Neurocognitive Approach to Successful Learning and Speaking of English Language among Day Secondary Schools in Nyagatare District, Rwanda

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ABSTRACT

Learning a foreign language, particularly English, poses challenges for Rwandan teenagers already introduced to other science subjects like mathematics, physics, and other different courses of action that have occupied their attention, or, on the other hand, disturbs their mind and hinders their learning spirit. This study aimed to investigate how the neurocognitive underpinnings of brain activation methods and integration multisensory work to activate those teenagers' brain attention to English language learning and develop speaking skills and enable learners to overcome the neurocognitive challenges like lack of motivation, emotions, stress, and anxiety that hinder English language learning and speaking. This study was built around the multisensory theory and brain-based learning theory. Using a semi-longitudinal approach, data was collected from 40 senior two students to explore difficulties in learning English from one school in Nyagatare district. These were selected purposefully from the population of 340 students. A six-week classroom experiment from April 15 to May 23, 2024, gathered both quantitative and qualitative data on how brain activation methods enable English learning speaking. Single-group experiments and observations were used to collect data. In the experiment, the procedure of pretest-treatment-posttest was implemented. SPSS software was used to analyze the data, with results showing improved post-test scores after targeted interventions. In the pre-test, the mean score ranges between 1 and 2.5 with a standard deviation that swings between 0.405 and 0.802 for all questions, while the mean score in the post-test aligns between 3.5 and 5 with a standard deviation that wheels between 0.267 and 0.813, which significantly indicates high scores after the treatment. Therefore, the study highlights the significant impact of brain activation methods accompanied by multisensory integration as the neurocognitive approach to English language learning and speaking. The research suggests that education stakeholders and policymakers should consider this approach for successful English language learning to avoid overloading teenagers' brains with heavy programs.

Keywords: Attitude, Brain Activating, Cognition, Emotions, Language Learning, Motivation, Neurocognitive, Neuroplasticity, Neurons, Speaking

1. INTRODUCTION

Foreign versus second language learning and its use in daily life is an interesting topic in a context like Rwanda, where the majority of people speak Kinyarwanda. How is it learned, and to which level is it used? When do we say that language learning succeeded and failed? In the context of Rwanda, English language is taught from primary and the level lesson outcomes is measured from the exams done on papers, and even when learners' fail they continue in the next level, except in private schools and other international schools that prioritize language learning and high level of language proficiency which is different from public schools (Tabaro, 2019; Nshimiyimana & Bazimaziki, 2024).

Consequently, learners who study in day secondary schools are judged of not speaking English language regardless of a number of efforts and methods applied by the teachers to teach them English language (Nshimiyimana & Bazimaziki, 2024). The intriguing question to ask in this context is: Why do these students fail to speak English? Where is the problem and how can it be solved? Muragijimana's (2022) study results reveal that learners from different schools have different abilities in speaking the English language. Specifically, those from high-ranked schools are better, while those from day schools are judged to have poor English language skills. Up to here, the problem is not solved because the program that is used in these different ranked schools is the same except for those that adopted international curriculum. This study calls for a cross-examination of how learners from different schools

of boarding and day schools, private schools, and public schools see what is the cause of the gap between the performance of learners in their English language speaking. According to scholars like SAGE (2018) and Elgamal (2019), neurocognitive factors are among the major factors that affect a second/foreign language learning and development of speaking skills. These factors include, but are not limited to, motivation, learners' attention, social and psychological emotions, stress, anxiety, learning environment, and neuroplasticity.

Cognitive scholars like Al-Harbi (2019) and Feixue (2020) re-confirm Piaget's idea of the Language Acquisition Device (LAD). It is an innate ability of a child to acquire a language from the surrounding environment. However, the research shows that this ability actively functions up to the age of 11 and 12 years old (Grimm, 2020). After this age, learners have a focus on other subjects and have started to experience other social and psychological decadences that affect their language learning. This might explain why learners in day secondary schools in Rwanda are challenged in learning the English language and developing speaking skills. This is also linked to the view of neuro-linguists, who emphasize that language learning is totally connected to brain functioning. The focus of neurolinguists is how new language learning materials are acquired, stored, and retrieved in a learner's brain (Bunting& Wen, 2023). This is where topics like memory, executive function, and brain ability to learn a new language and develop language skills get ground.

