Meta-analysis of impact of traumatic brain injuries in the development of receptive and expressive language disorder in adolescents.

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Abstract:

This study examined the role of traumatic brain injuries in the development of Receptive and Expressive Language Disorder. We considered 4 variables to determine the degree of development: age, learning proficiency, GPA and sport among adolescents. We predicted that the 4 variables will have strong correlation with TBI encounter when assessing the development of Receptive and Expressive Language disorder. Our studies suggested that involvement in sports and learning proficiency are clear indicators of this disorder and age acts as a constant though depending on initial cognitive abilities it can impact the results. Our finding on GPA (Grade Point Average) involvement with TBI encounters was different from our prediction. Even after TBI encounters, a large majority of students did not see any decline in their GPA.

Introduction:

Our mind is a centre of control, balanced by chemical reactions but often external stimuli cause unpredictable outcomes. The world sees the problem of comprehension in association with internal imbalance and lack of development in a child; however, the ignored fact is that trauma or brain injury can lead to the development of Receptive or Expressive Language Disorder.

Background:

Receptive Language Disorder is the difficulty observed in comprehension of words and their meanings. It can grow into lack of attention, lack of interest in conversations and difficulty with following directions. Language disorders are often linked with autism spectrum disorder and Down's syndrome but a proper Language-speech therapist can diagnose and differentiate these problems (Muller & Brady, 2016)

A receptive language disorder is an impairment that can lead to problems with understanding what others are saying. This barrier of communication prevents adolescents, especially students from contemplating the text and leads to lower scores compared to their peers.

Students affected by Receptive Language Disorder often face Expressive Language Disorder as well, where not only are they unable to comprehend what is being said but are unable to vocalize their point forward.

The affected adolescents are often a victim of family history, negligence, abuse or brain injuries. According to The World Health Report in 2001, out of the 450 million people with psychological disabilities today, 3 to 5 percent of people have receptive or language disorders or a mixture of both (ASHAWIRE, 2016). The studies conducted show the sum of diagnosed patients regardless of the cause. On the other hand, our research intends to share the relation between brain injuries in context with Receptive and Expressive Language Disorder.

The impairment can be treated by early diagnosis or consistent checkups with a Language therapist. Speech and language therapies are configured in respect to individual patients and advanced personalized learning is recommended instead of the whole-world learning system is one of the leading causes that restricts students with Language.

Our research paper analyzes the relation between brain injuries and the link with Receptive and Expressive language disorder. It seeks to find answers to the impairment that inhibits the use of basic human ability: comprehension and speech.

Method:

A survey was conducted among 100 participants in order to find out their past experience while assessing the number of people who have had any form of brain injury. Participants of different ages and backgrounds from 10 different nations participated in the survey. We conducted our research while considering the following variables: age, learning proficiency, GPA and sports.

Participants:

The total numbers of participants were 100 adolescents. The UN classifies those between the ages of 10 to 21 as adolescents. Adolescents makeup 1.2 billion people which is 16% of the population of the world (UNICEF, 2019).

Survey Sample:

The surveys were taken twice by each participant to ensure accuracy in the data that is being collected. The survey had no personal information about the candidate except for their age, the country of origin, class rank or the GPA, experience with brain injuries or head traumas, the types of sports that they play and their ability to understand and convey a message in an effective manner.

The candidates that participated in the survey were from 10 different nations which included:

- Pakistan
- India
- China
- United States of America
- Morocco
- Nigeria
- Italy
- Norway
- UK
- Tunisia

The above countries are categorized as: Pakistan, India, and China representing Asia. The USA represents North America Morocco, Nigeria, Tunisia representing Africa and Italy, Norway, UK representing Europe.

Asia is represented by Pakistan, India and China because the total population of these 3 countries combined is 2.95 billion out of 4.46 billion in Asia which accounts for 66% of the continent's population. North America is represented by The United States of America as it holds 56.7% of the population of North America. That is 328.2 million out of 579 million. Africa is being represented by Morocco, Nigeria and Tunisia because the total population of these three countries combined is 243.5 million out of 1.22 billion. Europe is represented by Italy, Norway and the United Kingdom making the combined population of 133.3 million combined out of 741.4 million population of Europe.

