with previous research suggesting that bilingualism benefits cognitive functions due to the constant requirement of managing two language systems and inhibiting one while using the other (Bialystok et al., 2012). The inclusion of d prime as a metric for working memory capacity is a novel aspect of the study. d prime provides a measure of an individual's ability to distinguish between hits and false alarms, reflecting the accuracy and efficiency of cognitive processing (Stanislaw & Todorov, 1999). By applying this metric, the study offers a more nuanced understanding of working memory, not only in terms of the quantity of correct responses but also the quality of discrimination between relevant and irrelevant stimuli.

The study investigated the effect of L2 proficiency on emotional intelligence. The findings indicated that high proficient bilingual individuals outperformed low proficient bilingual individuals. The former one scored significantly better than the latter one. The positive relationship between bilingual proficiency and emotional intelligence can be attributed to the social and mental demands

in different contexts, which enhance their ability to perceive and manage emotions (Grosjean, 2010).

The correlation analysis of personality traits with working memory measures and emotional intelligence (EI) subscales, including the overall EI score, revealed a positive correlation between extraversion and both WM measures and EI subscales. This finding concurs with previous research indicating that extraverted individuals generally possess superior working memory capacity. Extraversion is associated with dopaminergic functioning, which influences working memory. Consequently, extraverts tend to outperform introverts in WM tasks.

Conversely, psychoticism and neuroticism exhibited a negative correlation with WM measures and all EI subscales, including the overall EI score. These findings are consistent with previous research suggesting that psychoticism may encounter difficulties in tasks that require continuous updating and manipulation of stimuli, potentially due to elevated levels of impulsivity (Gruszka et al., 2010). The negative correlation of neuroticism with WM measures and EI subscales (including the overall EI) can be attributed to the emotional instability and anxious nature associated with this trait. Individuals with high scores in this trait may encounter challenges in emotional regulation and social interactions (Gross & John, 2003).

The findings of this study suggest that second language proficiency significantly mediates the relationship between personality traits (extraversion, psychoticism, and neuroticism) and emotional intelligence. For all personality traits, second language proficiency serves as a significant partial mediator between personality and emotional intelligence. Proficiency in a second language may foster socio-emotional and cognitive processes that align with the bilingual advantage hypotheses (Bialystok,

2011). Personality traits directly impact emotional intelligence, and second language proficiency either amplifies or mitigates these effects.

### **Conclusion and Future Directions**

This study presents substantial evidence demonstrating that second language proficiency and personality traits significantly impact working memory capacity and emotional intelligence among bilingual individuals. The findings elucidate the advantages of bilingualism on cognitive and emotional processes and demonstrate the mediating role of second language proficiency in elucidating the relationship between personality traits and emotional intelligence. The study's findings from Hindi English bilingual individuals provide extensive comprehension of its impact across diverse cultural contexts. This research offers valuable insights that can be applied in educational practices, cognitive training programs, and interventions. Future research should explore the long-term effects of bilingualism by employing a cross-sectional research design. Additionally, studies should investigate the influence of bilingualism on different age groups and cultural contexts. Neuroimaging studies could delve deeper into the underlying mechanisms through which bilingualism influences various cognitive processes and emotional functions. Incorporating objective measures for emotional intelligence would enhance the validity of the findings, and employing both behavioural and self-reported data would provide a comprehensive understanding of the relationship among the variables.

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