To this ending, this article is based on a semi-longitudinal study conducted with the learners who study in a day school in Rwanda. It was aimed at exploring the role of brain activating methods in enabling English language learning and speaking among day secondary schools by creating a conducive learning environment, activating memory, strengthening motivation, regulating learners 'emotions, and engaging them in speaking contexts that improve their speaking skills.

1.1 Statement of the Problem

Language learning is closely linked to brain function, specifically in the left hemisphere, which handles language production. Successful learning depends on cognitive development, motivation, and emotional factors. More importantly, learning takes place when all human senses are engaged and are actively working to assist a learner's brain to acquire the learned materials, avoid disturbance, attract learners, increase their motivation, and enable positive emotional situations that lead to successful learning and development of skills practices' attitude. In Rwanda, the use of the English language is in competition with the mother tongue, Kinyarwanda. English is taught as a second language, requiring students to develop skills in reading, writing, listening, and speaking (Tabaro, 2019).

Despite various teaching methods, many students struggle to communicate orally in English. Challenges include brain-related issues such as aphasia and cognitive barriers like inattention and motivation. In addition, the curriculum demands retention of large volumes of material, affecting students' enthusiasm and ability to learn. The environment in which the English language is taught also does not encourage learners to learn this language and to develop skills in it. Consequently, learners' ability to communicate orally using the English language is law. They often fail to construct correct sentences and struggle with vocabulary, making a number of grammatical and structural errors. Even after corrections from teachers, learners do not stop to make the same errors.

This research explores how brain activation methods aid language learning and addresses gaps in English language education to equip learners with speaking skills. Understanding these processes can improve teaching strategies and enhance students' language acquisition, enabling better communication skills essential for academic and professional success. The findings emphasize the importance of aligning teaching methods with brain function to facilitate more effective learning outcomes.

1.2 Research Objective

To explore how do brain activation methods integrate senses to enable English language learning and speaking

II. LITERATURE REVIEW

2.1. Theoretical Review

2.1.1Multisensory Approach

The multisensory approach was originally brought by Montessori in 1912. They were among the first to theorize language skills difficulties originate in the brain's language processing (Jubran, 2011). The multisensory approach in education is a method that employs different senses in the teaching and learning process. It integrates visuals like images, diagrams, chats, and written texts (Birsh, 2011). Auditory items like sounds, spoken words, and music. Kinaesthetic activities that involve physical activities and hands-on learning and tactile using touch, texture, and manipulation of learning materials and objects. As Nurdin and Hafidzi (2023) describe the aim of a multisensory approach to language teaching and learning, these learning styles intend to enhance memory, comprehension, and motivation. This approach was initially intended for learners with disabilities like 'dyslexia' and young learners in

lower grades. However, it later established itself as effective in assisting adult learners who possess language learning difficulties (Romero, 2020; Yalap & Gazioğlu, 2022). It is particularly effective for students with learning differences, as it provides multiple pathways for learning and reinforcing concepts, as it enables language learners to feel the language environment as they interact with learning materials, which leads to the development of language skills. Jubran (2011) argued that this approach has different benefits that are not limited to improving learners' engagement and motivation and improving retention and recall of the previous learned contents by linking information through multiple senses, supporting diverse learning styles and needs, and making learning more interactive and dynamic.

2.1.2 Brain-Based Language Learning Theory

Brain-based language learning theory encompasses neuroscience, psychology, and educational practices in a language teaching and learning environment. Different scholars, such as Willis (2007a), Garner (1983), and Willis (2007a), advocated this theory. For them, brain-based learning theory emphasizes the brain's ability to change and reorganize itself in building up neural connections, which is known as 'neuroplasticity' (Jensen, 2014). This neuroplasticity is more based on the language learner's *age*, *experience*, *motivation*, and *retention*. Stormon-Flynn (2014) emphasized that it is crucial to put "emotional engagement" of the learner into motion in the classroom, particularly in teenagers. While teaching a language, learners' emotions play a big role in successful learning because learners who are more emotional towards learning a subject learn and develop skills than the ones who have negative emotions.

For Eladl and Saad (2019), if a learner is emotionally unstable, for instance, frustrated or afraid, learning cannot be successful. For this reason, Stormon-Flynn (2014) advocated for *energizers in the classroom and other techniques that keep learners healthy emotionally and motivated*. This can be achieved through the creation of learning spaces that are conducive to language learning, like involving colors and drawings to increase the aesthetic and motivating learning environment that learners get through their senses. This research has exploited these factors systematically to ensure learners pull out their learning resources from the brain.