The above 10 countries represent not only the majority of the population of the world but also the majority population in 4 of the 7 continents. The sample size is on the model of the known population of the Earth.

Cause of Receptive and Expressive Language disorder:

Receptive and Expressive Language disorder though can be caused by multiple factors that are mentioned in the background of this research paper. The effect of brain injuries are, thus far, unexplored.
Brain Injury and Acquired Brain Injury.

Types of Brain injuries:

A brain injury is an injury to the brain that occurs after birth and is not congenital, degenerative or hereditary. The injury results in a change of the brain's neuronal activity (Brain Injury Allaince, New Jersey, n.d).
There are two types of brain injuries:
- Acquired Brain Injury
- Traumatic Brain Injury

Acquired Brain Injury:

Acquired brain injury (ABI) is defined as alteration in brain function or pathology caused by internal factors such as a lack of oxygen (Brain Injury Alliance, New Jersey, n.d). The causes of ABI include:
- Infectious diseases
- Stroke
- Tumor
- Alcohol/ Drug use
- Seizure

The long term effect of ABI is difficult to predict as it is different from person to person. It is common for many people with ABI to experience increased fatigue (mental and physical) and some slowing down in how fast they can process information, plan and solve problems. They may experience changes to their behavior and personality, physical and sensory abilities, or thinking and learning. (Synapse: Brain Injury Association of QLD, 2014).

Traumatic Brain Injury:

Traumatic brain injury (TBI) is defined as an impact, penetration or rapid movement of the brain within the skull that results in an altered mental state (Prins, Greco, Alexander, & Giza, 2013). The causes of TBI include:
- Falls
- Motor Vehicle accidents
- Domestic violence

- Child abuse
- Abusive head trauma

TBI is said to be challenging to diagnose as its symptoms vary with each individual and their age, gender and the type of head injury. As TBI is hard to diagnose and treat, the patients suffering from it are referred to rehabilitation services because rehabilitation aims to help the brain to learn alternative ways to minimize the long term impact of the injury (Headway, the brain injury association, n.d).

Our research highlights the restrictions patients face after receiving a head injury and provides context to the post-TBI problems the survey participants faced and whether or not this can be a concrete proof of showing symptoms for Receptive and Expressive Language Disorder. We focused on 5 main variables: age, learning proficiency, GPA and sports.

Age:

The survey was taken by adolescents who are from the age of 10 to 21. In general, the adolescents face several different psychological disabilities but, as they don't show any physical symptoms, it is hard to detect and cope with the disability.

The participants of the survey are further divided into three categories by age:

- 10 to 13 years old
- 14 to 17 years old
- 18 to 21 years old

We divided the participants into 3 age groups based on the difference in cognitive ability and brain development phase associated with each age group.

Cognitive Ability:

Cognitive ability may be defined as the "mental capability that involves the ability to reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly and learn from experience" (Batey & Hughes, 2017).

Cognitive abilities initially determine individual performance in academic as well as day to day life. However, Receptive and Expressive Language Disorder leads to decline in this cognitive ability.

Phases of Brain Development among adolescent:

There are 3 main areas of cognitive development that occur during adolescence.

1. Adolescents develop more advanced reasoning skills, including the ability to explore a full range of possibilities in a situation, think hypothetically (contrary-fact situations), and use a logical thought process.
2. Adolescents develop the ability to think abstractly. They move from being concrete thinkers, who think of things that they have direct contact with or knowledge about, to abstract thinkers, who can imagine things not seen or experienced. This allows adolescents to have the capacity to love, think about spirituality, and participate in more advanced mathematics. Youth who remain at the level of a concrete thinker focus largely on physically present or real objects in problem solving and, as a result, may present with difficulty or

frustration with schoolwork as they transition throughout high school. Clinicians can help parents recognize this problem to help adolescents adjust to the educational pace. (Sanders, 2013,)

3. The formal operational thinking characteristic of adolescence enables adolescents to think about thinking or meta-cognition. This characteristic allows youth to develop the capacity to think about what they are feeling and how others perceive them. This thought process, combined with rapid emotional and physical changes that occur during puberty, causes most youth to think that everyone is thinking not just about what they are thinking about but about the youth themselves (imaginary audience).

We also considered the three cognitive development phases in adolescence to categorize them in three age groups. In the age group of 10 to 13 years, a child's brain is developed to understand and solve multiple problems but is still not developed enough to think about the future or the consequences of their behavior.

Thirteen-year-olds develop the ability to think abstractly. Instead of only thinking in terms of tangible objects, they begin to understand concepts such as faith and trust (Morin, n.d).

Then, at the age of 14 to 17 years, the brain of a teen is still not fully developed but possesses far more cognitive capability compared to the age group of 10 to 13 years. The teens of these ages think that they are capable of understanding and doing everything but, at times, they are still unable to contemplate information and interpret meaning behind actions and patterns properly. Fluid intelligence is also reached around this age, which means an improved ability to cope with new problems and situations (Morin, n.d).

Between the ages of 18 to 21 years, the brain is fully developed but according to recent research by Tony Cox, the brain of a human being stops developing by the age of 25. Therefore, even in this age group, the brain is still in its development phase and TBI can lead to Receptive and Expressive Language disorder.

Learning proficiency:

Proficiency-based learning refers to systems of instruction, assessment, grading, and academic reporting that are based on students demonstrating that they have learned the knowledge and skills they are expected to learn as they progress through their education (Proficiency-Based Learning, 2016). In our first survey we asked the participants to rate themselves on their learning proficiency. We focused our questions in order to establish the level of proficiency. Participants were asked to rate their class rank, thought process and ability to convey their point effectively and, finally, made an overall assessment to generate the final rating of learning proficiency.

The four questions were selected due to the connection between the four components. The class rank question was used to evaluate their position among their peers. The learning proficiency question was used to determine the curve of comprehension. The effective thought

process question was used to assess Receptive Language disorder.The ability to convey their point effectively was used as a component to assess Expressive Language disorder. This is because people affected by Expressive Language Disorder are unable to communicate and convey what they are thinking adequately.

GPA:

GPA, or Grade Point Average, is a number that indicates how well or how high you scored in your courses on average. It is supposed to score you (usually on a GPA scale between 1.0 and 4.0) in your studies and show whether your overall grades have been high or low (Bacon & Bean, 2006).

As our applicants were from various parts of the world, the term GPA was not something they were all familiar with. Hence we translated their overall exam percentage or Cambridge International Examinations into a GPA format to provide a uniform assessment. We used Scholaro, GPA calculator, to convert the percentages and grades from around the world into GPA format.

The purpose of calculating GPA was to provide context of the participant's performance in school and to further assist our evaluation on their cognitive capabilities. According to Dr. Adebayo academic skills of pupils are affected drastically by language disorders(Adebayo & Mabuku, 2014). On that note, we decided to evaluate the cognitive skills of the participants based on GPA.

While pupils with low GPA for reasons other than language disorders might show strong resemblance to those with Receptive and Expressive Language Disorder,

patients but considering other factors we were able to estimate the number of candidates that were affected by TBI through the consideration of other indicators such as strong declines in their academic results.

Sports:

Sports were used as a variable to assess the outliers in our study. We asked the survey participants to share if they play one more of the sports from the following:
- Rugby/Football
- Soccer
- Hockey
- Basketball
- Wrestling
- Boxing

The above six sports are high contact team sports that result in TBI (Ling, Hardy, & Zetterberg, 2015). It is estimated that 1.7 to 3.8 million traumatic brain injuries occur each year in the United States, according to the CDC, of which 10 percent arise due to sports and recreational activities. Among American children and adolescents, sports and recreational activities contribute to over 21 percent of all traumatic brain injuries (Agarwal, Thakkar, & Than, n.d).

We evaluated the outliers by noticing that if they play one the following sports there is a high possibility of receiving TBI or a blow to the head that can lead to decrease in learning proficiency, ability of comprehension and ability of expression. Thus, this leads to the conclusion of having some intensity of Receptive or Expressive Language disorder.