On the other hand, Willis (2007a) conditioned that successful learning depends on the brain's ability to attract information from sensory transmitters and retain and retrieve information. Brain-based teaching strategies, such as personalizing instructional materials, enhance students' memory and learning. fMRI tests of Willis (2007a) show that personalized materials make learners store information effectively. The brain processes information from multiple senses, and stimulating these senses aids learning. Research by Wortman (1988), Duman (2007), Williams (2007a), and Sousa (2001) has shown that specific brain regions handle cognitive actions and store sensory and emotional data. This emphasizes the importance of sensory stimulation in language acquisition. Additionally, brain-based language learning addresses stress, which hampers memory and learning. To achieve this learning, which is based on the brain's ability to learn, there is a strong need for brain activation methods to enable the process (Willis 2007a). Brain activation methods include different techniques like games, dialogues, and role-play, audio-visual aids, and debates to keep learners focused and motivated. Ultimately, brain-based learning prioritizes learners' motivation and mental well-being. In language classrooms, individualized materials and an engaging, supportive environment that considers learners' preferences and needs are crucial.

III. METHODOLOGY

3.1 Research Design

As mentioned earlier in the introduction, this paper is built from semi-longitudinal research conducted in a day school with a period of six weeks. The aim was to investigate the neurocognitive factors affecting English language learning and speaking among 9-year-old basic education schools. The sample size was 40 learners who study in senior two, sampled purposefully from the population of 340 learners who study in day school. To collect data from the participants, observation and a single-group experiment were conducted within six weeks. A single group of subjects are given a pre-test (O), then treatment (X), and then afterward the post-test (O). The contents of the pre-test and post-test were the same but were given at different times: at the beginning and end of the experiment. The results that were examined are an indication of an improved change of results from pre-test to post-test, as McMillan and Schumacher (2012, p. 268) strongly supported this type of experimental design. The quantitative data were analyzed by using SPSS software version 22 and were presented by using tables, while the qualitative data were analyzed thematically following the pattern of objectives.

To ensure the reliability coefficient of the instruments, we referred to the Cronbach's alpha. According to Gliem (1992) Cronbach's alpha is a statistic commonly used to measure the internal consistency or reliability of a set of scales or test items. It assesses how closely related a set of items are as a group and is an estimate of the reliability of instruments.Cronbach's alpha ranges are $\alpha \geq 0.9$: is considered excellent, $0.8 \leq \alpha < 0.9$: is considered good, $0.7 \leq \alpha$

< 0.8: is acceptable, $0.6 \leq \alpha < 0.7$: is questionable, $0.5 \leq \alpha < 0.6$: is poor, and $\alpha < 0.5$: is considered unacceptable. Cronbach's alpha was found by using SPSS software through reliability analysis.

3.2 Reliability Statistics of this study

Table 1
Validity and Reliability of Instruments

Neurocognitive factors (variables)	No of items	English language learning and speaking	Cronbach's alpha
Brain activating methods	3	.779	.700
Motivation	2	.801	.781
Attitude and emotions	3	.697	.713
Memory	5	.704	.698
Learning Environment	2	.714	.704
Neurocognitive factors vs. English language speaking	3	.790	.709

The reliability of the data collection instrument was tested using Cronbach's alpha coefficient, and it was found that the score is 0.701, which falls into an acceptable range from the Cronbach's alpha analyses. Koonce and Kelly (2014) supported that the analysis determined the validity of the questions that made up each variable.

IV. FINDINGS & DISCUSSIONS

4.1 Demographic Characteristics of Respondents

4.1.1 Identification of Respondents by Age

Participants' ages were screened as language learning is the key to this element to factors for the outcome variable

Table 2
Participants' Age

Age	Frequency	Percent
between 12-15	21	52.5
between 16-18	16	40
19 years and above	3	7.5
Total	40	100

Table 3 indicates that a very large number of participants represent 52.5% of teenagers ranging between 12 and 15 years old. Forty percent (40%) ranged between 16 and 18 years of age. Participants who are above 19 are grouped in 7.5%.

4.1.2 Identification of Respondents by Gender

This study used gender to identify respondents. Where both boys and girls share the same school, teachers, and English language programme contents. They have the same teaching and learning process for English. Table 3 indicates the categories of respondents based on gender.