The term outliers is being used to utilize this variable: sports, is that people are unable to identify a brain injury or trauma and as it was identified from the first survey

that participants had difficulty in remembering whether or not they had TBI. Most who reported a brain injury were those who had to visit either a hospital or get stitches etc. Therefore, those who had played one of the contact sports were expected to have received a brain injury. Thus, the outliers were considered in the range of developing Receptive and Expressive Language disorder. Other variables were considered to determine whether TBI caused Receptive and Expressive Language disorder.

Results:

The results were compiled by comparing the 4 variables while considering the role of TBI: age, learning proficiency, GPA and sports. 105 participants were taken into consideration and 5 were eliminated after discovering that they are unable to fit in one of the 4 variables. After this discovery we did not include their data in the results.

●

Table 1

Age Group	% of Participant's response
(10 - 13 years)	28%
(14 - 17 years)	44%
(18 - 21 years)	28%

Learning proficiency tests were combined, seeing the rating (1-5) 1 being excellent and 5 being worst.

- 15.7% of participants reported (1)
- 36.0% of participants reported (2)
- 28.8% of participants reported (3)
- 14.5% of participants reported (4)
- 5.0% of participants reported (5).

Table 2

Learning Proficiency
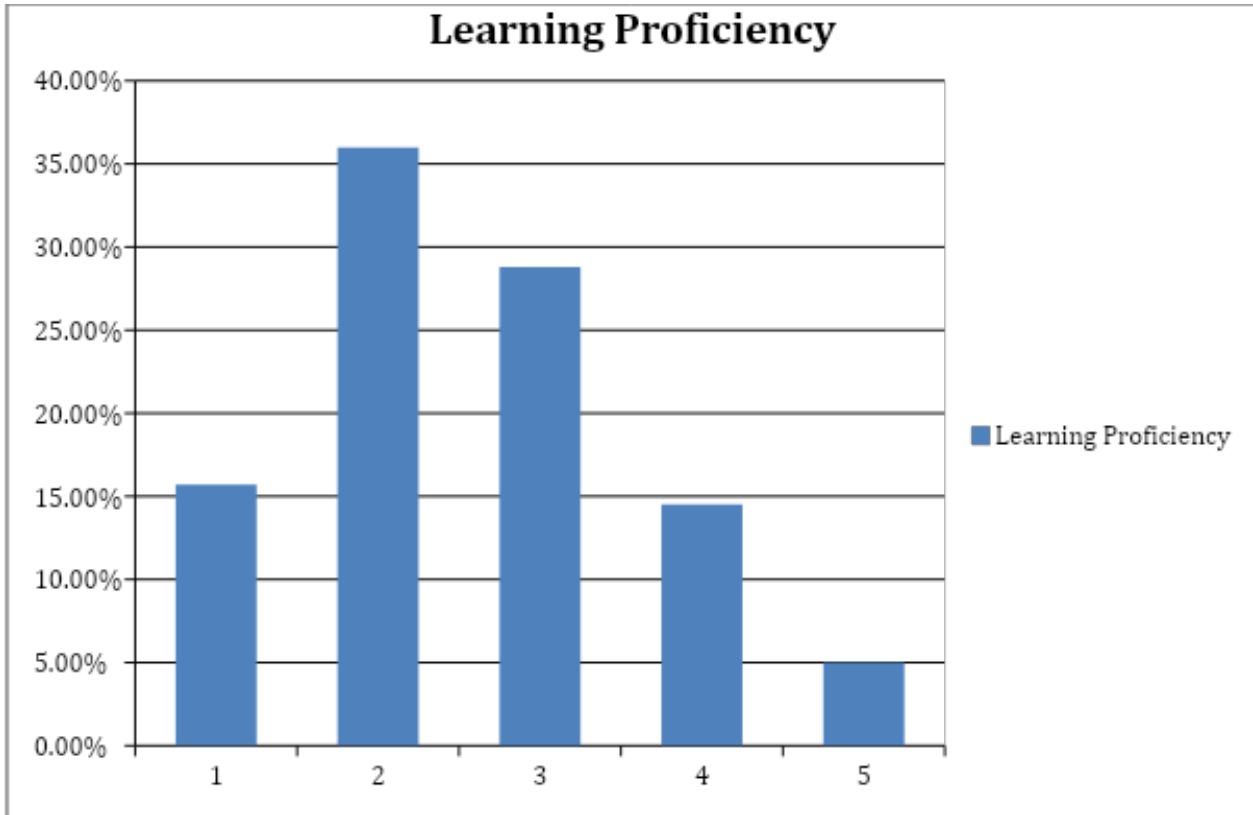
GPA self reporting was converted to the scale of (1.0 - 4.0). The result shows:

- 3% of (1.0)
- 18% of (2.0)
- 34% of (3.0)
- 45% of (4.0).

Table 3

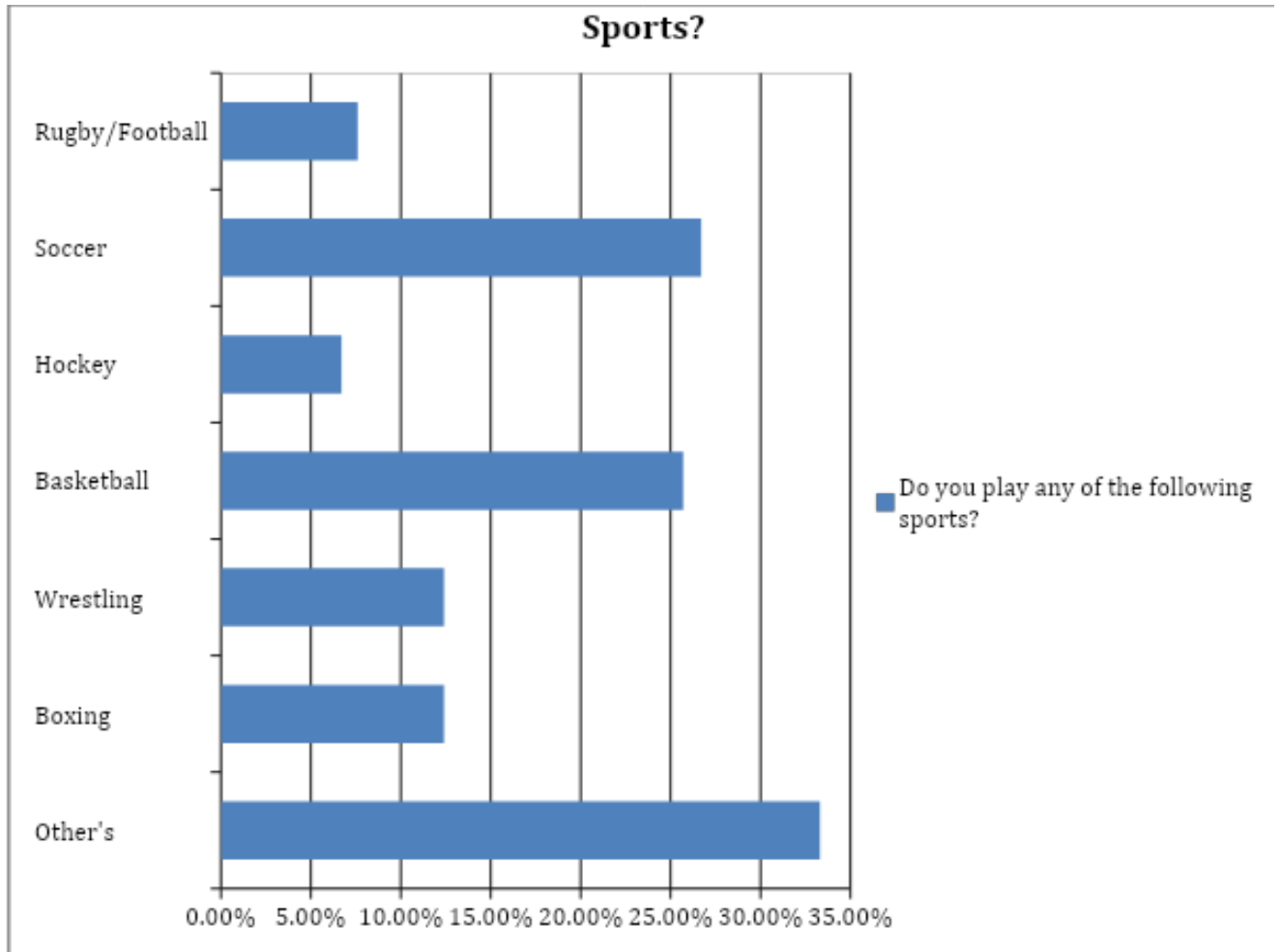| GPA	% of Participant's Response
1.0	3
2.0	18
3.0	34
4.0	45