Table 3
Participants' Gender

Gender	Frequency	Percent
Male	19	47.5
Female	21	52.5
Total	40	100

Table 4 indicates that 47.5% of the participants were males and 52.2% were females. Obviously, this study shows that the range of 2 is not a big deal between the number of boys and girls in the classroom. Thus, the table reveals that the government policy of promoting gender balance in all sectors has been fruitfully observed even in the education sector because the number of girls is bigger than the number of boys.

4.2 How do Brain Activation Methods Integrate Senses to Enable English Language Learning and Speaking

After analyzing the existing broad literature related to the function of the brain in learning a language and other courses, the model of acquiring information in a human brain was developed to explain this phenomenon. This model explains the work of neurons in the human brain in learning and acquiring information, storing, and retrieving it, which leads to the development of skills. This research has developed an *information acquisition model with the neurons connections model*, which demonstrates how neurons connections and their work in receiving information, processing it, storing and retrieving information—the process that starts from senses.

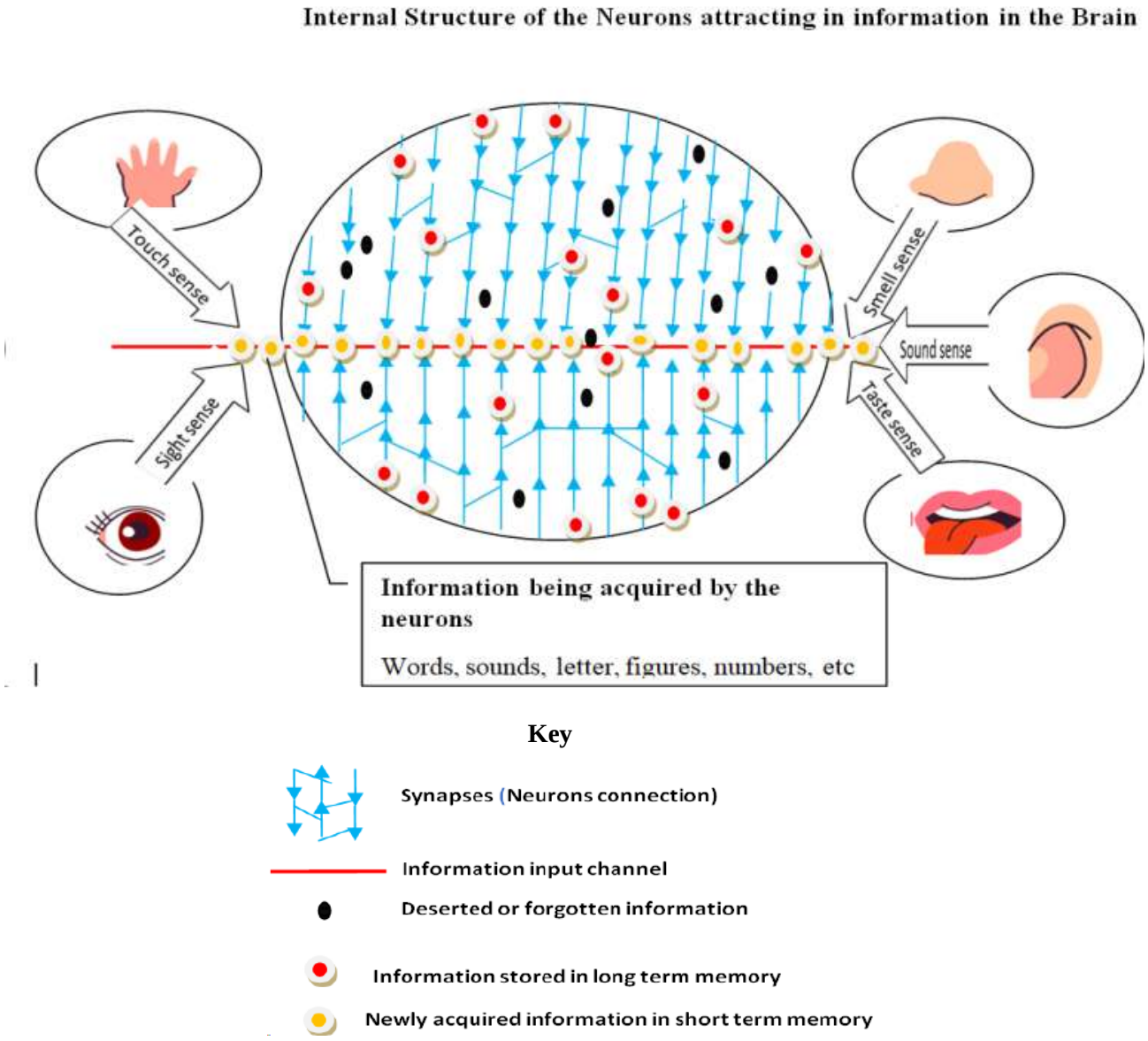

Figure 1
Brain'sInformation Acquisition, Processing, Retaining and RetrievingModel
Source: Researcher (2024)

4.2.1 Discussion of the Figure: Neurons function

Information acquisition in learners predominantly stems from sensory transmitters: taste, sight, smell, hearing, and touch. There is nothing in the brain that does not first come through the senses. All data that is stored in memory is either seen, touched, tasted, heard, or smelled. For instance, the sweetness of sugarcane cannot be stored in the brain if one has not tasted it, and the tales are remembered and retold because they were heard before. How can learners understand *red color* as a vocabulary and use it in speaking if they did not see something that is red? When and where will they use this vocabulary while they do not have an idea? This model is the heart of this study. It is mutually connected to successful teaching and learning as learners have to use their senses to acquire knowledge skills, including speaking skills. These are skills that learners acquire through the teacher's manipulation of teaching aids. Thus, the sensory information is stored in neurons, which function like electrical wires in the brain. During learning,

the brain produces *excitatory chemicals* that activate the firing of the neurons. When the neurons are firing, they exhibit a magnetic-like ability known as *action potentials***.** They attract and retain newly acquired information. Over time, this acquired information undergoes one of two fates: it is either transferred to *long-term memory* through active use and attention, or it is forgotten due to factors such as *lack of use, inattention*, s*tress,* and *cognitive overload*.

Active engagement in learning, such as participating in classroom activities, ensures that neurons remain on the alert and ready to capture and store information in the brain for future use. This actively acquired information initially happens in *short-term memory* and can transition to *long-term memory* through repeated use and r*eactivation* maintained by the connections between neurons known as *synapses*, the junction between two nerve cells consisting of a minute gap across which impulse passes thanks to the diffusion of a neurotransmitter (one neuron to another).

Equally enough, the passive reception of information is due to a lack of *action potential* in the brain, leading to poor information attraction and retention. For instance, if a learner is distracted, stressed, or bored during an English lesson, the brain will produce inhibition chemicals that will stop the neurons from activating information signals. This highlights the importance of attention, active engagement, and a disturbance-free learning environment for effective information acquisition and retention.

Moreover, Romero (2020) asserted that neurons have the capacity to resist and expel the bombarded information in the brain, a phenomenon known as *neuronal inhibition* or *synaptic inhibition.* It is the process that decreases the likelihood of a neuron firing an action potential in response to incoming signals, thereby regulating the flow of information in neural circuits. When a learner is inundated with information from multiple subjects simultaneously, the neurons become overwhelmed and may reject all incoming data. This cognitive overload can disrupt the connections between neurons, leading to a failure in information retention. For example, a learner bombarded with material from six subjects at once might experience neuron overload, resulting in the rejection of all new information items and subsequent disconnection of neuron links. Regrettably, this situation may cause strokes that result in a temporal or even permanent lack of memory, which is *amnesia*.

These findings align with Al-Harbi's (2019) analysis, which indicated that effective acquisition and retention of information in the brain depend on active engagement and proper management of cognitive load. Neurons require a balanced and attentive learning environment to effectively process and store information. Overloading neurons with excessive information can lead to the breakdown of neural connections, impairing the learner's ability to retrieve and use the information when needed. The following histogram presents how data from the experiment were distributed.