Out of the 7 options of sports, 7th being the option of (other) the data shows:

- 7.6% of participants have played rugby/football
- 26.7% have played soccer

- 6.7% have played hockey
- 25.7% have played basketball
- 12.4% have played wrestling
- 12.4% have played boxing
- 33.3% have played others.

Table 4

Sports?

51% of the participants reported having head injury and the majority of the participants were between the ages of (10-13 years).

Table 5

Head Injury (hitting head with any solid object)
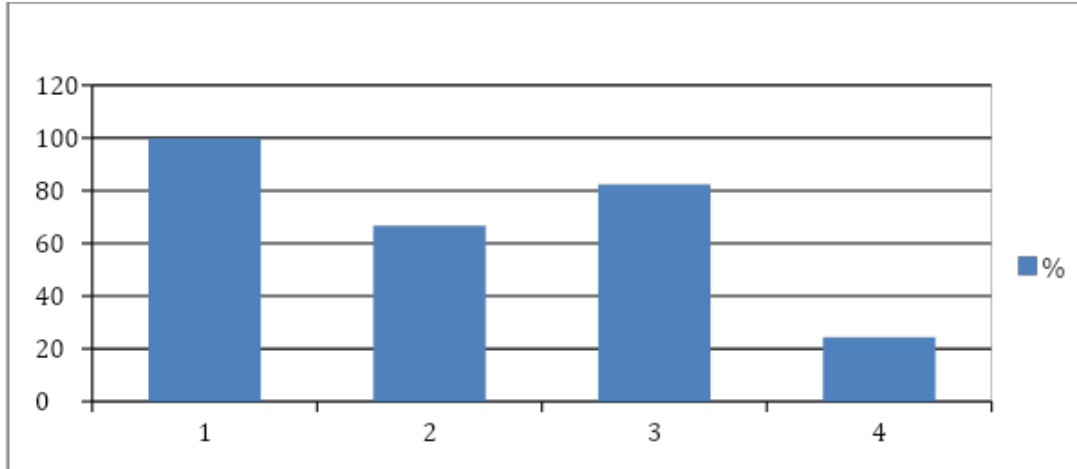
49%   51%

■ Yes
■ No
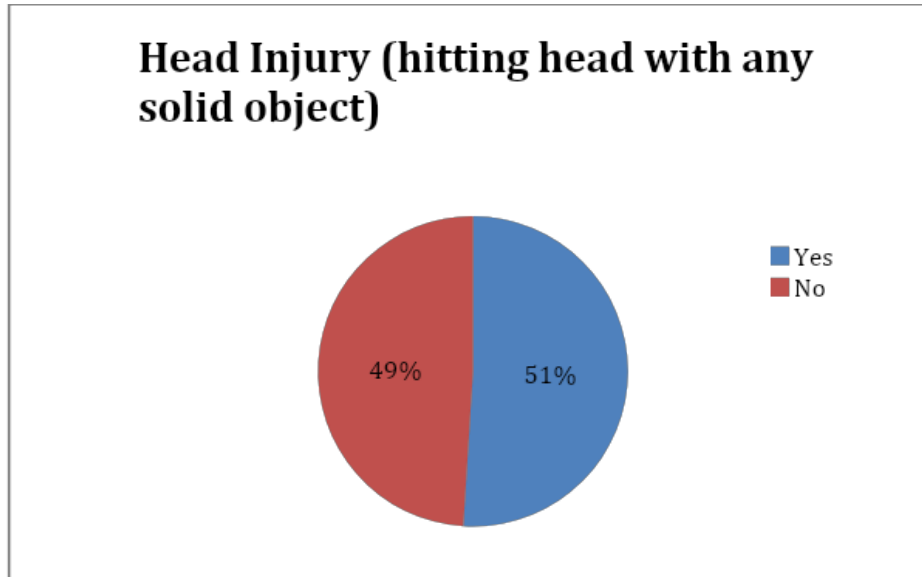
When TBI encounter was compared with the GPA, it was found out that 100% of participants with 1.0 GPA had encountered TBI, 66.7% participants with 2.0 GPA had encountered TBI, 82.4% participants with 3.0 GPA encountered TBI and 22.4% participants with 4.0 GPA had encountered TBI.