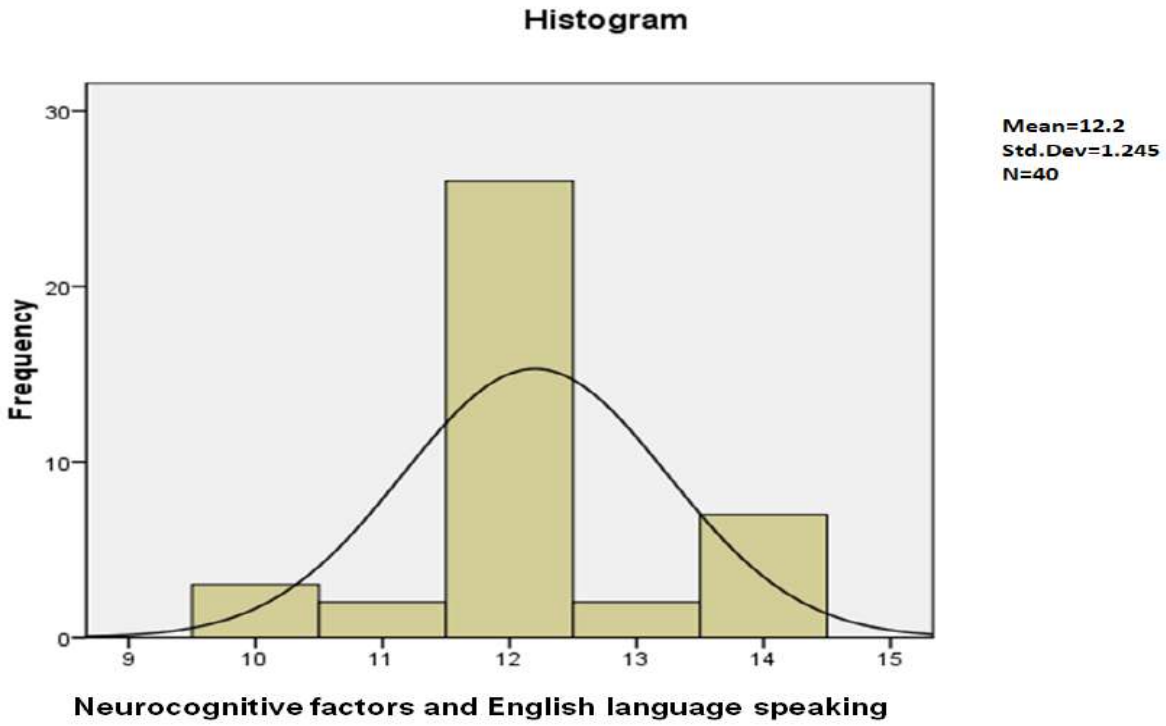

Figure 3

Normal Distribution of Data on Neurocognitive Factor and English Language Speaking after a Post-Test

This histogram displays the frequency distribution of a dataset related to neurocognitive factors and English language speaking with a normal distribution curve overlaid. The mean value of the dataset is 12.2, indicating that the average value of the speaking English language with controlled neurocognitive factors related to language learning and speaking skills. The standard deviation is 1.245, which measures the amount of variation or dispersion in the

dataset. From the histogram, it appears that the data is fairly symmetric skewed around the mean, but with a slight negative skew (left skew) as there are slightly more values to the right of the mean compared to the left. Kurtosis in the histogram shows that the data has a high peak around the mean and thinner tails, suggesting a leptokurtic distribution (kurtosis > 3). This indicates that the data has a sharper peak and fewer extreme values compared to a normal distribution. The leptokurtic in the histogram indicates that the data points are more concentrated around the mean with fewer outliers, which might imply that the nuerocognitive factors tend to influence results that are consistently close to the average in English language speaking. Generally, the figure suggests that the dataset is fairly normal with slight negative Skewness and high kurtosis.

Table 4

Coefficients

Coefficients[a]								
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	-2.763	1.119		-2.469	0.019		
	Motivation	0.237	0.108	0.224	2.193	0.035	0.627	1.596
	Attitude and emotions	0.065	0.052	0.243	1.249	0.22	0.574	2.753
	Memory	0.199	0.077	0.658	2.585	0.014	0.101	9.878
	learning environment	-0.304	0.139	-0.461	-2.19	0.036	0.348	4.764
	Brain activating methods	0.251	0.113	0.233	2.211	0.048	0.64	1.649

a. Dependent Variable: English language learning and speaking

Table 4 shows coefficients of this study. When all predictors are zero, the expected value of English language learning and speaking is -2.763, which is significantly different from zero ($p < .05$). Motivation has a positive and significant effect on English language learning and speaking ($p < .05$). For every unit increase in motivation, the dependent variable increases by .237 units, controlling for other variables. The VIF indicates no significant multicollinearity problem. Attitude is not a significant predictor of English language learning and speaking ($p > .05$). The high VIF indicates a potential multicollinearity issue. Memory has a significant positive effect on English language learning and speaking ($p < .05$). For every unit increase in memory, the dependent variable increases by .199 units. Learning environment has a significant negative effect on English language learning and speaking ($p < .05$). For every unit increase in the learning environment score, the dependent variable decreases by .304 units. The high VIF indicates multicollinearity issues. Brain activating methods are a predictor at the .05 level is significantly high ($p < .05$). The high VIF indicates severe multicollinearity. The VIF values for attitude, memory, and learning environment are notably high (VIF~5), indicating slight multicollinearity among these predictors. This multicollinearity can deflate the standard errors and make it easier to assess the individual contribution of each predictor.