Table 6

| GPA	% of TBI Encountered
1	100
2	66.7
3	82.4
4	24.4

Table 7

When TBI encountered compared with scores on learning proficiency we observed the highest mean score was 2.5 on the basis of fluency, learning proficiency, effective thought process and ability to convey points. We observed the following results:

- 1-2 score 9.8% of the participants
- 2-3 score 35.3% of the participants
- 3-4 score 43.1% of the participants
- 4-5 score 11.8% of the participants

Table 8

Mean Score on Learning Proficiency	% of TBI Encountered
1 to 2	9.8%
2 to 3	35.3%
3 to 4	43.1%
4 to 5	11.8%

Table 9
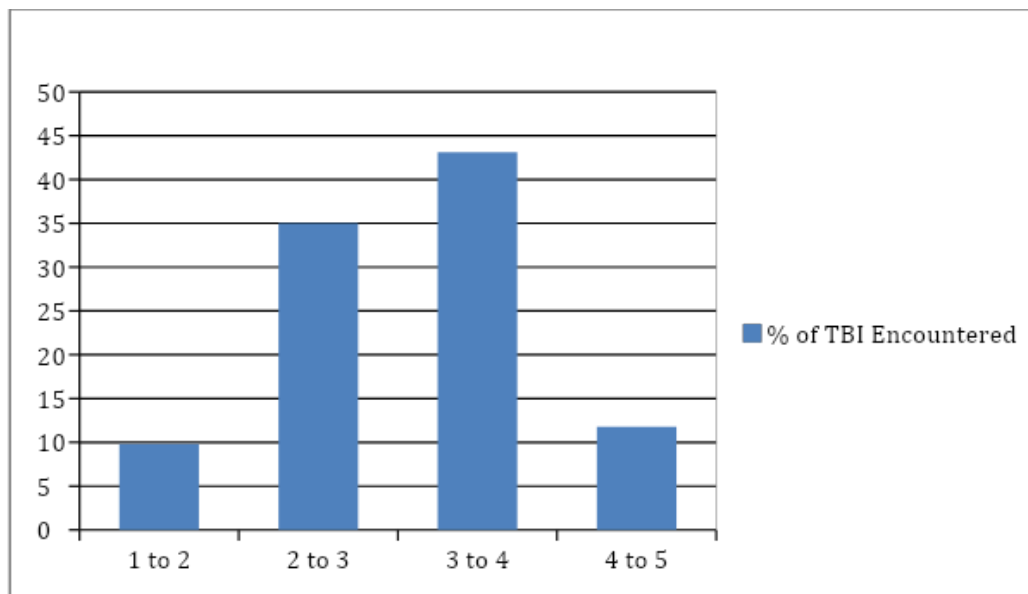
Limits:

The research faced some restrictions and obstructions. There 5 outliers reported backgrounds like homeschooling, no sports participation and being above the age of 21. This led to the removal of their data from the study. The conversion of GPA had slight accuracy issues as we had to convert the grading and percentages from different school systems to one uniform format. The course rigor was also not determined so it might show some spikes in GPA as we found 51% have encountered some form of brain injury while 45% of the participants had reported to have secured 4.0 GPA. Lastly, we were unable to determine the intensity of brain injury for individual participants.

Conclusion:

The results proved that age group and sports had a strong correlation as participants between ages (10-13 years) showed that 85% of them have received a TBI of some type. According to the study conducted by BMC Sports Science, Medicine and Rehabilitation: the maximum participation in sports is of age

groups (10-14years) (Eime, Harvey, Charity, Casey, Westerbeek, & Payne, 2016). Sports related TBI have proven to play a part in the development of Receptive and Expressive Language disorder.

According to our prediction for the relationship between TBI and GPA, we expected 1.0 to be 100% and 2.0 to around 70% but participants with 3.0 GPA showed a great spike which further speculates that maybe higher GPA doesn't indicate that a student, or a participant in this case, was suffering from Receptive and Expressive Language disorder as our study didn't include number of hours individual participant studied for each week.

According to our prediction for the relationship between mean learning proficiency rating and TBI,   we expected that around 60% of participants with TBI encounters will have proficiency tests between (3-5) which was approximately true as participants with scores between (3-5) were 54% as learning ability is a strong indicator of behavioral patterns indicated by (Psychol, 2013). We expected participants

with TBI encounters to show lower performance as it can help us indicate symptoms of Receptive and Expressive Language disorder. Our prediction was supported by our findings which further reinforces that TBI encounters are a determinant in decline in learning proficiency.

Our study communicates the role Traumatic Brain Injury (TBI) plays in development of Receptive and Expressive Language disorder in adolescents with sports and learning proficiency as strong indicators and age as a moderate indicator. Further research on GPA's connection with determination of Receptive and Expressive Language disorder is required. The experiment not only clarifies TBI's role in this disorder but also indicates the importance of these 3 variables in early diagnosis of this disorder. Moreover, further emphasis should be laid on spreading awareness of Receptive and Expressive Language disorder so that parents as well as education systems can detect and provide proper guidance to adolescents suffering from this disorder. Comprehension and Expression are basic rights that a human requires to live a normal life. We are optimistic that this disorder will be treated efficiently in the future and further advancements in personalized learning will provide a proper solution to treat this disorder.

Appendices:

Table 10

Age	% of TBI Encountered
10 to 13	85%
14 to 17	42.5%
18 to 21	32%

Table 11

% of TBI Encountered
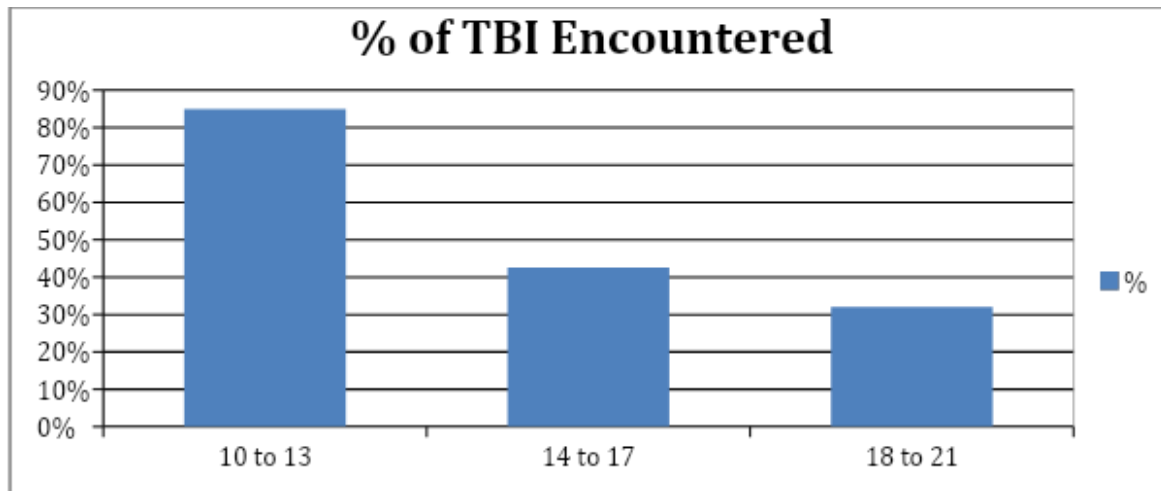
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