Table 5

Correlations

Correlations				
			Neurocognitive situation of a learner	English language learning and speech production
Spearman's rho	Neurocognitive situation of a learner	Correlation Coefficient	1	.921**
		Sig. (2-tailed)	.	0
	English language learning and speech production	Correlation Coefficient	.921**	1
		Sig. (2-tailed)	0	.

**. Correlation is significant at the 0.01 level (2-tailed), n=40

Table 5 shows the correlation of this study. The diagonal values (1.000) represent the correlation of each variable with itself, which is always 1. The off-diagonal values (0.921) represent the correlation between the "neurocognitive situation of a learner" and "English language learning and speech production." The significance level for the correlation between the two variables is 0.000, which is highly significant ($p < 0.01$).

Correlation Coefficient ($r = 0.921$): There is a very strong positive correlation between the "neurocognitive situation of a learner" and "English language learning and speech production." This implies that, as the neurocognitive situation of a learner improves, their English language learning and speech production also tend to improve, and vice versa. In practical terms, this suggests that interventions or factors that positively influence the neurocognitive situation of learners could have a beneficial impact on their ability to learn English and produce speech. According to

Muragijimana (2022), this strong correlation underscores the importance of considering neurocognitive factors in educational strategies for language learning since it fuels the learning abilities of learners.

V. CONCLUSIONS & RECOMMENDATIONS

5.1 Conclusions

The human brain plays a paramount role in learning and application of learned skills. This study has found the influence of brain activation methods and the integration of all senses in teaching English language to the learners who study in day secondary schools. To this end, brain activation methods should be integrated in the classroom, focusing on the integration of all senses as the information transmitters to the neurons in the brain. The quantity of materials to teach should also be considered. Otherwise, learners will suffer from overflow of information in the brain with experiencing brain cracks, and this will generate brain diseases of all kinds such as stroke, madness, and the like that hinder neurons to process information, as Montaigne had strongly argued in their own words: "*Mieuxvautune tête bienfaitequ'une tête pleine."* (Better a well-made head than a full head.)

This study has introduced a novel approach to challenge traditional methods of teaching English in the classroom, which have been unproductive because of the ignorance of brain function. This research reiterates the classical maxim that "There is nothing in the mind (brain) if it does not first come through sense itself." Thus, senses are the source of knowledge, which is stored in anybody's brain. This means all human knowledge arises from senses. Therefore, a multisensory approach to teaching and learning should be applied in the classroom to enable learners to learn skills as they manipulate learning materials. Learning the English language well is done through the practice of taking notes and writing instructions. Exercises in books, quizzes, and forms of assessments do not make learners develop their English language speaking skills. On the contrary, practical activities make learners speak English jovially. These activities are not only limited to games, storytelling, role playing, debates, and discussions.

While this research provides valuable insight into neurocognitive factors affecting or impacting English language learning and speaking, it is important to acknowledge certain limitations. These include the large sample size for the experiment. Forty (40) individual students were many to handle at once in this classroom experiment. There is limitation related to time. Six weeks was a short time for a longitudinal study about behavioral change of English language among senior two students who always speak Kinyarwanda.

5.2. Recommendations

Making recommendations in relation to the study's goals and findings is worthwhile after drawing conclusions from the study's findings. This study recommended learners to be flexible to learn and practice speaking English without fearing to make mistakes because they are part of learning. This study recommended teachers integrate senses in learning preparation and delivery. Teachers should use brain activation methods to spark neurons in the learners' brain for successful learning of the English language and to achieve improved English language speaking skills because, The research has found that learners beyond 11 year olds' neurons shift from learning languages to other subjects like sciences. Moreover, this study recommends to curriculum designers to prepare a balanced quantity of learning materials and provide sufficient time for skills practices. Therefore, future research should assess the effectiveness of brain activation methods in a sample of a smaller group within a little longer time and extend this research to other subjects to investigate how neurocognitive factors affect learning and performance of learners in those subjects like mathematics, physics, chemistry, and any other subject apart from English.

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